BMG Closure Project (Phase 1) Environment Plan

VIC/RL13

Decommissioning | BMG | EP

Document Control

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Table of Contents

List of Appendices

List of Figures

List of Tables

1 Introduction

Cooper Energy Limited (Cooper Energy) is the titleholder (100%) of Petroleum Retention Lease VIC/RL13 in the Gippsland Basin, located entirely within Commonwealth waters approximately 55 km southeast of the Orbost Gas Plant on the Victorian coast (Figure 1-1). VIC/RL13 includes the Basker Manta Gummy (BMG) subsea facilities.

This Environment Plan (EP) has been prepared to cover activities related to Phase 1 of the BMG Closure Project.

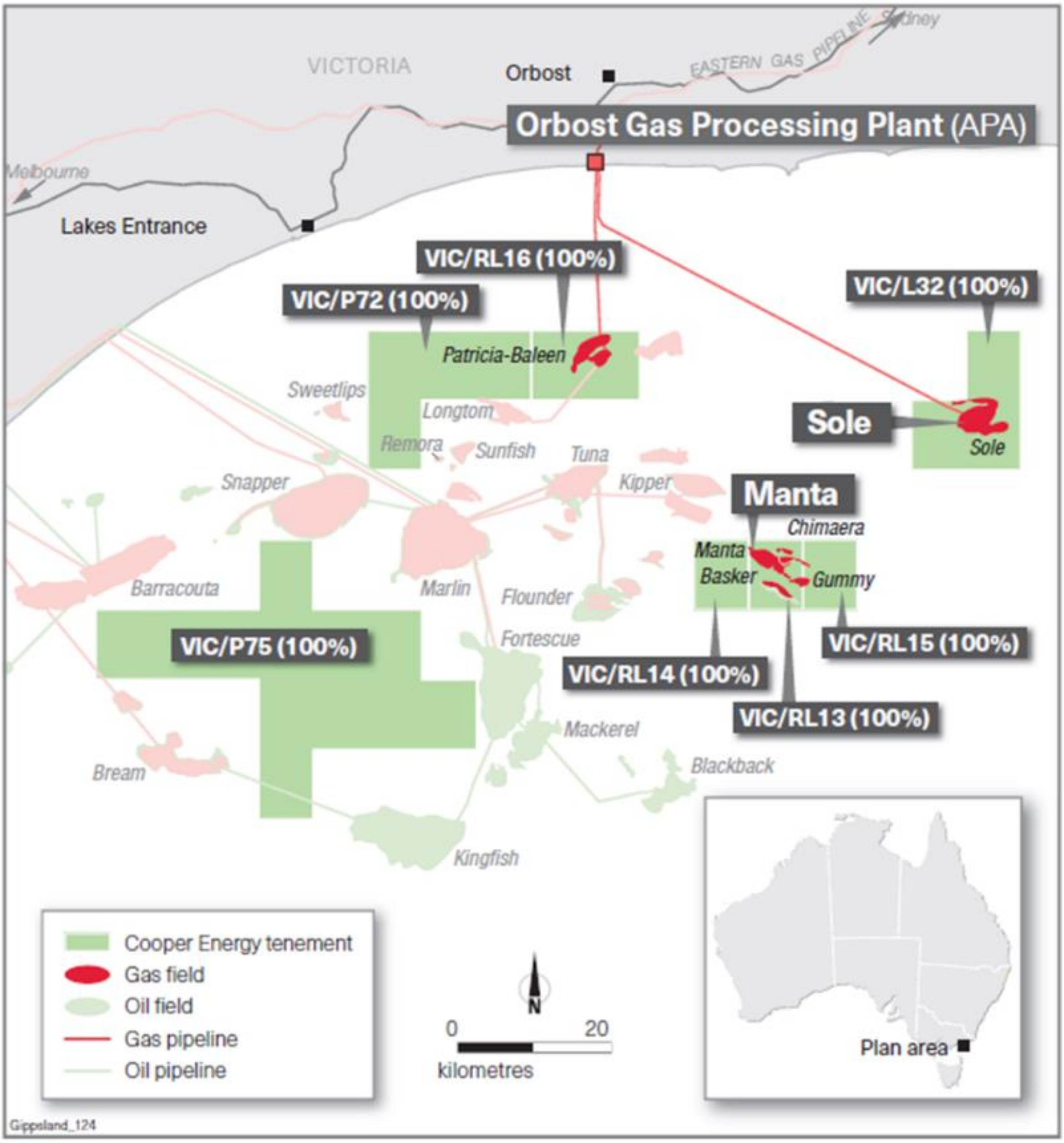


Figure 1-1 Location of Permit VIC/RL13

1.1 Environment Plan Summary

This BMG Closure Project (Phase 1) EP Summary has been prepared from material provided in this EP. The summary consists of the following (Table 1-1) as required by Regulation 11(4) of the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E)R).

Table 1-1: EP Summary of material requirements

EP Summary Material Requirement	Relevant Section of EP Containing EP Summary Material
The location of the activity	Section 3.1.2
A description of the receiving environment	Section 4
A description of the activity	Section 3
Details of the environmental impacts and risks	Section 6
A summary of the control measures for the activity	Section 8
A summary of the arrangements for ongoing monitoring of the titleholder's environmental performance	Section 9.12
A summary of the response arrangements in the oil pollution emergency plan	Refer to OPEP
Details of consultation already undertaken and plans for ongoing consultation	Section 10
Details of the titleholders nominated liaison person for the activity	Section 1.6

1.2 Background

Between 2005 and 2010, the BMG fields were operational and produced crude oil from seven subsea wells to a floating production storage and offloading unit (FSPO) and shuttle tanker. This production phase was known as Development Phase 1. Phase 2 was envisaged to involve an expanded development piggybacking onto Development Phase 1 facilities.

In November 2010, ROC Oil (the then Titleholder) and joint venture partners (JVPs) determined that BMG production under its current operational configuration was not commercially viable, and a decision was taken to enter a non-production phase (NPP), pending a decision for the future Phase 2 development.

In 2011, to prepare for the NPP, the BMG subsea facilities (wells and subsea infrastructure) were shut-in, depressurised, flushed, and preserved with inhibited water. The mooring system and mid-water equipment were removed in 2012, and the flowline and umbilical were trenched to facilitate reduction of the petroleum safety zone (PSZ). The following PSZs remain around the facilities including the wells (as per Gazette notice A443819); shown in Figure 3-1:

- A distance of 500 metres, around the Basker-Manta-Gummy Field Infrastructure,
- A distance of 360 metres, around the Basker-6 wellhead; and
- A distance of 300m around the exposed flowlines.

The BMG titles and facilities were acquired by Cooper Energy in 2014, during the NPP. Cooper Energy plans to develop gas reserves from the Manta Field. The most likely future development concept for Manta involves new subsea gas wells and production equipment tied back to shore. The existing BMG architecture and layout was designed specifically around the production of the fields oil reserves via an FPSO, and is not considered suitable for reuse as part of a future Manta gas development. Any future development of the Manta gas reserves would be covered by a separate EP.

Accordingly, Cooper Energy intends to decommission the remaining BMG oil production infrastructure (Section 3), in two phases:

- Phase 1a – Facility cleaning, preparations and well abandonment (covered under this EP).
- Phase 1b – Removal of structures, flowline spools and flying leads depending on progress with well abandonment (covered under this EP).
- Phase 2 – Decommissioning of flowline, umbilicals and any remaining equipment not removed in Phase 1 (to be covered under a separate EP).

The plug and abandonment of the wells was originally planned in 2018 and an EP providing for the activity was accepted by NOPSEMA in 2018 (BMG-EN-EMP-0002 / NOPSEMA Reference A682731). The 2018 campaign was cancelled prior to MODU arrival due to the non-acceptance of a separate regulatory approval (Well Operations Management Plan) and the EP was subsequently closed.

Well abandonment plans have now been revised and a new methodology progressed in consultation with the regulator. In parallel to this planning process, NOPSEMA issued General Direction 824 to Cooper Energy on 1 September 2021 (Sections 2.1.1.1 and 2.1.1.2).

1.3 Purpose

This EP has been prepared to demonstrate how the proposed petroleum activities at BMG will be managed to meet the requirements of the Commonwealth OPGGS (Environment) Regulations 2009 (OPGGS (E) Regulations), administered by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA). Its development has been guided by N-04750-GN1344 Environment Plan Content Requirements (NOPSEMA, 2020).

The EP also serves to outline how matters related to Direction 824 and Sections 571 and 572 of the OPGGS Act 2006 will be addressed.

Refer to Appendix 1 for full list of relevant legislation and requirements addressed within this EP.

1.4 Scope

Cooper Energy has developed this EP to manage the environmental impacts and risks associated with the Phase 1 activities. Activities included in the scope of this EP are described in Section 3.

This EP also provides for emergency (oil spill) response activities including for worst case spill scenarios.

Activities excluded from the scope of this EP are:

- Property inspection and maintenance provisions during NPP which are already provided for within the existing Gippsland Operations EP (VIC-EN-EMP-0002);
- Decommissioning of flowlines and umbilicals (to be covered under separate Closure Project (Phase 2) EP under development);
- Planned activities beyond the operational area including onshore activities and vessels transiting to or from the Operational Area (as defined in Section 3.1.2). Vessels in transit are deemed to be operating under the *Commonwealth Navigation Act 2012* and not performing a petroleum activity, and are therefore not within the scope of this EP.
- Future appraisal / development of the Manta gas reserves.

1.5 BMG Development History

VIC/RL13 was acquired by Cooper Energy from the previous JVP in 2014. With the acquisition came the BMG facilities, which at that point were in an NPP and had been partially deconstructed (Section 1.5.3). A summary of the BMG development history is provided in Table 1-2, with further details in subsequent sections, providing context for the broader decommissioning work, technical challenges, and schedule.

Table 1-2 BMG Field Development Phases

Development Phase		Timing	Activities
Production Phase	Extended Production Test (EPT)	2005 – 2006	Basker-2 oil production well with associated gas flared.
	Full Field Development (FFD)	2006 – 2008	Basker-2, 3, 4, 5 and Manta-2A oil production wells with gas-lift and gas re-injection.
	Oil Development Phase 2 (ODP2)	2008 – 2010	Basker-6 (ST1) oil production well and tie back to the Basker Manifold (BAM).
			Work-over of Basker-3 and Basker-5. Drilling and completion of Basker-7 well and tie back to the BAM.
	Flare Gas Compressor Project	2010	Re-injection of flare gas: installation of one, two stage screw compressor to the FPSO process module, starboard side.
Cessation Phase		2011-2012	Production stopped. Facilities are shut in. Vessels are removed. Moorings and midwater equipment is decommissioned and removed.
Non-Production Phase (NPP)		2012 – present	Routine offshore inspections with ROV. Cooper Energy take ownership in 2014.
Decommissioning Phase		Circa 2023 to 2026	Per Section 572 of the *OPGGS Act*, the base case for decommissioning the BMG facilities is to remove all infrastructure.

Development Phase	Timing	Activities
Future appraisal and development Phase	From 2023	Appraisal and development of Manta gas reserves in accordance with title activity plans and conditions.

1.5.1 Production Phase

Phase timing: 2005 to 2011

Phase description: Production from the BMG Development commenced in 2005 utilising an FPSO facility, the Crystal Ocean and a shuttle tanker, the Basker Spirit. Initially production was from the Basker-2 (B2) production well via a production flowline and control umbilical. The development was expanded with a series of additional subsea wells (B3, B4[1], B5, B6, B7 and Manta-2A (M2A)). Production from the Basker wells was accumulated via the Basker-A Manifold (BAM); Manta was produced directly to the FPSO. The subsea production system was tied into the FPSO via a Disconnectable Turret-Mooring (DTM) arrangement.

The shuttle tanker would periodically detach from a Single Point Mooring (SPM) and leave the field to deliver crude to onshore refineries.

1.5.2 Cessation Phase

Phase timing: 2011 to 2012

Phase description: In November 2010, a decision was made by the BMG JVP to commence field preparations for NPP. This (production cessation) phase involved the following activities:

- Depressurisation, flushing and flooding (with inhibited water) the subsea flowline system
- Removal of FPSO and Shuttle Tanker, DTM, SPM and respective mooring systems from the field
- Removal of the FPSO to shuttle tanker crude export flowline.
- Disconnection and removal of midwater elements (e.g., risers / sections of flowlines from FPSO to midline connections on the seabed) with pressure (gas) vented subsea
- Debris clearance campaigns, seabed / facility surveys; and
- Stabilisation of the B6 6-inch flowline and B6 umbilical by trenching below the seabed; this enabled a reduction in the size of the facility PSZ, making a section of the B6 flowline and umbilical route accessible to fisheries. The areas excised from the PSZ has since seen an increase in fishing activity (SETFIA 2020).

The remaining facilities and their as left status are described in Table 1-3.

Table 1-3 BMG Facility As-left Status (Cessation Phase)

Facility Component	As left status
Subsea wells	**Barriers** • All completed wells are shut-in with at least two independent mechanical barriers confirmed and tested (to API 14 B) on both the tubing and annulus sides of all wells; • Subsurface safety valves (SSV) and valves on the wellheads were verified closed except at B5, where the production master valve (PMV) could not be closed following well intervention due to expected cement; however multiple barriers including isolation of the reservoir with three (3) cement plugs remain in the well; • Chemical isolation valves on chemical supply lines were closed and lines tested; and • Hydraulically actuated down-hole Interval Control Valves (ICVs) were closed except at B2, noting these valves are not considered a well barrier. **Annulus** • The annulus of each of B2, B3, B7 and M2A were partially topped up during cessation with inhibited seawater. The annuli of B4, B5 and B6 contain inhibited completion brine; and

[1] Basker 4 (B4) well was a gas injection well. All other wells were oil producers.

Facility Component	As left status
	• Annulus chemical injection (ACI) ROV operable completion isolation valves (CIV) were closed on wells, except B6 and B7 which do not have ACI. **Control lines** • Downhole control lines (where present) vented at surface and the ROV operable CIV on the subsea tree were closed; and • Long term storage plates were installed on the subsea Xmas tree bridging plates to prevent potential gas leaking via the control lines and the Subsea Control Manifold (SCM) high pressure vent. All wells except B5.
Manifold and Flowlines	• All gas was vented from pipework downstream of well wing valves. Project records indicate gas was vented subsea; • Flowlines were flushed several times (three selected as minimum) and the flush water monitored for hydrocarbon content. Flushing ceased when hydrocarbon concentrations in the flush water asymptote at 30ppm or less; • The B6 flowline was displaced to inhibited water via chemical injection umbilical in 2009. A total of 125m^3 of inhibited water displaced the 100m^3 flowline (ROC, 2010). Due to flow rate limitations during flushing associated with the chemical injection skid, it is believed that pockets of diesel (up to 2.3 m^3), wax and residual pour point depressant may remain within the PS-B6 flowline; • Vented and flushed pipe work was displaced with inhibited, depressurised freshwater; • Flowline isolation valves were closed and where practicable tested, and a rated blind was placed on the end of the Basker Production, Basker Gas Injection and Manta Production lines where they once connected to the FPSO; • Some level of pressurisation of the flowline system is expected, accounting for standard leakage rates across system valves; and • Spools, risers and flying leads not removed were laid on the seabed.
Umbilicals	• Displacement of umbilical chemical injection service lines with uninhibited freshwater. The umbilical service control lines were left filled with control fluid. Some of the B6 umbilical cores also contain a pour point depressant chemical used during production to enhance flow of B6 production fluids; • The service control lines to the SSSV and CIV have been left filled with control fluid; and • Other chemical injection service lines have been displaced with uninhibited freshwater and capped with long term storage plates.

1.5.3 Non-Production Phase (NPP)

Phase timing: 2012 to present day.

Phase description: All remaining flowlines (production, gas-lift, and gas reinjection), service chemical and control umbilicals were left connected (i.e. fixed) to existing equipment (trees/manifold) following cessation. Section 3.2 provides the description of remaining facilities.

1.5.3.1 Asset integrity management during NPP

Cooper Energy has processes in place to ensure the integrity of assets through all phases of life, from initial concept through to final decommissioning. The BMG Offshore Facilities Integrity Management Plan (BMG-IR-IMP-0001) describes how Cooper Energy manages integrity of the BMG assets whilst in NPP (Section 9.2). The existing Gippsland Operations EP provides for NPP activities including offshore inspection and integrity maintenance.

During the NPP phase Cooper Energy have undertaken studies to inform the technical considerations for decommissioning. These studies include:

- Technical considerations for decommissioning of the B6 flowline and umbilical (17-033-RP-002).
- Technical considerations for decommissioning of subsea infrastructure at BMG (17-033-RP-001).
- BMG Field Decommissioning Comparative Assessment (BMG-EN-REP-0019 Rev A).

The studies assess equipment status and describe options for decommissioning end states with full removal as the base case. The technical studies 17-033-RP-001/002 identify the asset integrity aspects to be addressed in an extended NPP phase: inspection, CP life assessment and retrofit of anodes (if necessary). These integrity considerations during NPP are accounted for within the BMG Offshore Facilities IMP.

Performance Outcomes, Standards and control measures related to BMG facility asset integrity management during the well plug and abandonment (P&A) program are provided in Table 8-1.

1.5.3.2 Asset inspections and condition

During the NPP Cooper Energy have been planning the decommissioning of the facility. Planning as well as facility maintenance during this phase has involved multiple offshore inspection campaigns to confirm equipment status and integrity. The BMG Offshore Facilities IMP includes a log of asset condition over time and includes data gathered during offshore inspections. Seven inspection campaigns have been undertaken at the BMG asset since production cessation. The most recent inspection at BMG (2020) delivered the following findings (VIC-SS-REP-4900-0001):

- No significant debris observed, and no obvious damage, distortion, or new displacement of structural or line assets, although some protective caps on structure intervention points were found to be missing or dislodged;
- No significant corrosion observed, in general anodes were estimated at less than 40% depleted and mostly less than 30% depleted (i.e., 75% remaining). All observed anodes were active, with obvious oxide layers;
- In general, Cathodic Protection (CP) readings on structural steel ranged from -906mV to -992mV, with average -955mV indicating well protected steel. M2A had slightly lower readings (-921mV average) than the field average, but still well protected;
- No significant scour was observed at or around structural assets;
- Flying leads between structures generally were partially buried with original/earlier, small stabilisation bags in place, lightly sand-covered but visible;
- The 6” flowline between the B6 drill centre and the main Basker-A drill centre was almost totally buried over its length with no effective spans. Likewise, the B6 umbilical from Basker-A was mostly buried, other than at its mid-line Umbilical Termination Assembly (UTA) interconnections, with the only spans being the catenaries down from end fittings on its UTAs (max = 15.8 m at UTA-3 exit);
- All other flowlines and umbilicals were mostly partially buried, typically to greater than 75% of diameter, interspersed with minimal lengths of full burial and intermittent short spans; and
- Small bubbles observed at the B2 tree Crossover Valve (XOV) spool elbow block (Figure 1-2), similar size and rate to previous years inspections as detailed within existing regulatory plans.

Figure 1-2 Basker-2 Well Bubble Observation (2020)

Risk reviews considering the internal status of the subsea wells have also been undertaken through the NPP phase. A corrosion assessment (BMG-DC-STU-0001) has been completed to evaluate the level of corrosion to the wells during the NPP. Based on the study results there is no significant integrity risk for the BMG wells related to tubing and corrosion by the end of NPP.

1.5.4 Decommissioning Phase (Planned)

Decommissioning of the BMG facilities is managed as a dedicated project. Cooper Energy uses a gated process to plan and execute projects; the process workflow is divided into five phases (Figure 1-3). Each phase is subject to assurance processes and a gate review, the outcomes of which include continue, stop, hold, or recycle.

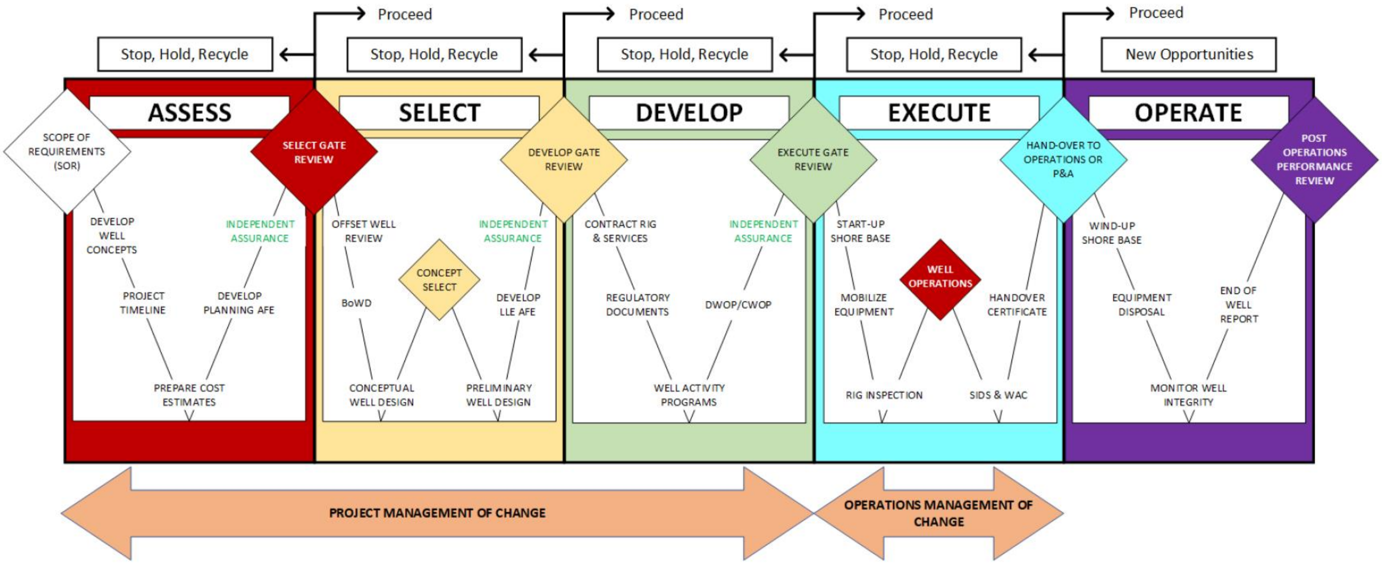


Figure 1-3 Well Engineering Project Workflow

Phase timing: circa 2023 to 2026

Phase description: Under Section 572 of the OPGGS Act, the base case for decommissioning the BMG facilities is to remove all infrastructure. Table 1-4 outlines the base decommissioning cases and alternatives currently being evaluated.

Table 1-4 BMG facility decommissioning end-states under consideration

Facilities	Planned end state	Alternatives under consideration
Subsea production wells	Permanently seal subsurface reservoirs Removal surface well equipment	None
Major structures	Removal	None
Umbilical flying leads	Removal	None
Flowline Jumpers	Removal	None
Auxiliary structures	Removal	None
Flowlines **Umbilicals**	Removal Options include cut & lift, lift & cut, reverse reel	In-situ decommissioning including the following remediation options: - trench full length of lines - rock cover full length of lines - rock cover spans / exposures - trench spans / exposures

		- remove ends / remediate snag risk - no intervention

Decommissioning of the BMG facilities will involve the following phases, with timings planned to align with that required by General Direction 824 (Table 2-2):

- Phase 1 (this EP)
  - Seabed and facility inspection and preparatory activities;
  - Plugging and abandonment of all wells to permanently isolate the production zones (by end 2023)
  - Removal of structures on the seabed, flowline jumpers and flying leads; and
- Phase 2 (to be covered by a separate EP)
  - Decommissioning of flowlines and umbilicals and any other remaining equipment via full removal (base case) or alternative in-situ option subject to regulatory acceptances (by end 2026). This will be undertaken as a separate campaign following well P&A.
  - Screening studies for full removal of the flowlines and umbilicals have been undertaken and indicate removal via reverse reeling, lifting, and cutting, or cutting then lifting are possible accounting for the design and condition of equipment (17-033-RP-001, 17-033-RP-002, BMG-EN-REP-0018).

Figure 1-4 provides an overview of the BMG decommissioning schedule showing indicative timing of project regulatory submissions and supporting environmental studies. The decommissioning timings provided here supplants the indicative timings provided within existing Environment Plans for the BMG NPP activities (Gippsland Operations EP).

Further details of the decommissioning activities provided for under this EP are found in Section 3.

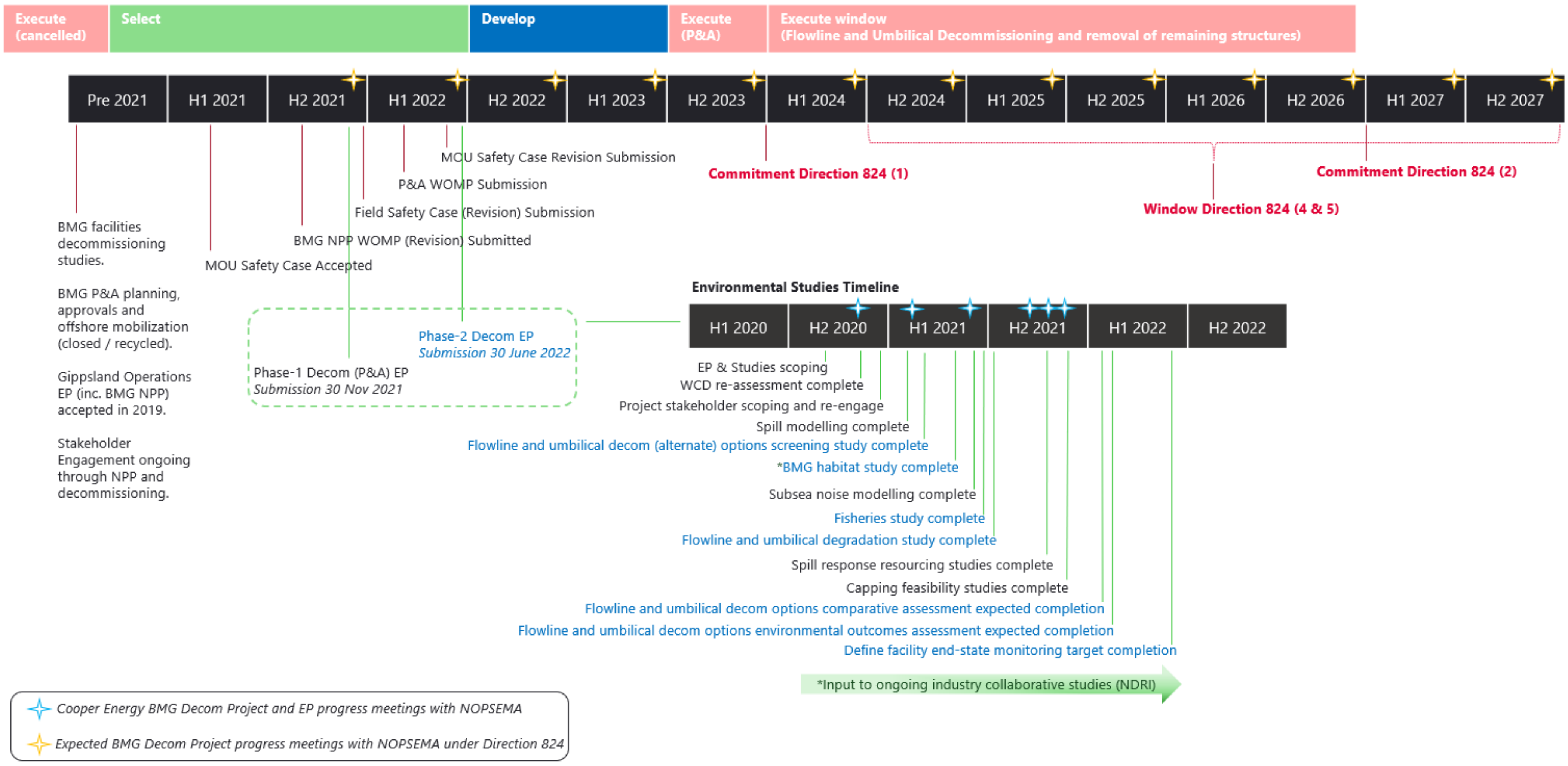


Figure 1-4 BMG decommissioning schedule showing indicative regulatory submission timings

1.5.5 Future appraisal and development

Phase timing: From 2023

Phase description: Appraisal and development of Manta gas reserves in accordance with recent title activity plans and conditions.

Future phases of the BMG development were envisaged by the previous JVP to involve the recovery of additional reserves by utilising the existing BMG subsea infrastructure. At the time of cessation, the equipment left on the seabed was considered by the JVP to be suitable for reuse in field (per BMG Non-Production Phase EP [BMG-EN-EMP-0001]).

Cooper Energy acquired the BMG title interests in 2014 with plans to develop gas reserves from the Manta Field. The most likely development concept for Manta involves new subsea gas wells and production equipment tied back to shore either directly or via an existing subsea tieback facility. The current BMG architecture and layout was designed around the production of oil reserves via an FPSO and is not considered suitable for reuse as part of the current Manta gas development concept.

Any future development of the Manta gas reserves would be covered under a separate EP.

1.6 Titleholder Details

In accordance with the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E)R) Regulation 18(2), Table 1-5 provides the details of titleholders and liaison person for the VIC/RL13 retention lease where the petroleum activity will take place.

If the titleholder's nominated liaison person or contact details for the nominated liaison person changes, Cooper Energy will notify the Regulator in accordance with Regulation 15(3) of the OPGGS(E)R.

Table 1-5 Details of Titleholder and Liaison Person

Titleholder	Titleholder Details	Liaison Person
Name: Cooper Energy Limited **ABN:** 93 096 170 295 **Lease:** VIC/RL13	**Address:** Level 8, 70 Franklin Street, Adelaide, 5000 **Telephone Number:** (08) 8100 4900	Mike Jacobsen General Manager Projects and Operations Cooper Energy Limited Level 15, 123 St Georges Tce, Brookfield Place Tower 2, Perth, WA, 6000 **Phone:** (08) 8100 4900 **Email:** mike.jacobsen@cooperenergy.com.au

2 Requirements

This section provides information on the requirements that apply to the petroleum activity described in the EP, including relevant laws, codes, other approvals and conditions, standards, agreements, treaties, conventions, or practices (in whole or part) that apply to jurisdiction/s in which the activity takes place.

The proposed activity is located within Commonwealth waters off the Victorian coast. Planned petroleum activities undertaken in this area are regulated by Commonwealth legislation, primarily under the Offshore Petroleum and Greenhouse Gas Storage (OPGGS) Act 2006 and associated regulations.

Table 2-1 details the requirements of the OPGGS (Environment) regulations, and the corresponding section of this EP.

On the basis that a worst-case credible oil spill has the potential to intersect state and Commonwealth waters, a summary of Commonwealth, Victorian, Tasmanian, NSW and Queensland requirements and any codes or guidelines applicable to the activity is provided in Appendix 1.

Table 2-1 Requirements of the OPGGS(E) Regulations

OPGGS(E) Regulations	Description	Document Section
13 (1)	A description of proposed activities	Section 3
13 (2) and (3)	A description of the existing environment including details of the particular relevant values and sensitivities (if any) of that environment that may be affected by the activity including details of matters of National Ecological Significance (NES) as outlined under Part 3 of the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).	Section 4
13 (4), 14 (10)	An overview of the environment legislation applicable to the proposed activities and a demonstration on how they are met.	Section 2 (this section)
13 (5) and (6)	An identification and evaluation of environmental risks of described activities and details of control measures that will be used to reduce impacts and risks to as low as reasonably practicable (ALARP) and an acceptable level, for both planned and unplanned activities.	Section 6 and Section 7
13 (7)	The environmental performance outcomes, standards and measurement criteria that apply to both planned and unplanned activities.	Per aspect Section 6 and Section 7 (Summarised Section 8)
14 (1) and (2)	An appropriate implementation strategy including routine reporting arrangements to the Regulator in relation to environmental performance.	Section 9
14 (3)	A description of the environmental management system and measures to ensure that impacts and risks are continually identified and reduced, control measures are effective in reducing impacts and risks, and that performance outcomes and standards are being met to as low as reasonably practicable.	Section 9
14 (4) and (5)	Details of role and responsibilities of personnel in relation to implementation, management, and review of this EP, including measures to ensure personnel are aware of their responsibilities	Section 9.4
14 (6), 26C	Details of monitoring, recording, auditing, management of non-conformance and review of environmental performance and the implementation strategy.	Section 9.12
14 (7)	Details of monitoring and maintenance of quantitative records for emissions and discharges.	Section 9.12.1
14 (8)	Details of the Oil Pollution Emergency Plan (OPEP), provision for its updating, inclusion of arrangements for monitoring and responding to oil pollution and details of testing of the plan.	Section 7 and Section 9.6.2
N/A	An environmental emergency response manual that describes emergency response arrangements, is maintained, kept up to date, and tested	OPEP
16I, 26A and B	Details of reportable incidents in relation to the activity, procedures for reporting and notifying reportable and recordable incidents.	Section 9.11

OPGGS(E) Regulations	Description	Document Section
11A, 14 (9) and 16 (b)	Details of stakeholder consultation that has been undertaken prior to, and during preparation of the EP, including all correspondence.	Section 9
15 (1), (2) and (3),	Details of the titleholder and an appropriate nominated liaison person, including arrangements for notifying the Regulator should this change.	Section 1.6
16 (a)	Details of the titleholders' environmental policy.	Section 2.3.1
25(a)	Details of titleholder notification requirements at end of activity.	Section 1.6

2.1 Commonwealth Legislation

The Operational Area is located entirely in Commonwealth waters. Legislation relevant to the Commonwealth and this activity is listed in Appendix 1.

2.1.1 OPGGS Act 2006 and OPGGS(E) Regulations 2009

The OPGGS Act addresses all licensing, health, safety, environmental and royalty issues for offshore petroleum exploration and development operations extending beyond the 3 nm limit. The OPGGS(E)R specify the requirements to manage the environmental impacts of petroleum activities. Key to these regulations is the submission of an EP to the regulatory authority (NOPSEMA) for acceptance prior to commencing the proposed activities.

Section 572 of the OPGGS Act describes the requirement for titleholders to maintain all structures, equipment, and property in a title area in good condition and repair, and to remove property when it is neither used nor to be used in connection with operations authorised by the title. NOPSEMA guidance note "Section 572 Maintenance and Removal of Property" (N-00500-PL1903 Rev A, April 2020) outlines NOPSEMA's compliance oversight and enforcement of Section 572. This EP has been prepared to describe the removal of property and compliance with the obligations described in Section 572 of the OPGGS Act where relevant to the activity.

2.1.1.1 General Direction 824

In September 2021 NOPSEMA issued a General Direction under Section 574 of the OPGGS Act in relation to the BMG Facilities. The Schedule of directions, and the relevant permissioning documents are outlined in Table 2-2.

Performance Outcomes, Standards and control measures related to General Direction 824 are provided in Table 8-1.

Table 2-2 General Direction 824: Directions and relevant plans

Direction	Schedule 1 – Directions	Relevant Plans
1	Plug or close off, to the satisfaction of NOPSEMA, all wells made in the title area by any person engaged or concerned in operations authorised by the title as soon as practicable and no later than 31 December 2023.	BMG Closure Project (Phase 1) EP [this document]
2	Remove, or cause to be removed, to the satisfaction of NOPSEMA, from the title area all property brought into that area by any person engaged or concerned in the operations authorised by the title as soon as practicable and no later than 31 December 2026.	BMG Closure Project (Phase 1) EP [this document]
3	Until such time as direction 1 and 2 are complete, maintain all property on the title to NOPSEMA's satisfaction, to ensure removal of property is not precluded.	BMG Closure Project (Phase 1) EP [this document] Gippsland Operations EP (VIC-EN-EMP-0002) BMG Facility Integrity Management Plan (BMG-IT-IMP-0001. BMG Well Operations Management Plan.

Direction	Schedule 1 – Directions	Relevant Plans
4	Provide, to the satisfaction of NOPSEMA, for the conservation and protection of the natural resources in the title area within 12 months after property referred to in direction 2 is removed.	BMG Closure Project (Phase 2) EP
5	Make good, to the satisfaction of NOPSEMA, any damage to the seabed or subsoil in the title area caused by any person engaged or concerned in those operations within 12 months after property referred to in direction 2 is removed.	BMG Closure Project (Phase 2) EP
6	Annual Progress reporting until all directions have been met.	BMG Closure Project (Phase 1) EP [this document] BMG Closure Project (Phase 2) EP

2.1.1.2 Matters to be addressed (permissioning documents)

In September 2021 NOPSEMA issued a list of matters to be addressed in relation to Policy 572 and Direction 824 for the BMG assets within permissioning documents. Table 2-3 describes how these matters have been addressed within this plan, or will be addressed within future plans.

Table 2-3 Matters to be addressed (permissioning documents)

Item	Matters to be addressed	How / where addressed		
		Gippsland Operation EP (accepted)	BMG Closure Project (Phase 1) EP (this EP)	BMG Closure Project (Phase 2) EP
A	Description of all property brought onto the title, including its current status and condition.	The Gippsland Operations EP provides for the non-production phase of the BMG facilities. The EP provides a description of the facilities and links to the asset integrity management plan (IMP) which provides a detailed inventory of all property.	The BMG Closure Project (Phase 1) EP includes a description of all property at BMG and provides an overview of status and condition.	The BMG Closure Project (Phase 2) EP will include a description of all property at BMG and an overview of status and condition.
B	Description of the activities associated with the plugging or closing of wells and removal of remaining property from the title area to meet the requirements of s 572(3) and the General Direction 824 to NOPSEMA's satisfaction.	N/a	The BMG Closure Project (Phase 1) EP provides for plugging of wells and removal of structures. Specifically, to meet the requirements of s 572(3) and Direction 1 of General Direction 824 as soon as practicable and by no later than 31 December 2023.	The BMG Closure Project (Phase 2) EP will provide for the decommissioning of remaining equipment including any alternate end states. Specifically, to meet the requirements of s 572(3) and Direction 2 of General Direction 824 as soon as practicable and by no later than 31 December 2026.
C	Description of the planning processes and timetable of activities to support decommissioning. In particular, the fate of all property on the title, proposed decommissioning methodology, scope of work and execution strategy.	The Gippsland Operations EP describes the indicative decommissioning dates for the BMG facilities. These dates are superseded by General Direction 824 and the dates outlined within the decommissioning activity EPs.	BMG Closure Project (Phase 1) EP includes description of the planning process and timetable for decommissioning of BMG facilities, with reference to the BMG Closure Project (Phase 2) EP for the remaining scope. The BMG Closure Project (Phase 1) EP includes a description of the fate of all property within the scope of the EP, the proposed decommissioning methodology, scope of work and execution strategy. This description will supplant details within the Gippsland Operations EP once the BMG Closure Project (Phase 1) EP is accepted.	BMG Closure Project (Phase 2) EP will include description of the planning process and timetable for decommissioning the remaining BMG facilities post Phase-1. The BMG Closure Project (Phase 2) EP will include a description of the fate of all property, proposed decommissioning methodology, scope of work and execution strategy.
D	Provision of the schedule of activities including submission of permissioning documents to support decommissioning.	N/a	BMG Closure Project (Phase 1) EP schedule of activities includes all decommissioning activities and permissioning documents.	BMG Closure Project (Phase 2) EP schedule of activities to include schedule of all decommissioning activities and permissioning documents.
E	An evaluation of all impacts and risks from the decommissioning activities to	N/a	The BMG Closure Project (Phase 1) EP provides for plugging of wells and removal of structures. BMG /	The BMG Closure Project (Phase 2) EP will provide for the decommissioning of remaining equipment, including any alternate end states. BMG / activity

Item	Matters to be addressed	How / where addressed		
		Gippsland Operation EP (accepted)	BMG Closure Project (Phase 1) EP (this EP)	BMG Closure Project (Phase 2) EP
	demonstrate they are managed to acceptable levels and as low as reasonably practicable (ALARP).		activity specific studies integrated into the EP that support the evaluation of impacts and risks include: • Existing Environment. • Subsea noise modelling. • Subsea Noise adaptive management plan. • Worst case discharge assessment. • Oil spill modelling. • Spill response resourcing. • Subsea dispersant study. • Expansion of OSMP. • Capping feasibility study. An activity specific OPEP has been drafted for the P&A activity (BMG Closure Project (Phase 1) OPEP), noting the spill scenario for P&A differs significantly in nature and scale compared to NPP scenarios and Phase-2 decommissioning scenarios. Stakeholder engagement (informing the assessment) has also been undertaken for the P&A and structure removal scope inclusive of State government engagement on the OPEP.	specific studies completed or underway relevant to this scope includes: • Habitat Study undertaken by Deakin University and AIMS. • Fishing type and intensity study by SETFIA. • Flowline and umbilical decommissioning options screening study. • Flowline and umbilical comparative assessment of decommissioning options. • Flowline and umbilical environmental outcomes assessment of decommissioning options. Stakeholder engagement (informing the evaluation to date) has also commenced for the BMG Closure Project (Phase 2) EP scope, including with DAWE on Sea Dumping Permits. Further engagement will be required with stakeholder as decommissioning studies are completed.
F	Description of how Cooper will maintain all property on the title as required by s572(2) of the Act to ensure that wells can be plugged or closed off and decommissioning end states are not precluded.	The Gippsland Operations EP provides for integrity management of facilities whilst in NPP. The EP links to the BMG facilities offshore IMP. The IMP is a control measure which steps out the strategies required/implemented to maintain the assets as close to their design condition as possible.	BMG Closure Project (Phase 1) EP outlines how the P&A activities will be managed such that full removal is not precluded.	BMG Closure Project (Phase 2) EP will provide for the decommissioning end states for the facility.
G	Description of the arrangements for reporting to NOPSEMA on progress with implementing the activities under the EP, until these activities are complete.		BMG Closure Project (Phase 1) EP includes description of arrangements for reporting to NOPSEMA on progress with implementing the activities under the EP, until the activities are complete. This includes reports submitted to	BMG Closure Project (Phase 2) EP will include description of arrangements for reporting to NOPSEMA on progress with implementing the activities under the EP, until the activities are complete. This will include reports submitted to

Item	Matters to be addressed	How / where addressed		
		Gippsland Operation EP (accepted)	BMG Closure Project (Phase 1) EP (this EP)	BMG Closure Project (Phase 2) EP
			NOPSEMA under Direction 6 of General Direction 82	NOPSEMA under Direction 6 of General Direction 824.

2.1.2 Environment Protection and Biodiversity Conservation Act 1999

Since February 2014, NOPSEMA's environmental management authorisation process has been endorsed by the Federal Minister for the Environment as a Program (the Program) that meets the requirements of Part 10, Section 146, of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Under the Program, the Minister for the Environment has approved a class of actions which, if undertaken in accordance with the endorsed Program, will not require referral, assessment, and approval under the EPBC Act. Petroleum and greenhouse gas activities undertaken in Commonwealth waters in accordance with the Program are considered to be "approved classes of action". The Program has objectives which include ensuring activities undertaken in the offshore area are conducted in a manner consistent with the principles of ecologically sustainable development (ESD) and will not result in unacceptable impacts to matters of national environmental significance (MNES) protected under Part 3 of the EPBC Act.

In 2019, a statutory review of the EPBC Act commenced, with an independent reviewer appointed and supported by an Expert Panel. This review was completed in October 2020, and the final report (Samuel, 2020) concluded that the EPBC Act does not clearly outline its intended outcomes and requires fundamental reform to enable to Commonwealth to:

- set clear outcomes for the environment and provide transparency and strong oversight to build trust and confidence that decisions deliver these outcomes and adhere to the law
- actively plan for environmental outcomes and restore the environment to accommodate Australia's future development needs in a sustainable way
- measure effectiveness to ensure that the Act delivers the right level of protection to make a difference for the environment and to support adjustments where changes are needed
- respect and harness the knowledge of Indigenous Australians to better inform how the environment is managed.

Central to the recommended reforms are proposed legally enforceable National Environmental Standards, which should focus on outcomes for matters of national environmental significance and on the fundamental processes for sound decision-making.

The final report from the independent review outlines the steps required to achieve full reform, with the final phase (complete legislative overhaul) recommended to be finalised by 2022.

This EP considers the impacts to protected matters (summarised in Table 2-4 and Table 2-5), as described in the *in force* EPBC Act at the time of writing. This has included making specific reference in Section 4 to the values of matters protected under Part 3 of the EPBC Act using references and relevant guidance documents, such as EPBC Act significance guidance documents, relevant policy statements, plans of management established by government, recovery plans and on-line databases.

The assessment of these protected matters has been conducted as per the assessment process described in

Figure 2-1.

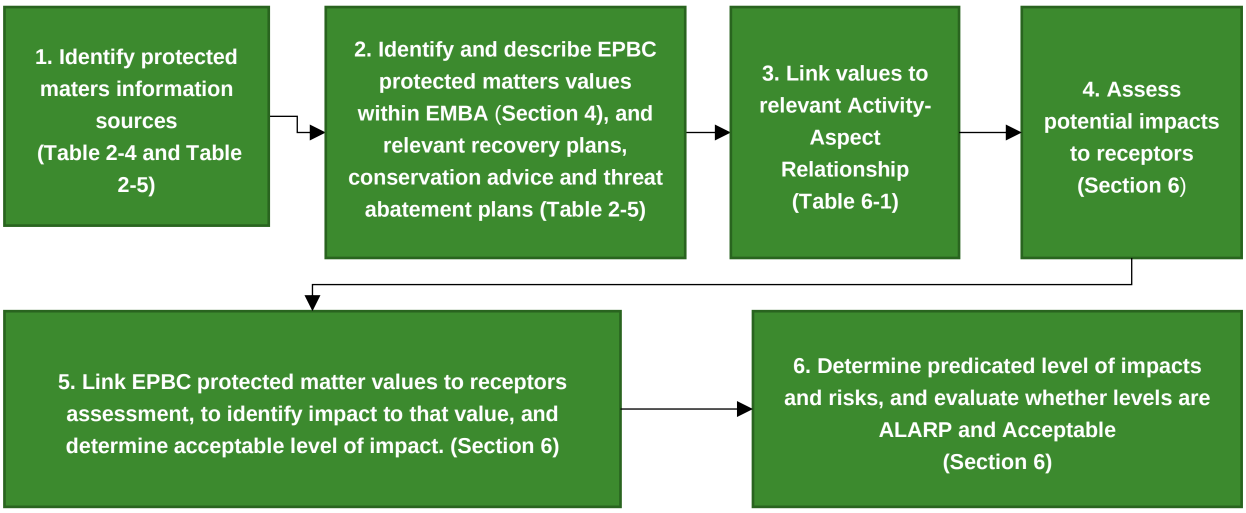


Figure 2-1: Impact assessment process of EPBC MNES

Table 2-4 Act information incorporated into this EP

EPBC Act Relevant Information Considered	How information is used	Document Section
Protected matters search tool (PMST)	An EPBC Act Protected Matters Database search has been conducted for the project boundaries (as defined in Section 4.2). A description of the marine or coastal receptors occurring within the EMBA is provided in Section 4. The EPBC PMST report also includes some terrestrial receptors (e.g. threatened species, threatened ecological communities (TEC), or heritage places); some of which have not been considered further within this EP given impacts are not expected and considered outside the bounds of oil spill impact assessment. The EPBC PMST reports are included in Appendix 2.	Section 4 and Appendix 2
Threatened species recovery plans, threat abatement plans and species conservation advices	Relevant plans or advice are identified in Table 2-5 along with the management advice applicable to the activity and associated impacts and risks.	Section 2.1.2
Plans of management for World Heritage properties, Australian marine parks, or National Heritage places	The Australian Government has established numerous Australian Marine Parks (AMPs) around Australia under the EPBC Act. There are 15 AMPs that intersect with the EMBA; the closest is East Gippsland Marine Park, approximately 130 km to the east of the BMG well locations. The Commonwealth Heritage List is a list of natural, Indigenous, and historic heritage places owned or controlled by the Australian Government. There are 98 Commonwealth Heritage Places / Properties listed in the EPBC PMST for the EMBA, of which many are buildings or sites without a marine / coastal influence. Sites accepted to the World Heritage listing are only inscribed if considered to represent the best examples of the world's cultural and natural heritage. There are 13 World Heritage property that intersects with the EMBA, including (not limited to): • Great Barrier Reef • Lord Howe Island Group The National Heritage list is Australia's list of natural, historic, and Indigenous places of outstanding significance to the nation. There are 21 National Heritage Places within the EMBA, including (not limited to): • Great Barrier Reef • Kurnell Peninsula Headland; • Lord Howe Island Group.	Section 4.4.1.2
EPBC Act-related guidelines	Relevant guidelines/policies are considered in the management of impacts and risks • EPBC Act Policy Statement 2.1 – Interaction between offshore seismic exploration and whales: Industry guidelines • EPBC Act Policy Statement 3.21—Industry guidelines for avoiding, assessing, and mitigating impacts on EPBC Act listed migratory shorebird species • National Light Pollution Guidelines for Wildlife Including marine turtles, seabirds, and migratory shorebirds (2020a) • Threat Abatement Plan for the Impact of Marine Debris on Vertebrate Marine Life.	Section 4
Ramsar wetland ecological character descriptions	There are eleven Ramsar wetlands that have coastal boundaries intersecting with the EMBA: • Corner Inlet; • East Coast Cape Barren Island Lagoons; • Elizabeth and Middleton Reefs Marine National Nature Reserve • Gippsland Lakes;	Section 4.4.1.2

EPBC Act Relevant Information Considered	How information is used	Document Section
	• Hunter estuary wetlands; • Logan Lagoon; • Moreton Bay; • Moulting Lagoon; • Myall Lakes; • Towra Point Nature Reserve; and • Western Port	
Marine bioregional plan	Marine bioregional plans are identified and considered in Section 4. Key Ecological Features (KEF) are elements of the Commonwealth marine environment that are considered to be of regional importance for either a region's biodiversity or its ecosystem function and integrity. Multiple KEFs intersect with the EMBA, including: • Big Horseshoe Canyon; • Canyons on the Eastern Continental Slope; • Elizabeth and Middleton Reefs; • Lord Howe Seamount Chain; • Norfolk Ridge; • Seamounts South and East of Tasmania; • Shelf Rocky Reefs; • Tasman Front and Eddy Field; • Tasmantid Seamount Chain; • Upwelling East of Eden; and • Upwelling off Fraser Island.	Section 4
The Conservation Values Atlas	The Conservation Values Atlas has been developed by the Commonwealth Government, and has been used for the identification of features, including biologically important areas (BIAs) and KEFs, within the EMBA. These have been presented specific to receptors in the Section 4 and considered in the assessment of impacts and risks in Section 6. BIAs are identified by the Commonwealth Government, are spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour, such as breeding, foraging, resting or migration. Multiple BIAs intersect with the EMBA, including: • Two shark species (Section 4.4.1.1) • 41 bird species (Section 4.4.1.1) • Two turtle species (Section 4.4.1.1) • Three whale species (Section 4.4.1.1) • Two dolphin species (Section 4.4.1.1)	Section 4
Species profile and threats (SPRAT) database	This database has been used in Section 4 as a source of information on the receptors. Information accessed has included species details such as habitat, movements, feeding, reproduction, and taxonomic comments. Note that profiles are not available for all species and ecological communities	Section 4

Table 2-5 Recovery plans, threat abatement plans and species conservation advices, relevant to BMG Closure Project (Phase 1)

Relevant Plan/Advice	Description	Threats or Management Advice Relevant to the Activity
Fish		
Approved Conservation Advice	Conservation advice provides management actions that can be	None identified

Relevant Plan/Advice	Description	Threats or Management Advice Relevant to the Activity
for *Epinephelus daemelii* (Black Rock-cod)	undertaken to ensure the conservation of the species	
Approved Conservation Advice for *Pristis zijsron* (Green Sawfish)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the species	None identified
Approved Conservation Advice for *Rhincodon typus* (Whale Shark)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the whale shark	• **Vessel disturbance**: Evaluate risk of vessel strikes 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 • **Climate change impacts**: No explicit relevant management actions; threat identified as 'climate change ecosystem effects as a result of habitat modification and climate change (including changes in sea temperature, ocean currents and acidification).'
Recovery Plan for the Grey Nurse Shark (*Carcharias Taurus*)	Recovery plan provides strategy for recovery of grey nurse shark	None identified
Recovery Plan for Three Handfish Species: Spotted handfish *Brachionichthys hirsutus*, Red handfish *Thymichthys politus* and Ziebell's handfish *Brachiopsilus ziebelli*	Provides strategy for recovery for three species of handfish	None identified
Approved Conservation Advice for *Thymichthys politus* (Red Handfish)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the species	None identified
National Recovery Plan for Australian Grayling	The recovery plan is a co-ordinated conservation strategy for the Australian grayling.	None identified
Sawfish and River Sharks Multispecies Recovery Plan	Strategy for recovery for multiple river shark and sawfish species	None identified
Recovery Plan for the White Shark (*Carcharodon carcharias*)	The recovery plan is a co-ordinated conservation strategy for the white shark.	None identified
Marine Turtles		
Approved Conservation Advice for *Dermochelys coriacea* (Leatherback Turtle)	See below for the recovery plan for marine turtles in Australia, 2017-2027.	See 'Recovery Plan for Marine Turtles in Australia, 2017-2027'
Recovery Plan for Marine Turtles in Australia, 2017- 2027	The long-term recovery plan objective for marine turtles is to minimise anthropogenic threats to	• **Marine pollution**: Evaluate risk of oil spill impact to marine turtles and, if required, appropriate mitigation measures are Implemented.

Relevant Plan/Advice	Description	Threats or Management Advice Relevant to the Activity
	allow for the conservation status of marine turtles	• **Marine debris**: Evaluate risk of marine debris (including risk of entanglement and/or ingestion) and, if required, appropriate mitigation measures are implemented. • **Noise interference**: Evaluate risk of noise impacts to marine turtles and, if required, appropriate mitigation measures are implemented. • **Light interference**: Evaluate risk of light impacts to marine turtles and, if required, appropriate mitigation measures are implemented. • **Vessel disturbance**: Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented.
Migratory shorebirds and seabirds		
Approved Conservation Advice for *Botaurus poiciloptilus* (Australasian bittern)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Australasian bittern.	None identified
Approved Conservation Advice for *Calidris canutus* (Red Knot)	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)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the curlew sandpiper.	• **Marine pollution**: Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented
Approved Conservation Advice for *Calidris tenuirostriss* (Great Knot)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the species	• **Marine pollution:** Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented
Approved Conservation Advice for *Charadrius leschenaultia* (Greater Sand Plover)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the greater sand plover.	• **Marine pollution**: Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented
Approved Conservation Advice for *Charadrius mongolus* (Lesser Sand Plover)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the species	• **Marine pollution**: Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented.
Approved Conservation Advice for *Halobaena caerulea* (Blue Petrel)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the blue petrel	None identified
Approved Conservation Advice for *Limosa lapponica bauera* (Bartailed Godwit (western Alaskan))	Conservation advice provides management actions that can be undertaken to ensure the conservation of the bar-tailed godwit	• **Marine pollution**: Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented

Relevant Plan/Advice	Description	Threats or Management Advice Relevant to the Activity
Approved Conservation Advice for *Limosa lapponica menzbieri* (Northern Siberian Bartailed Godwit)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the species	• **Marine pollution**: Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented
Approved Conservation Advice for *Numenius madagascariensis* (Eastern Curlew)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the eastern curlew.	• **Marine pollution**: Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented
Approved Conservation Advice for *Pachyptila subantarctica* (fairy prion (southern))	Conservation advice provides management actions that can be undertaken to ensure the conservation of the fairy prion (southern).	None identified
Approved Conservation Advice for *Pterodroma heraldica* (Herald Petrel)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the species	None identified
Approved Conservation Advice for *Pterodroma mollis* (Soft-plumaged Petrel)	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)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Australian painted snipe.	None identified
Draft National Recovery Plan for the Australian Painted Snipe	The plan considers the conservation requirements of the species across its range and identifies the actions to be taken to ensure the species' long-term viability in the wild, and the parties that will undertake those actions.	Deterioration of water quality, human disturbance.
Approved Conservation Advice for *Sternula nereis* (Australian Fairy Tern)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the fairy tern.	• **Marine pollution**: Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented
Draft National Recovery Plan for *(Sternula nereis nereis)* (Australian Fairy Tern)	Draft recovery plan for actions so species no longer qualifies for listing as threatened under any of the EPBC Act listing criteria.	• **Habitat degradation and loss of breeding habitat**
Approved Conservation Advice for *Thalassarche chrysostoma* (Grey-headed Albatross)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the species	See 'National Recovery Plan for Threatened Albatrosses and Giant Petrels, 2011-2016'
Approved Conservation Advice for *Thinornis rubricollis*	Conservation advice provides management actions that can be undertaken to ensure the conservation of the species	• **Marine pollution**: Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented

Relevant Plan/Advice	Description	Threats or Management Advice Relevant to the Activity
(Hooded Plover, Easter)		• **Marine debris**: Evaluate risk of marine debris (including risk of entanglement and/or ingestion) and, if required, appropriate mitigation measures are implemented
Gould's Petrel (*Pterodroma leucoptera leucoptera*) Recovery Plan	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Gould's petrel.	None identified
Little Tern (*Sterna albifrons*) Recovery Plan	Conservation strategy for the recovery of little tern	• **Marine pollution**: Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented.
National Recovery Plan for Eastern Bristlebird (*Dasyornis brachypterus*)	Conservation strategy for the recovery of eastern bristlebrid	None identified
National Recovery Plan for the *Lathamus discolour* (swift parrot) Draft National Recovery Plan for the Swift Parrot (*Lathamus discolor*)	The recovery plan is a co-ordinated conservation strategy for the swift parrot.	None identified
National Recovery Plan for the Orange-bellied Parrot (*Neophema chrysogaster*)	The recovery plan is a co-ordinated conservation strategy for the orange-bellied parrot.	None identified
National Recovery Plan for Threatened Albatrosses and Giant Petrels, 2011- 2016	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
Wildlife Conservation Plan for Migratory Shorebirds – 2015	The long-term recovery plan objective for migratory shorebirds is to minimise anthropogenic threats to allow for the conservation status of these bird species.	• Habitat degradation / modification (oil pollution)
Draft Wildlife Conservation Plan for Seabirds	The Plan aims to provide a strategic national framework for the research and management of listed marine and migratory seabirds and to outline national activities to support the conservation of listed seabirds in Australia and beyond.	• **Habitat modification:** Evaluate the risk of oil spill impacts on the ability of a seabird to use an area for breeding, roosting, or foraging.
Cetaceans		
Approved Conservation Advice for *Balaenoptera borealis* (Sei Whale)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the sei whale.	• **Vessel disturbance:** Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented • **Noise interference**: Evaluate risk of noise impacts to cetaceans and, if required, appropriate mitigation measures are implemented.

Relevant Plan/Advice	Description	Threats or Management Advice Relevant to the Activity
Approved Conservation Advice for *Balaenoptera physalus* (Fin Whale)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the fin whale.	• **Vessel disturbance:** Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented • **Noise interference**: Evaluate risk of noise impacts to cetaceans and, if required, appropriate mitigation measures are implemented.
Listing Advice for *Megaptera novaeangliae* (Humpback Whale) in effect from 26 February 2022.	Listing advice confirming species removed from the Threatened species list following new information provided to the Threatened Species Scientific Committee. The advice characterises past threats, current impacts (not threatening or preventing population growth), or as potential future threats, and outlines other plans that protect the humpback whale such as the National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna.	**Current impacts*:** • **Noise interference**: Evaluate risk of noise impacts to cetaceans and, if required, appropriate mitigation measures are implemented Vessel disturbance: Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented. • **Marine debris**: Evaluate risk of marine debris (including risk of entanglement and/or ingestion) and, if required, appropriate mitigation measures are implemented. **Current impacts* and future threats:** • **Vessel disturbance**: Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented. **not threatening or preventing population growth* (DAWE 2022)).
Conservation Management Plan for the Blue Whale, 2015-2025	The long-term recovery plan objective for blue whales is to minimise anthropogenic threats to allow for their conservation status to improve	• **Noise interference**: Evaluate risk of noise impacts 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. Key terms of the Conservation Management Plan and how they have been considered in this EP are provided in Table 2-6.
Conservation Management Plan for the Southern Right Whale, 2011-2021	Conservation management plan provides threat abatement activities that can be undertaken to ensure the conservation of the southern right whale.	• **Noise interference**: Evaluate risk of noise impacts to cetaceans and, if required, appropriate mitigation measures are implemented. • **Vessel disturbance**: Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented.
Pinnipeds		
Conservation Listing Advice for the *Neophoca cinerea* (Australian sea lion) (TSSC, 2010)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the Australian sea lion.	• **Noise interference**: Evaluate risk of noise impacts to cetaceans and, if required, appropriate mitigation measures are implemented. • **Vessel disturbance**: Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented. • **Marine debris**: Evaluate risk of marine debris (including risk of entanglement and/or ingestion) and, if required, appropriate mitigation measures are implemented.
Recovery Plan for the Australian Sealion	The plan considers the conservation requirements of the species across its range and identifies the actions to be taken to ensure its long-term	• **Vessel strike** Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented. • **Marine Debris**: and/or ingestion) and, if required, appropriate mitigation measures are implemented.

Relevant Plan/Advice	Description	Threats or Management Advice Relevant to the Activity
	viability in nature and the parties that will undertake those actions.	• **Pollution and oil spills**: Evaluate risk of oil spills and, if required, appropriate mitigation measures are implemented.
Threatened Ecological Communities		
Draft Conservation Advice for Salt-wedge Estuaries Ecological Community	Conservation advice provides management actions that can be undertaken to ensure the conservation of the species	• **Pollution**: Evaluate risk of oil spills and, if required, appropriate mitigation measures are implemented
Preliminary draft conservation advice (incorporating listing advice) of the Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community	Conservation advice provides management actions that can be undertaken to ensure the conservation of the species	None identified
Recovery Plan for the Eastern Suburbs Banksia Scrub endangered ecological community	Strategy for recovery of eastern suburbs banksia scrub	None identified
Draft Conservation Advice (incorporating listing advice) for Illawarra–Shoalhaven subtropical rainforest of the Sydney Basin Bioregion	Conservation advice provides management actions that can be undertaken to ensure the conservation of ecological community	None identified
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	Conservation advice provides management actions that can be undertaken to ensure the conservation of the ecological community	None identified
Draft Conservation Advice for the Natural Damp Grasslands of the South East Coastal Plain Bioregion	Conservation advice provides management actions that can be undertaken to ensure the conservation of the ecological community	None identified
Draft Conservation Advice for Subtropical and Temperate Coastal Saltmarsh	Conservation advice provides management actions that can be undertaken to ensure the conservation of the ecological community	• **Pollution**: Evaluate risk of oil spills and, if required, appropriate mitigation measures are implemented
Other relevant		
The Threat Abatement Plan for the impacts of Marine Debris on Vertebrate Wildlife of Australia's Coasts and Ocean	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.
Norfolk Island Region Threatened Species Recovery Plan	Recovery plan for threatened species on Norfolk Island	None identified

Table 2-6 Key terms of the Blue Whale Conservation Management Plan (September 2021) and how they relate to this EP

Key term (DAWE, September 2021)	How key terms have been considered within this EP
Recovery Plans	The Conservation Management Plan for the Blue Whale, 2015-2025 has been treated as a recovery plan (under the EPBC Act) throughout the EP.
Recovery plan actions	Actions identified in the Conservation Management Plan for the Blue Whale, 2015-2025 have been considered in the assessment of impacts and determination of acceptability of impacts to blue whales, specifically in Section 6.5 (underwater sound emissions impact assessment).
Biologically important areas	BIAs for blue whale, as provided in the Conservation Management Plan for the Blue Whale, 2015-2025, are described in Addendum 1 and Section 4.4.
Legal requirement - Action A.2.3. from the Blue Whale CMP: *'Anthropogenic noise in biologically important areas will be managed such that any blue whale continues to utilise the area without injury, and is not displaced from a foraging area'* Further, the DAWE key terms state: '*The recovery plan requirement, Action A.2.3, applies in relation to BIAs. A whale could be displaced from a Foraging Area if impact mitigation is not implemented. This means that underwater anthropogenic noise <u>should</u> not:* *- Stop or prevent any blue whale from foraging* *- Cause any blue whale to move on when foraging* *- Stop or prevent any blue whale from entering a Foraging Area* *It is considered that a whale is displaced from a Foraging Area if foraging behaviour is disrupted, regardless of whether the whale can continue to forage elsewhere within that Foraging Area. Mitigation measures must be implemented to <u>reduce the risk</u> of displacement occurring during operations where modelling indicates that behavioural disturbance within a Foraging Area may occur'*	Action A.2.3 and the DAWE key terms (September 2021) have informed the assessment of acceptability of underwater sound emissions, described in Section 6.5. In the assessment of underwater sound emissions, Cooper Energy has taken a precautionary approach. This is presented through the application of conservative impact thresholds for potential disturbance and injury, the application of ALARP Decision Context B, and the adoption of additional control measures to achieve ALARP and acceptability. Adaptive management approaches have been investigated and designed in consultation with government agencies, industry and scientists. The measures adopted reflect a precautionary approach; they are designed such that the risk of injury and displacement are reduced so that the foraging behaviour of any blue whale should not be impacted.
Definition of 'a foraging area'	The activity Operational Area is located within a possible foraging BIA. Blue whale foraging is considered throughout the assessment of potential impacts and risks to blue whales. Timeframes when blue whale foraging is more likely to occur has been defined based on contemporary literature.
Definition of 'displaced from a foraging area'	The definition of 'displacement from a foraging area' has been adopted throughout the assessment of underwater sound emissions (Section 6.5).
Definition of 'injury to Blue Whales'	Injury has been defined as PTS and TTS throughout the assessment of underwater sound emissions (Section 6.5).

2.2 State Legislation

Although the BMG infrastructure is located entirely in Commonwealth waters, the EMBA intersects Victoria, Tasmania, NSW, and Queensland State waters (Figure 4-1). As such legislation relevant to these States and have been described in Appendix 1.

Activities associated with the establishment and operation of a shore base to support the activity are regulated by the relevant state government and are outside the scope of the EP.

2.3 Environment Policies, Guidelines and Codes of Practice

This section describes the environmental policies, government guidelines and codes of practice involved in offshore petroleum activities.

The Australian Petroleum Production and Exploration Association (APPEA) Code of Environmental Practice 2008 provides guidance on a set of recommended minimum standards for petroleum industry activities offshore. These standards are aimed at minimising adverse impact on the environment and ensuring public health and safety by using the best practical technologies available.

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000) are also relevant to the activity and provide water quality guidelines proposed to protect and manage the environmental values supported by water resources.

2.3.1 Cooper Energy Environment Practices and Policy

The Activities covered by this EP will be planned and executed in accordance with the Cooper Energy Management System (CEMS). The Cooper Energy Health, Safety, Environment and Community (HSEC) Policy is shown in Figure 9-2. Further information regarding the implementation of this policy and related procedures are outlined in the description of the CEMS in Section 9.1.

3 Activity Description

To meet the requirements of the OPGGS(E)R, this section provides a description of the petroleum activity, including:

- Location and timing of the activity;
- Description of existing facilities, including layout and current state;
- Field characteristics; and
- A description of the petroleum activity.

Outside of the activities provided for under this plan, the BMG facilities will continue to be managed in accordance with Gippsland Operations EP (VIC-EN-EMP-0002).

3.1 Activity Details

3.1.1 Activity Objective

The primary objective of the Activity is to safely install permanent barriers in all seven wells, sealing off subsurface oil and gas reservoirs. The project will also utilise the campaign vessels to remove structures and well equipment depending on progress with the primary objective.

3.1.2 Operational Area

The Operational Area is the area within which petroleum activities managed under this EP will take place.

The Operational Area is defined as a 2 km area surrounding the BMG facilities within which all petroleum activities will occur. The Operational Area is located mostly within VIC/RL13, and incorporates the gazetted PSZs (Figure 3-1).

Vessel activity and transit outside the Operational Area falls under the *Commonwealth Navigation Act 2012* and is outside of the scope of this EP.

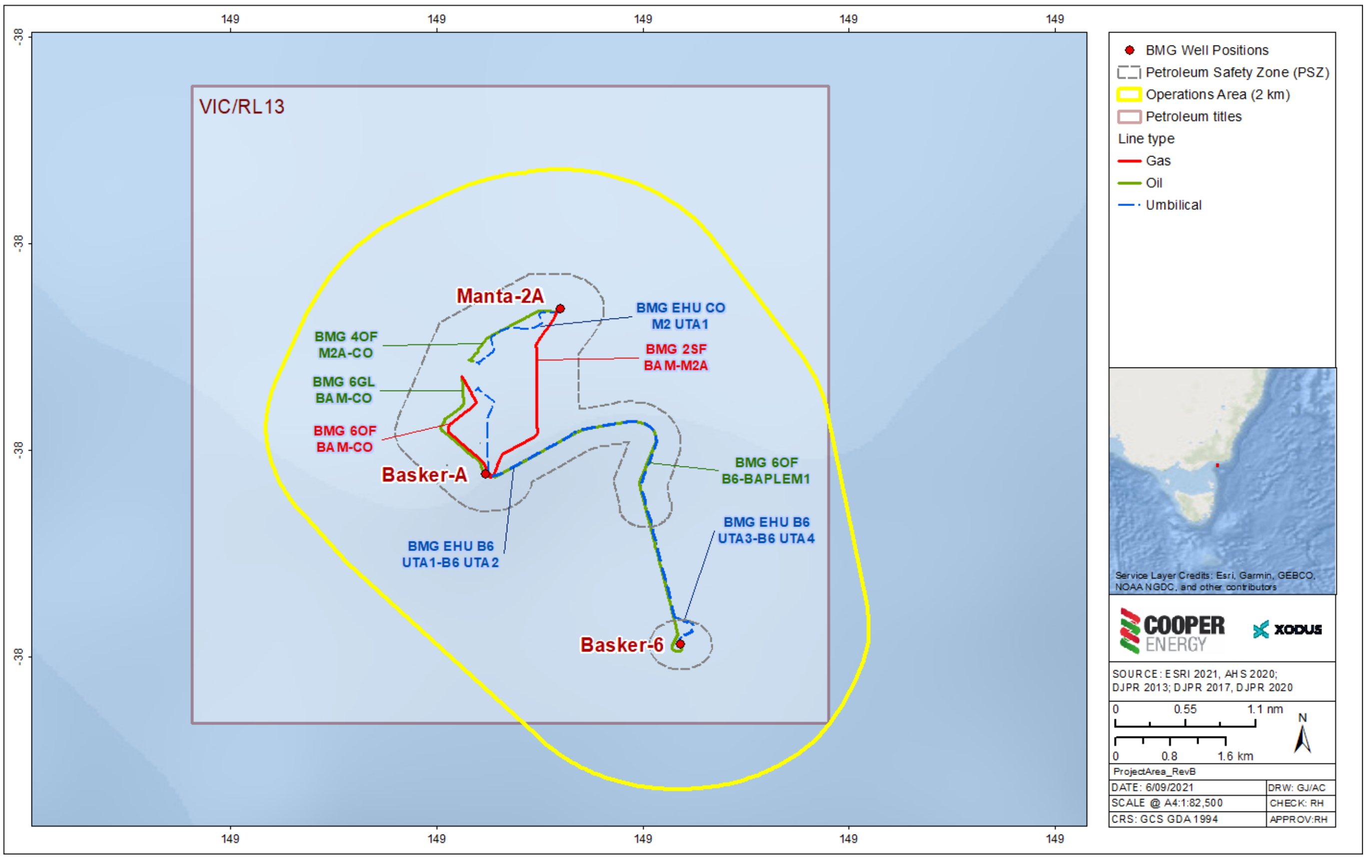


Figure 3-1 Operational Area and Petroleum Safety Zone (ref Gazette notice A443819)

3.1.3 Activity Timing

Activities are planned to commence in 2023 with a duration of approximately 130 days. Normal operations are conducted 24-hours a day.

The well plugging activities provided for within this EP will be completed by end 2023 in accordance with Direction 1 of General Direction 824, with well equipment removal activities expected to be completed by end 2024. Accelerating the offshore activities to 2022 has been considered; doing so is unlikely to provide sufficient time to plan and prepare for these activities and contingencies. Further information on planning and progress is provided within the BMG Closure Project Annual Progress Report published on the Cooper Energy website: https://www.cooperenergy.com.au/our-operations/reports.

Activities could be brought forward within the planned operating window (2023 to end 2024), subject to arrival of the Mobile Offshore Unit (MOU) which is depended on the MOU operators project portfolio, and environmental windows which may restrict timing.

Operationally, the optimum time to undertake the activity is in the austral summer. This period typically provides the most settled weather and the largest windows within which to undertake key activities that are sensitive to sea state, such as working through the splash zone and at the seabed.

A single campaign is planned, although multiple campaigns may be required depending on factors including weather and vessel availability.

3.2 Description of Existing Facilities

3.2.1 Facility Location

The BMG facility is located within Retention Lease VIC/RL13 in Commonwealth waters (Figure 1-1). The facility lies in water depths circa 135 m – 270 m, approximately 50 km from the Victorian coastline.

BMG lies to the east of the Area to be Avoided (ATBA); an exclusion zone around a large proportion of the existing oil and gas facilities within the Gippsland region, detailed in schedule 2 to the *OPGGS Act*.

Table 3-1 provides location details for the main drill centre (Basker-A) and satellite wells (Basker-6ST1 and Manta-2A) at BMG.

Table 3-1 BMG Subsea infrastructure Key Location Coordinates (GDA94)

Locations	Longitude I	Latitude (S)	Approx. Water Depth (m)
Basker-A Drill Centre			
Basker-A Manifold (BAM)	148° 42' 24.32''	38° 17' 58.74''	155
Basker-2 Well (B2)	148° 42' 24.72''	38° 17' 58.51''	155
Basker-3 Well (B3)	148° 42' 24.94"	38° 17' 58.97''	155
Basker-4 Well (B4)*	148° 42' 23.58"	38° 17' 58.86''	155
Basker-5 Well (B5)	148° 42' 23.80"	38° 17' 59.31''	155
Basker-7 Well (B7)	148° 42' 22.31''	38° 17' 58.79"	155
Satellite Wells			
Basker-6 ST-1 Well (B6)	148° 43' 54.76''	38° 19' 17.47''	263
Manta-2A Well (M2A)	148 42' 58.03''	38º 16' 39.41''	135

*All wells were producers with the exception of Basker-4 which was a gas injector.

3.2.2 Facility Inventory

Table 3-2 provides details of the remaining subsea facilities associated with the BMG development. The contents of the equipment are as left during production cessation (Section 1.5.2).

The table is separated into facilities and infrastructure planned to be removed during Phase 1a (Section 3.7), and those planned to be decommissioned (base case removal) in Phase 2 (covered by a separate EP).

Figure 3-2 illustrates the architecture and arrangement of the multi-well Basker-A drill centre. The Basker-6ST1 well and Manta-2A well are single satellite wells, located approximately 4 km and 3.5 km (respectively) from the Basker-A drill centre.

Table 3-2 BMG Facility remaining infrastructure Current State and details

	Dimensions					Primary Materials	Burial Status
	Height (m)	Width (m) or OD [ID] (mm)	Length (m)	Volume Fluid (m^3)	Dry Weight (kg)		
Planned removal during Phase 1B (this EP)							
Subsea Production Wells (x7) B2, B3, B4, B5, B6ST1, B7, Manta 2A							
Xmas Trees x 7 (B2-B7 and Manta 2A)	3 – 3.2 m	3.4 - 6 m	3.5 – 4.4 m	0.4 m^3 ea.	23,000 – 32,000 kg	Steel	-
Control Modules x 5	1.6 m	2.1 m	1.5 m	0.07 m^3 ea.	2,000 kg	Steel	-
Permanent Guide Base x 7	2.5 m	2 m	2 m	N/a	3,000 kg	Steel	-
Temporary Guide Base x 2	1.5 m	2.5 m	2.5 m	N/a	15,000 kg	Steel	Partial self-burial
Wellheads x 7	2-4 m (above seabed)	762 mm (into 508 mm)	-	N/a	1,100 kg/m	Steel	Installed partially below seabed
Major Structures							
Basker-A Manifold	5 m	11.1 m	12.9 m	5.6 m^3	64,183 kg	Steel	-
Basker-A Manifold Pile	3.5 m above seabed	Approx. 1 m OD Wall thickness: 1.5-inch (38 mm)	40 m	N/a	40,000 kg	Steel	Piled to 36 m below seabed
Umbilical Flying Leads							
HFLs x 9	-	-	15 m to 110 m (total 325 m)	<1 m^3	Per umbilical weights	Polyethylene, steel	Laid on seabed – some self-burial
EFLs x 9	-	-	15 m to 82 m (total 482 m)	N/a	Per umbilical weights	Polyethylene, steel, copper	Laid on seabed – some self-burial
Basker and Manta FLs x 4	-	-	15 m to 49m (total 162 m)	<1 m^3	Per umbilical weights	Polyethylene, steel, copper	Laid on seabed – some self-burial
Auxiliary (minor) Structures							
BA PLEM1	3.9 m	4.5 m	6 m	0.9 m^3	44,800 kg	Steel	-
BAM-UTA-1	2.9 m	2.2 m	5.2 m	0.01 m^3	6,000 kg	Steel	-
B6-UTAs x 4	2.4 m	0.9 m	1.6 m	0.04 m^3ea.	1,431 kg	Steel	-
Parking stand	6 m	6.3 m	6.3 m	N/a	>3,000 kg	Steel	-
UTA foundation (Basker & Manta) x 5	1.8 m	3.6 m	3.6 m	N/a	3,388 kg	Steel	-
M2A-UTA	2.4 m	0.9 m	1.6 m	0.01 m^3	1,431 kg	Steel	-

	Dimensions					Primary Materials	Burial Status
	Height (m)	Width (m) or OD [ID] (mm)	Length (m)	Volume Fluid (m^3)	Dry Weight (kg)		
Planned decommissioning (base case removal) during Phase 2 (covered by a separate EP)							
Flowlines and Well Jumpers							
6" Oil flowline BAM – FPSO	-	279.39 mm [152.4mm]	1,450 m	26.76 m^3	93.62 kg/m	HDPE[2], syntactic foam, steel	Partial self-burial (>75% of diameter)
6" Gas injection line FPSO – BAM	-	220.4 mm [152.4mm]	1,550 m	28.27 m^3	80.9 kg/m	HDPE, syntactic foam, steel	Partial self-burial (>75% of diameter)
B6 Well 6" Flowline	-	279.39 mm [152.4mm]	5,567 m	101.07 m^3	93.62 kg/m	HDPE, syntactic foam, steel	Trenched to 0.3m. Some uncovered sections
4" Oil Flowline M2A – FPSO	-	304.34 mm [101.6mm]	1,360 m	11.03 m^3	105.06 kg/m	HDPE, syntactic foam, steel	Partial self-burial (>75% of diameter)
2" Gas Lift Flowline FPSO – BAM	-	105.89 mm [50.8]	2,797 m	5.67 m^3	22.92 kg/m	HDPE, syntactic foam, steel	Partial self-burial (>75% of diameter)
Flowline Jumpers x 10	-	Various	44 m to 100 m (total 725 m)	3.64 m^3	Various	HDPE, syntactic foam, steel	Partial self-burial (>75% of diameter)
Umbilicals (including control and production chemical cores)							
EHU[3] FPSO to BAM-UTA	-	145.4 mm	1,750 m	4.2 m^3	36.7 kg/m (hoses filled)	Polyethylene, steel, copper	Partial self-burial (>75% of diameter)
EHU B6-UTA-1 to B6-UTA-3	-	159 mm	1,135 m	3.1 m^3	38.7 kg/m (hoses filled)	Polyethylene, steel, copper	Partial self-burial (>75% of diameter)
Basker-6 Umbilical (B6-UTA-3 to B6 UTA-4)	-	159 mm	4,385 m	11.8 m^3	38.66 kg/m (hoses filled)	Polyethylene, steel, copper	Trenched to 0.25m depth. Some uncovered sections
Manta 2A Umbilical	-	93.5 mm	1,900 m	1.6 m^3	14.84 kg/m (hoses filled)	Polyethylene, steel, copper	Partial self-burial (>75% of diameter)
Stabilisation Materials							
Concrete Mattresses x 2	0.2 m	2.5 m	5 m	N/a	3,000 kg	Concrete, polymer coating and rope	Some self-burial
Grout Bags (multiple)	0.2 m	0.5 m	0.3 m	N/a	25 kg	Grout, polymer bag	Some self-burial

[2] High-density polythylene
[3] Electro-hydraulic umbilical

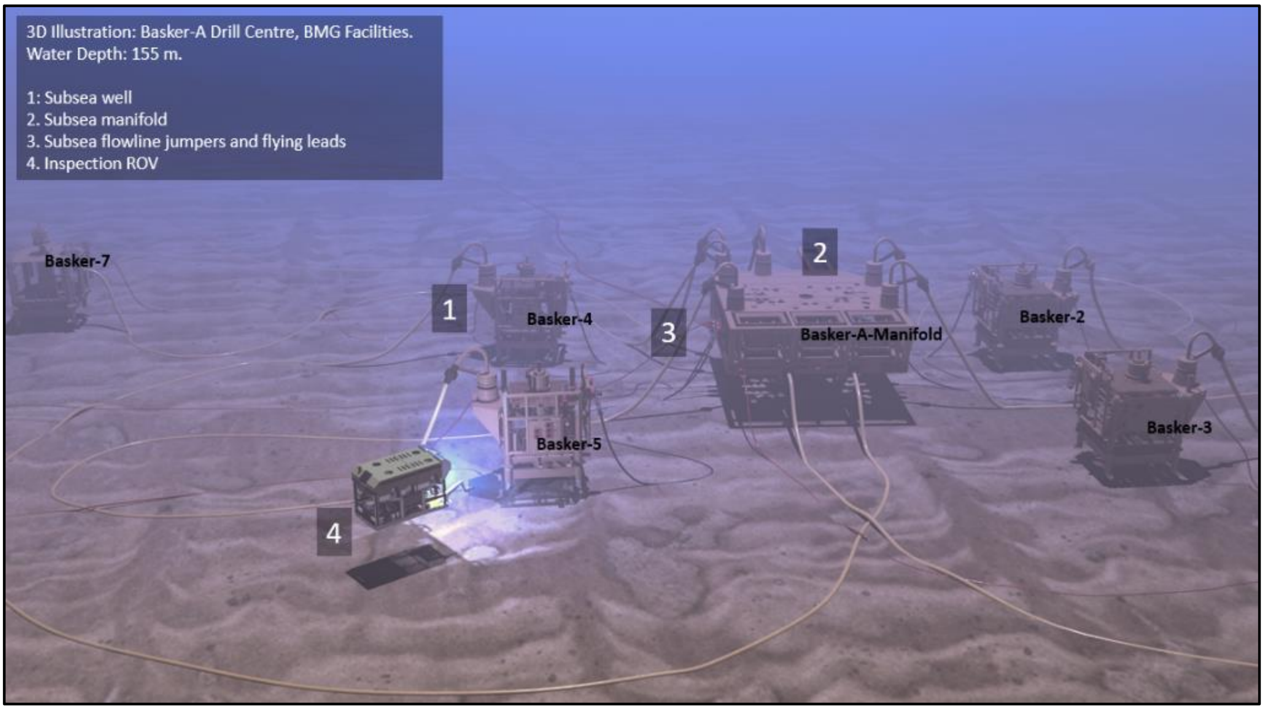


Figure 3-2 Facility Illustration: Basker-A Drill Centre

3.3 Field Characteristics

The BMG development produced light crude oil. Gas was produced as a by-product and was used for gas lift at the Manta-2A wells and the Basker-A Drill centre, injected into Basker-4 or otherwise flared from the FPSO.

Table 3-3 and Table 3-4 summarise the Basker hydrocarbon properties (RPS, 2020) based on assay information generated during the production phase, as relevant to the spill scenarios described in Section 6.7.

Throughout the production phase and flushing operations (Section 1.5.1), there was no evidence of Naturally Occurring Radioactive Substances (NORMs) or Mercury (17-033-RP-001).

Table 3-3 Basker Light Crude Oil Hydrocarbon Physical Properties (RPS,2020)

Physical Properties	Value
Density (kg/ m^3)	829.8 (at 15°C)
API	45.2
Dynamic Viscosity (cP)	2.8 (at 40°C)
Pour Point (°C)	15
Wax Content (%)	27.7
Hydrocarbon property category	Group II
Hydrocarbon property classification	Light – Persistent

Table 3-4 Distillation Characteristics of Basker Light Crude Oil (RPS, 2020)

Parameter	Volatiles	Semi-volatiles	Low volatiles	Residual
Boiling Point (°C)	<180	180-265	265-380	>380
Aromatic 'Type'	MAHs	2 ring PAHs	3-ring PAHs	≥ 4-ring PAHs
Aliphatics	C4-C10	C10-C15	C15-C20	>C20
Basker Crude (%)	19.4	19.5	20.8	40.3
	Non-Persistent	*Persistent*		

3.4 Decommissioning Challenges

Technical decommissioning challenges have guided the selection of planned and contingency activities relevant to this EP (Table 3-5).

To address these challenges and to further optimise the program, new technologies are actively being pursued and may be utilised for the project. The use of new technologies as part of the well abandonment scope will form part of the activity Well Operation Management Plan (WOMP) approval. Changes to the activity due to implementing new technologies will be assessed in accordance with the Cooper Energy Management of Change Process and relevant sections of the OPGGS (Environment) Regulations.

Table 3-5 Technical Decommissioning Challenges at BMG

Technical Challenges	Descriptions	Solutions being worked
BMG tree re-entry hubs	The re-entry hub on top of the BMG trees is a flowline connector bolted to the top of the tree. It is inherently weaker and more prone to flex than a typical re-entry hub which is usually integral to the tree itself. The BMG re-entry hubs are at a higher risk of over utilisation from intervention activities.	• Selection of suitable well control equipment. • Riser analysis and optimisation. • Accidental case utilisation factors for operations. • Re-entry hub bracing system retrofitted to tree. • Tethering system for pressure control equipment deployed onto the BMG trees to minimise bending forces on the re-entry hub. • Utilisation analysis for emergency source control.
Deep set control lines run on production tubing.	Basker wells were designed with smart well completions which require deep set control lines connected to the outside of the production tubing to control the down hole inflow control valves. The control lines form a conduit from the lower wellbore (hydrocarbon zone) to the subsea tree (SST). As such the control lines, if not modified during Plug and Abandonment (P&A), are an obstacle to achieving a laterally continuous (rock to rock) barrier across the well and well annulus.	• DynoSlot perforating guns used to cut the control lines into short sections which will enable the sections to fall deeper into the well removing the conduit from across the abandonment barrier zone • Thermite and Bismuth to melt tubing and control lines to form an impermeable metal plug. • System integrity testing (SIT) is being completed to validate methods.
Control lines and reservoir isolation	Deep set control lines behind the production tubing of some wells may have accumulated gas or fluids from the reservoir during the production phase, and provide a potential conduit to the annular space once cut which could cause potential cement contamination issues.	Cut control lines downhole at depth via one or more methods including: • E-line cutter or alternate; • Engineered explosive cutting device; • Thermite technology to melt tubing and control lines to form an impermeable metal plug; and • SIT is being completed to validate methods. • Sealing polymer solution or self-healing cement to be squeezed into the control lines just above the upper production packer to isolate the control lines and reservoir
B6 flowline residual wax and diesel	Residual wax is anticipated within the B6 flowline and may also occur within other components of the subsea production system. During production wax dropout was managed via the addition of pour point depressant at 1000ppm to the production fluids. In 2009 restrictions within the B6 flowline due to wax were reduced via pumping of diesel into the flowline. As-left records indicate there is a flow path through the flowline, but that residual wax and diesel, and pour point depressant is likely to remain due low flushing rates in 2009 when the flowline was displaced to inhibited water.	• Well Returns Management Philosophy (Section 3.8.1.2), noting residual wax, hydrocarbons and chemicals may remain trapped in the flowlines including within the carcass grooves and annulus. • Fluids handling package to treat any oily returns prior to discharge.

Technical Challenges	Descriptions	Solutions being worked
Production system gas recharge	Gas recharge within the production system occurred during the production cessation phase and is expected to remain or have increased since then. The B2 well bubble (Section 1.5.3) indicates some gas is present within the surface production system. Pressure relief and hydrocarbon disposal will need to be managed through a number of methods and at different stages of the activity. The chosen method of pressure relief at a given stage depends on the volume, pressure, and activity sequencing.	• Testing of pressure within the production system. • Flushing of production system bullheading contents back down wells where possible. • Controlled venting of pressure subsea. • Fluids handling package to manage hydrocarbons circulated back to the MOU.
Casing corrosion	Corrosion of the 244 mm (9-5/8”) production casing, 89 mm (3-1/2”) and 114 mm (4-1/2”) production tubing strings could result in reduced Burst, Collapse and Tensile ratings	Pressure testing and operational sequences will be managed to prevent exceeding the mechanical limits of the tubulars. Note, based on corrosion study results there is no significant integrity risk for the BMG wells related to tubing and corrosion by the end of NPP (BMG-DC-STU-0001).
Production casing cement quality	The cement behind the production casing needs to be evaluated to confirm cement bond and quality between the casing and formation cap rock to ensure there is sufficient reservoir isolation	• A through tubing cement bond log will be run to evaluate the casing cement quality and confirm the top of the cement for reservoir abandonment. • Possible Perf/Wash/Cement. This involves perforating the casing and washing across the required cement interval and squeezing new cement into the annulus and across the tubing creating a rock-to -rock isolation barrier. • Possible heavy metal section milling. This involves milling the casing across the required zone using a new technology which distributes all the mill cuttings deeper into the well. Once the zone is milled a cement plug is placed and provides a permanent barrier. • Possible Thermite technology – This involves melting all tubing, control lines, casing, and cement to form an impermeable metal plug across the cap rock formation. This barrier is supported by a verified cement plug above.

3.5 Activities that have the potential to impact the environment

The following sections describe the activities included in this EP which have the potential to result in environmental aspects or hazards, leading to impacts on receptors.

Activities are separated as follows:

- Phase 1a Activities – Facility cleaning, preparations and well abandonment;
- Phase 1b Activities – Removal of structures, flowline spools and flying leads;
- Support operations; and
- Contingency operations.

A summary of disturbance, discharges and emissions is provided in Section 3.10.

3.6 Phase 1a Activities

3.6.1 Facility cleaning and preparations

Preparation activities will be required at the facilities. These activities will be undertaken from a vessel or the Mobile Offshore Unit (MOU) (described in Section 3.8.1), and will utilise one or more remotely operated vehicles (ROVs).

Cleaning and preparation activities may include:

- **Subsea Equipment Cleaning**: sediment, marine growth and mineral deposits will be cleaned from subsea BMG equipment to enable access for intervention. Cleaning will include mechanical and chemical techniques, resulting in discrete chemical discharges.
- **System Pressure measuring**: system pressure will be measured using instrumentation deployed from surface. It is anticipated that gas will have accumulated within the flowline system since production cessation (Section 1.5.2). System pressure will be checked before and during the activity and will provide information for the subsequent flowline system flushing activities.
- **Subsea Equipment Modifications**: subsea components may be modified to enable subsequent scopes such as the running of pressure control equipment during abandonment. This may involve cutting and removing components to enable clear access.
- **Subsea Inspections**: including facility inspections and seabed surveys (described in Section 3.8.4).
- **Installation and Deployment of temporary structures**: subsea bracing structures or piles for tethering system, adjusting umbilicals to allow for piles or clump weight placement, mooring pre-lays (if needed).

Approximately four gravity anchors (25 t to 50 t each) or suction piles may be used for each well as part of the tethering system for the well intervention equipment. Each gravity anchor or pile is located within approximately 25 m of the well and is attached to the intervention equipment via tethers. Gravity anchors laid onto the seabed have a footprint of approximately 20 m^2 per anchor. Suction piles penetrate the seabed and have a smaller footprint than gravity anchors. Seabed tethering systems are shown in Figure 3-3. These will be temporarily placed on the seabed, and recovered at the end of the activity.

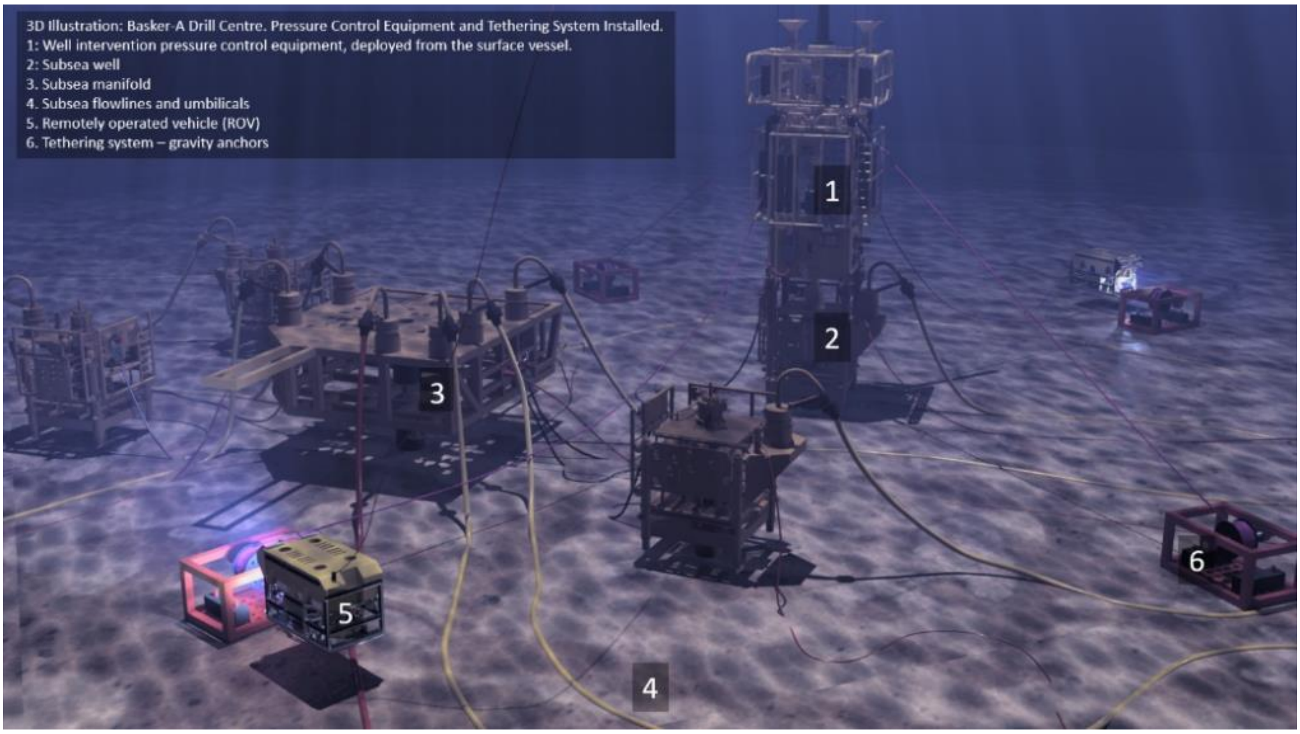


Figure 3-3 Seabed tethering systems

3.6.2 Seabed Survey

Seabed surveys will be required throughout the activity and will involve visual and sonar inspection. Surveys could occur anywhere within the Operational Area.

Surveys are likely to be via ROV but may also include towed survey equipment. Survey equipment will likely include video, magnetometer, multibeam sonar, sidescan sonar and /or sub-bottom profiler. The sound profiles of indicative survey equipment are provided within Table 3-6.

Table 3-6 Indicative Survey Equipment – Sound level Profiles

Tool		Frequency Range	Max. Sound Level
MBES		12 kHz – 700 kHz	221 dB re 1 µPa RMS
Sidescan Sonar		100 kHz – 400 kHz	235 dB re 1 µPa RMS
Sub-bottom profiler	*Compressed High-Intensity Radar Pulse (CHIRP) System*	3 – 40 kHz	208 dB re1µPa RMS
	Boomer System	500 Hz – 5 kHz	227 dB re 1µPa RMS

3.6.3 Well Abandonment

In total, 7 subsea production wells will be abandoned as part of the Phase 1a activities. A single abandonment campaign is planned with wells abandoned sequentially; however multiple campaigns may be required. Pressure control equipment and tethering systems used during well abandonment are shown in Figure 3-3.

During well abandonment activities fluids will be circulated in and out of the well to maintain a dynamic barrier, and to clean the well in preparation for cementing. Fluids will include those incumbent in the well, as well as clean fluids and chemicals specifically selected for the well abandonment program. All introduced chemicals that are planned to be discharged or associated with the well abandonment program will be assessed in accordance with the Cooper Energy Offshore Chemical Assessment Procedure (Section 0).

During some activities, fluids recovered from the wells may be contaminated with formation fluids. The MOU will be prepared to receive formation fluids including liquids and gas within the well annuli, tubing, and flowline system. These fluids will be treated in accordance with the Well Returns Management Philosophy (Section 3.8.1.2).

Coiled tubing and associated tooling may be used to sever the production tubing and control lines and a polymer sealing solution may be placed and squeezed into the cut control lines. This provides an impermeable barrier prior to a permanent barrier being placed. Polymer sealing solution and MEG carrier fluid should remain downhole, though excess may be circulated out of the well and discharged overboard, subject to meeting discharge criteria. Residual MEG and sealant will be discharged with tank washings.

3.6.3.1 Well Intervention and Suspension

Well intervention and suspension will be achieved through the following steps.

- **Remove Tree Cap**

Tree caps are small pressure retaining debris caps which cover the top of the tree spool.

A tree cap running tool is deployed from the MOU to remove the tree cap from the SST and retrieve to the surface. A small amount of inhibited seawater and trapped gas may be released.

- **Install Pressure Control Equipment**

Pressure control equipment such as an intervention riser system (IRS) or blowout preventor (BOP) will be deployed on top of the SST. The riser system provides a conduit to the MOU through which the wells can be intervened. The riser system is full of fluid which varies in composition from seawater to kill weight brine, and possible reservoir fluids depending on the stage of abandonment operations. Under normal conditions the riser system is displaced to clean brine or seawater prior to disconnection. Displaced fluids are returned to the fluids handling package and not discharged subsea.

The pressure control equipment will provide shearing, sealing and emergency disconnection capability. During normal operation and testing of pressure control equipment multiple different valves are functioned which result in the venting of control fluids to sea. Multiple function tests will be performed over the campaign.

- **Flowline Flushing**

Flowlines were previously flushed during the production cessation phase to 30ppm oil in water or less, except for the B6 flowline. Whilst the B6 flowline has been displaced to inhibited seawater; residual wax and small pockets of diesel are expected based on cessation phase reports.

Where possible, all flowlines will be flushed again with water during this campaign. Flowline contents will be forcibly pumped (bullheaded) downhole or, if bullheading is obstructed, returned to the MOU where practicable.

The flowline system is anticipated to contain some gas. Any gas returned to the MOU will be managed via the fluids handling package.

Depending on corrosion studies, the flowlines may be displaced to inhibited water after flushing, if required, to maintain integrity sufficient to allow removal within the period 2024-2026 (Phase 2 campaign).

– ***Flowline flushing methodology***

In general, the BMG field Subsea Trees (XTs), Manifold, Gas lift lines and Flowlines are connected in one continuous circuit where subcomponents can be isolated with valves. There are exceptions to this circuit where some lines are dead ended. Lines connected to the FPSO are now capped and do not have a continuous flow path through them.

Table 3-7 Flowline Circuit Descriptions

Well	Circuit Path	Circuit Type (Annulus)	Circuit Type (Production)
Basker 2	XT-Gas lift Line-Manifold-Flowline-XT	Continuous	Continuous
Basker 3	XT-Gas lift Line-Manifold-Flowline-XT	Continuous	Continuous
Basker 4	XT-Gas lift Line-XT(B7)-Flowline-Manifold-Flowline-XT	Continuous / Complex	Continuous / Complex
Basker 5	XT-Gas lift Line-Manifold-Flowline-XT	Continuous	Continuous
Basker 6	XT-Flowline-Adjacent XT	Continuous	Continuous
Basker 7	XT-Gas lift Line-XT(B4)-Flowline-Manifold-Flowline-XT	Continuous / Complex	Continuous / Complex
Manta 2	XT-Gas lift Line-Manifold-Flowline- Adjacent XT	Continuous / Complex	Dead Ended
Manifold	Multiple	Continuous / Complex / Deadened	Continuous / Complex / Deadened

Six of the seven wells have existing circuits that will allow water to be pumped from the MOU, through the subsea circuit and into an available reservoir (Figure 3-4). Flushing fluids to the reservoir will be followed by a flush to the surface so that fluid cleanliness can be verified and documented. Wells that fall into this category are Basker-2, Basker-3, Basker-4, Basker-5, Basker-6, Basker-7 and most of the Manifold. The high-level methodology is as follows:

1. Pressure test the line-up to the Subsea Tree
2. Open the Subsea Tree valves and pressure test the line-up to the Manifold.
3. Open the Manifold valves and test the line-up to the Subsea Tree.
4. Open the Subsea Tree valves and pump clean fluid at a high rate from the MOU to the reservoir for approximately 1.2 system volumes.
5. Change the Subsea Tree valve line-up to divert pumped fluids back to the MOU for sampling.
6. If the sampled fluid is ≤30ppm oil in water, then flush is complete, else circuit flushing will repeat. Returns will be managed in line with the well returns management philosophy, Section 3.8.1.2.

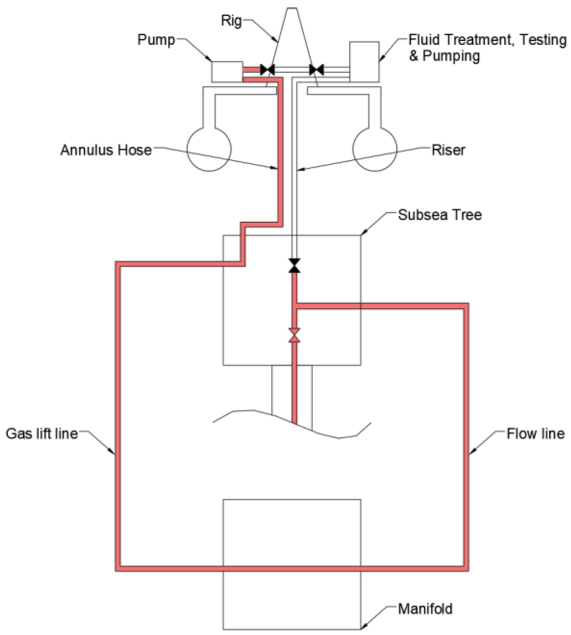


Figure 3-4 Circuit – Flush flowline to reservoir

A contingency case for this circuit type is where access to the reservoir is not possible due to downhole valves failing closed or a blocked formation. The modified methodology (Figure 3-5) is as follows.

1. Pressure test the line-up to the Subsea Tree.
2. Open the Subsea Tree valves and pressure test the line-up to the Manifold.
3. Open the Manifold valves and test the line up to the Subsea Tree.
4. Open the Subsea Tree valves and pump clean fluid at a high rate from the MOU and back for approximately 1.2 system volumes.
5. Sample fluid returns.
6. If the sampled fluid is ≤30ppm oil in water, then flush is complete, else circuit flushing will repeat. Returns will be managed in line with the well returns management philosophy, Section 3.8.1.2.

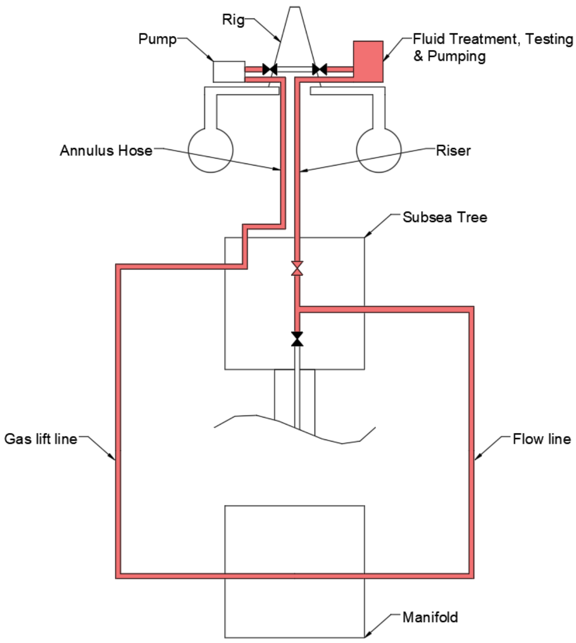


Figure 3-5 Circuit – Flush flowline to surface

One of the seven wells' circuits and several Manifold lines will not allow for clean fluid to be pumped from the rig, through the subsea circuit and into an available reservoir. These dead-ended spaces will be lubricated with clean fluid. Lubricating is the process of injecting clean fluid at high pressure into the closed void and diluting the existing volume with the clean volume added. The pressurised system will then be vented back to the surface fluid treatment package. The vented system is re-pressurised with clean fluid, and the process is repeated until clean returns are measured at the surface. The high-level methodology is as follows:

1. Pressure test the line-up to the Subsea Tree.
2. Open the Subsea Tree valves and pressure test to the Flowline.
3. Vent pressurised Flowline contents back to the MOU Fluid Treatment and Testing package.
4. Check the fluid cleanliness.
5. If the sampled fluid is ≤30ppm, then flush is complete, else circuit lubricate and bleed will repeat. Returns will be managed in line with the well returns management philosophy, Section 3.8.1.2.

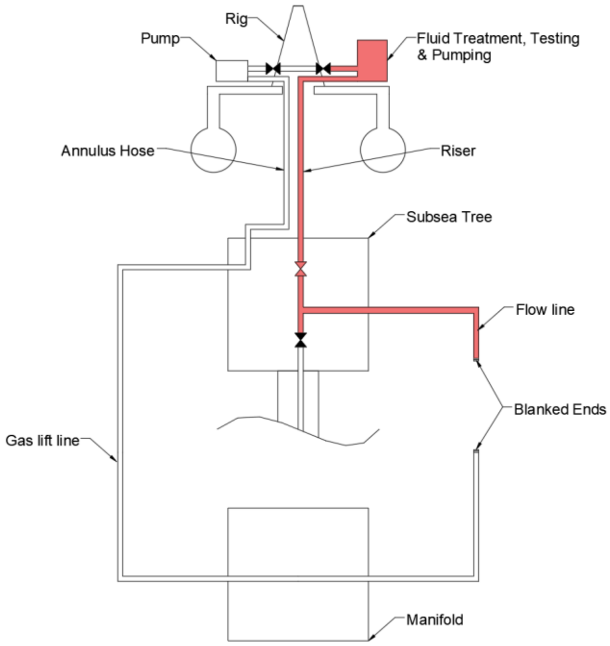


Figure 3-6 Circuit – Lubricate dead-ended flowline

- **Kill and Suspend the Well**

Wells will be killed by pumping kill weight brine downhole. Kill weight brine is brine with a density high enough to produce a hydrostatic pressure at the point of influx into the wellbore that is sufficient to shut off flow into the well. A series of perforations and / or cuts to the tubing are made, followed by pumping specially formulated cement slurry according to the operations program and the Well Operations Management Plan (WOMP) (EP Section 3.6.5). Once the cement has cured it will form a plug within the well, and will be verified in accordance with the WOMP.

During these steps the tubing and some annular spaces within the well are displaced to clean brine. Returns at surface will include the incumbent liquids (i.e. liquids currently within the well) and some gas. The fluids will be routed through a fluids handling package for treatment prior to disposal. The fluids returned to the MOU will be managed via the fluids handling package.

Once the reservoir is isolated and the well is suspended in accordance with the WOMP, pressure control equipment on top of the tree is removed. This will result in a small release of well displacement fluids.

- **Disconnect Equipment and Remove Subsea Tree**

An ROV will disconnect or cut the flowline jumpers, gas lift lines, electrical and hydraulic leads from the SST and lay them on the seabed. Following disconnection / cutting, flowline jumpers will be un-capped, and any contents will begin exchange with the surrounding sea. Contents will include residual quantities of chemicals (i.e. inhibitor such as Hydrosure O-3670 @650ppm), hydrocarbons including liquids (at ≤30ppm) and/or residual gas. This dispersion will occur from initial cut, dependent on ambient sea conditions, and full displacement of any remaining content from the jumpers is expected to occur during their removal in the Phase 1 campaign. Umbilicals and flying leads with self-sealing connections will only be cut if attempts to disconnect are unsuccessful.

Depending on corrosion studies, the flowlines may be capped, if required, to maintain integrity sufficient to allow removal within the period 2024-2026 (Phase 2 campaign).

The B6 flowline currently contains residual wax, diesel and pour point depressant following previous flushing attempts prior to production cessation (Section 1.5.2); at seabed temperatures the wax is solid, and will remain within the flowlines when they are cut. Given its relative buoyancy, the diesel is likely to have accumulated (and will remain) within high points along the PS-B6 flowline (U-tube effect) away from the pipeline ends (Figure 3-7). It is possible the solid wax may present a barrier or restriction which prevents the line from being swept completely of existing contents. The B6 flowline will be flushed and tested prior to disconnection in line with the flushing methodologies presented above.

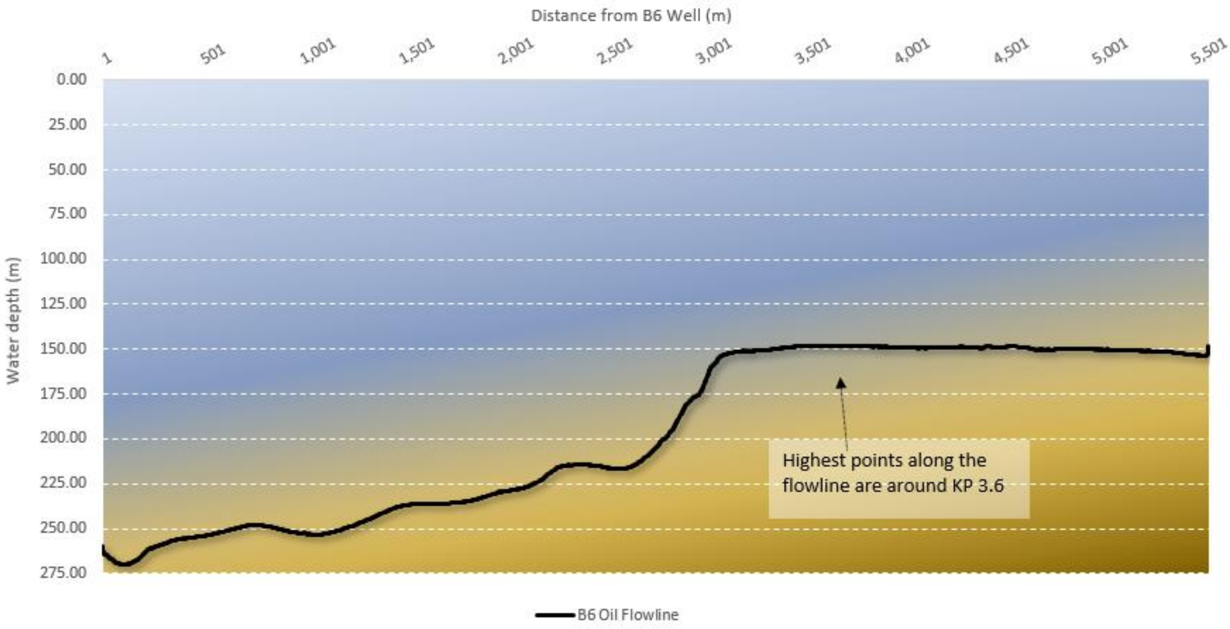


Figure 3-7 B6 Flowline Route Profile (water depth)

The SSTs will be disconnected from the wellhead. It will either be recovered immediately or wet parked (i.e. left on the seabed temporarily) within the existing infrastructure PSZ and recovered later in the campaign.

3.6.3.2 Restoring cap rock

Once well intervention and suspension is complete, permanent plugging is achieved through restoration of the cap rock. Cap rock is a relatively impermeable rock, commonly shale, anhydrite, or salt, that forms a barrier or seal above and around reservoir rock so that fluids cannot migrate beyond the reservoir.

- **Installation and Removal of Pressure Control Equipment**

Pressure control equipment such as a Riserless Open Water Abandonment Module (ROAM) or BOP will be deployed on top of the well, either using a crane wire or using a riser. The ROAM is controlled via HFL/EFL jumpers from the IRS or via downlines from the MOU. Pressure control equipment will be capable of shearing and sealing the well.

Prior to retrieving tools or tubing through open water, and prior to disconnection from the well, the well and pressure control equipment will be circulated with clean brine or seawater via circulation hoses to surface. The clean brine or seawater is displaced to sea from equipment during retrieval.

- **Remove Tubing and Control Lines**

Depending on the evaluation and integrity of cement behind the casing, tubing and accessories may be cut and recovered, or left in place. If cut and recovered, the tubing and control lines will be cut (e.g. with a wireline tubing cutter or equivalent) above the deep-set temporary cement suspension plug. The tubing hanger, tubing and control lines would be partially recovered to the MOU. A sacrificial tubing hanger may be installed to allow production tubing and accessories to be re-run into the well for disposal downhole. This decision will be made depending on tubing condition and other operational considerations at the time. The wells are circulated clean before pulling tubing to surface, checking well contents are treated to specification (Section 3.8.1.2).

Control line fluids are expected to be released and mix with well fluids (brine) as they are recovered through the well or may be displaced when recovering the tubing and control lines to surface through open water.

Use of new technologies, such as DynoSlot perforating guns or thermite, may remove the requirement to recover any tubing and control lines for placement of the reservoir abandonment barriers as the thermite will melt these and incorporate them into the barrier it creates, or the DynoSlot perforating guns cut the control lines into small sections which drop below the abandonment barrier zone.

- **Install Permanent Reservoir Barriers**

A series of perforations and/or cuts to the production tubing and casing may be made, followed by pumping specially formulated quantities of cement slurry according to the operations program and WOMP (Section 3.6.5). Once the cement has cured, it will form a plug within the well restoring the caprock, and will be verified in accordance with the campaign WOMP.

If remedial cement repair is required, the well including annular spaces behind casing are displaced with clean brine. Returns at surface will include excess cement spacer, the incumbent liquids including old drilling fluids, inhibited water, and debris solids (e.g. cement cuttings). Incumbent fluid content will differ between wells, but includes a mixture of water-based mud, brine, and inhibited water. Incumbent inhibitor chemicals include film-forming amine corrosion inhibitor, biocide, oxygen scavenger and dye.

Fluids displaced from the well are circulated to surface and treated prior to disposal (Section 3.8.1.2).

Once permeant barriers are installed, pressure control equipment can be recovered. The pressure control equipment is flushed with seawater, disconnected then either recovered to surface or moved across to another well.

3.6.4 Logging

A series of downhole drift runs, and data acquisition logging activities will be undertaken during well abandonment to evaluate the condition of the well including tubing, casing, and existing cement. These activities enable assessment of the casing and tubular condition for determination mechanical load limits (safe test pressure of the annuli) and cement quality for well abandonment barriers.

3.6.5 Cementing Operations

Cement slurry can be used at various points during the well P&A, including:

- Setting suspension and abandonment plugs inside the well above the reservoir;
- Forcibly pumping cement into the perforations across the tubing at the reservoir; and
- Reinstating the reservoir isolation barrier between the production casing and cap rock.

Cement spacer fluids are used in combination with cement slurry. A spacer is a fluid used to separate one special purpose liquid from another. In this case, the cement spacer is used to separate the cement slurry from fluids already in the well.

The cement spacers are pumped ahead of the cement slurry, displacing the fluids already within the well to ensure a clean pathway for the subsequent cement slurry. In some cases, the spacer and/or cement can become contaminated with the incumbent well fluids (e.g. mud or brine) and needs to be circulated out of the well. The returned cement is discharged overboard to prevent it setting and contaminating equipment. After a cement job the surface cement unit including cement tanks are washed out; these washings are discharged overboard on location.

Excess cement, barite, and bentonite (dry bulk) will either be retained on board if required for a future campaign, or discharged overboard.

3.6.6 Transponders

Transponders are small units deployed to the seabed or fixed onto equipment (e.g. tethering system anchors). They emit short high frequency chirps which are received at the vessel. This aids in the station keeping of dynamic positioning (DP) vessels at surface, and also in keeping track of deployed equipment. Transponders are typically deployed attached to a piece of equipment, or to the seabed on a frame or ballast with an indicative footprint of 1.5 m^2. Multiple transponders may be deployed over the course of the campaign. The equipment is recovered prior to or at the end of the campaign.

3.7 Phase 1b Activities

3.7.1 Subsea well infrastructure removal

During the activity the MOU and support vessels will commence removal of subsea well infrastructure subject to progress with the primary well abandonment objectives. The following equipment (described in Table 3-2) may be removed at this time:

- 7 subsea trees (B2, B3, B4, B5, B6ST1, B7, Manta 2A);
- 7 wellheads, PGBs and associated equipment such as spools and umbilicals flying leads;
- Basker manifold;
- Manifold pile – cut and recovered from below mudline
- BA PLEM1;
- UTAs (and x 5 UTA foundations); and
- parking stands.

The condition of subsea infrastructure as found at the time will be assessed prior to removal. Structures may need to be modified subsea to facilitate removal. The seabed around structure foundations may need to be excavated or structures may need to be toppled to break sediment suction. If equipment is not able to be retrieved at the time of the well abandonment campaign, the equipment will remain in situ until the next phase of decommissioning. Equipment remaining in situ will be managed as described within Section 1.5.3 of this EP and Direction 824(3).

Decommissioning of subsea infrastructure beyond that listed above is outside the scope of this EP.

3.7.2 Wellhead and Manifold Pile Removal

The wellheads and manifold pile extend deep into the seabed and are cemented in place. Full removal is not considered feasible. The wellheads and manifold pile are planned to be cut below the seabed and the cut section recovered to surface.

Cutting wellheads and the manifold pile is anticipated to take approximately 12 hours per location. An abrasive cutting tool, knife system or external diamond wire cutters may be used. Cutting will generate metal swarf and some cement cuttings at the seabed and inside the steel pipe. Cutting may also involve subsea discharges of grit and flocculent.

Obtaining access to the inside of the pile may require excavation of materials inside the pile, for example via suction dredge. If access to the inside of the pile is not possible, it may be cut externally. For an external cut the seabed around the pile may first require excavation. After cutting, any berms created by excavation will be moved back into the excavation, or excavations will be left to naturally backfill.

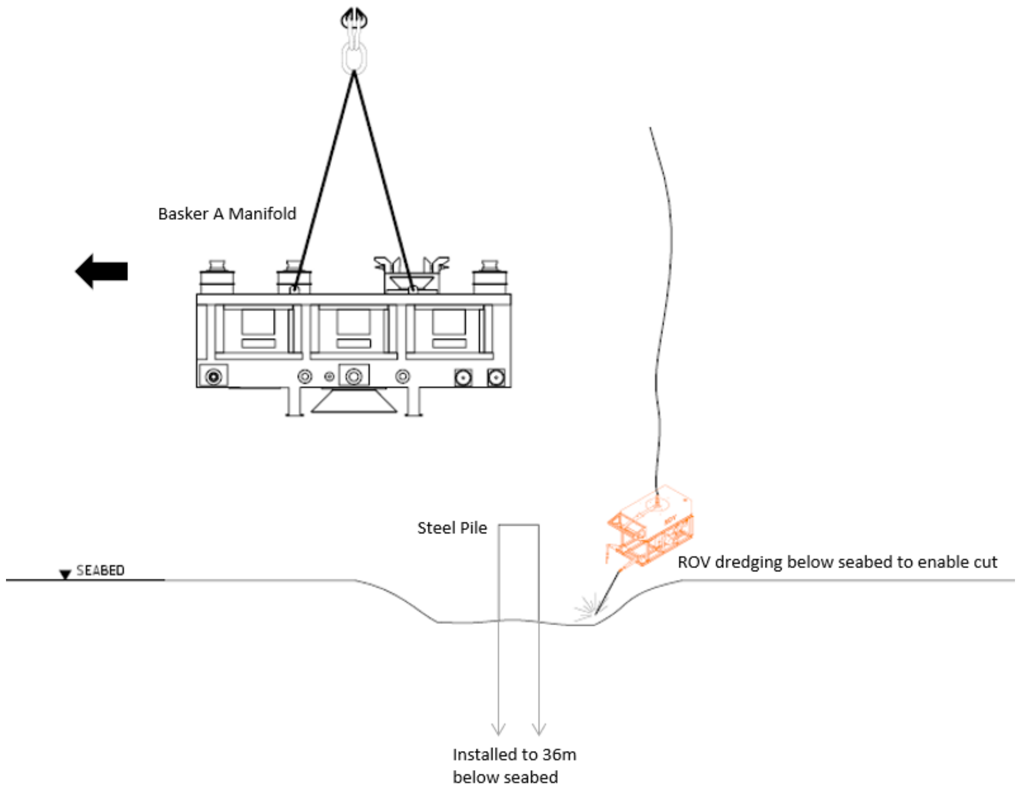


Figure 3-8 Illustration Manifold Pile

3.7.3 As-left Survey

On completion of subsea infrastructure removal activities, a survey will be conducted (Section 3.6.2) to confirm as left status of the remaining facilities and seabed. The survey may include visual, acoustic, and electromagnetic survey techniques.

3.8 Support Operations

3.8.1 Mobile Offshore Units and Operations

For the purposes of the EP, Mobile Offshore Units (MOU) refers to the vessels including construction and heavy well intervention vessels (HWIVs) and Mobile Offshore Drilling Units (MODUs). Either may be used during the activity.

The base plan is to use a self-propelled, dynamically positioned heavy well intervention vessel (Figure 3-9) to undertake the well abandonment scope. The well intervention vessel is mobile and has offline field deconstruction capability which are important attributes for this particular campaign. A different type of vessel may be used, dependent on vessel availability and suitability. Indicative MOU specifications and capacities are shown in Table 3-8.

The MOU will be equipped with:

- Pressure control equipment capable of sealing the well such as a conventional or intervention BOP, IRS, ROAM or alternate. A tethering system may be required to support the pressure control equipment installed on the well;
- Coiled tubing and/or wireline (and variants) for downhole well abandonment operations. The MOU may instead, or also be equipped with rotating equipment and drill pipe;
- Fluids handling package, providing clean-up capability of returned fluids to ≤30ppm oil in water, safe venting, and flaring capability;
- Cement unit;
- Work Class ROV;
- Either dynamic positioning (DP) or mooring system (contingency); and

- Wellhead cutting tool (may be located on an MOU or support vessel depending on the type of tool used).

Refuelling of the MOU and bunkering will be required during the activity. Bunkering and bulk transfer will be managed by the MOU.

Figure 3-9 Helix Q7000 CWIV

Table 3-8 MOU Indicative Specifications and Capacities

Technical specification	HWIV	MODU
Vessel type	Semi-submersible or monohull	Typically semi-submersible
Size	Length 100 m, Width 100 m	Length 120 m, Width 120 m
Deck height above sea level	20-30m	Similar
MPT / Derrick height above main deck	57m	Similar
Weight	30,000 T	50,000 T
Maximum persons on board	140	150 to 200
Station keeping	Dynamic positioning (DP2)	DP2 or Moored (8-12 anchors)
Helideck	Yes	Yes
Crane / Lifting capacity	150 T	150 T
Flare Boom	Height 11-15 m above sea level	Height 11-15 m above sea level
Fuel type	MDO	MDO / MGO
Bunkering	Offshore	Offshore
Maximum fuel tank size	~500 m^3	~500 m^3
Fuel oil storage capacity	1,799 m^3	1,100 m^3
Bilge Discharge OIW limit	15ppm	15ppm
Ballast Water Management	Per IMO and Australian requirements as applicable to age and class	

3.8.1.1 MOU Mooring (contingency)

The preferred MOU uses DP for positioning and will not require anchoring. Alternative MOUs may require mooring.

Should MOU mooring be required between 8 and 12 anchors could be deployed, with each anchor having a footprint of approximately 30 m^2. Each anchor is located within 2 km of the MOU, connected to the MOU via single component of combination of either fibre, wire and/or chain. Mooring analysis will determine the anchor distance from the MOU, and requirements for mooring line configuration. Pre-lay moorings are typically set by one or more anchor handling vessels prior to MOU arrival.

During the activity, it is expected that the MOU (if moored type) will be re-positioned (moorings re-set) between three locations within the BMG PSZ multiple times. These locations will be pre-planned at the Basker-A drill centre, and the Manta-2a and Basker-6 ST1 wells.

3.8.1.2 Well Displacement Fluids Management and Disposal

During well abandonment activities fluids will be circulated in and out of the well to maintain a hydrostatic barrier over the wellbore pressure, and to clean the well in preparation for cementing. Fluids will include those incumbent in the well, as well as clean fluids and chemicals specifically selected for the well abandonment program. All introduced chemicals that are planned to be discharged will be assessed in accordance with the Cooper Energy Offshore Chemical Assessment Procedure (Section 9.7).

During some of the activities, fluids recovered from the wells have the potential to be contaminated with formation fluids (hydrocarbons). The MOU will be prepared to receive formation fluids including liquids and gas within the well annuli, tubing, and flowline system. These fluids will be managed via the fluids handling package (Figure 3-10) in accordance with the Well Returns Management Philosophy.

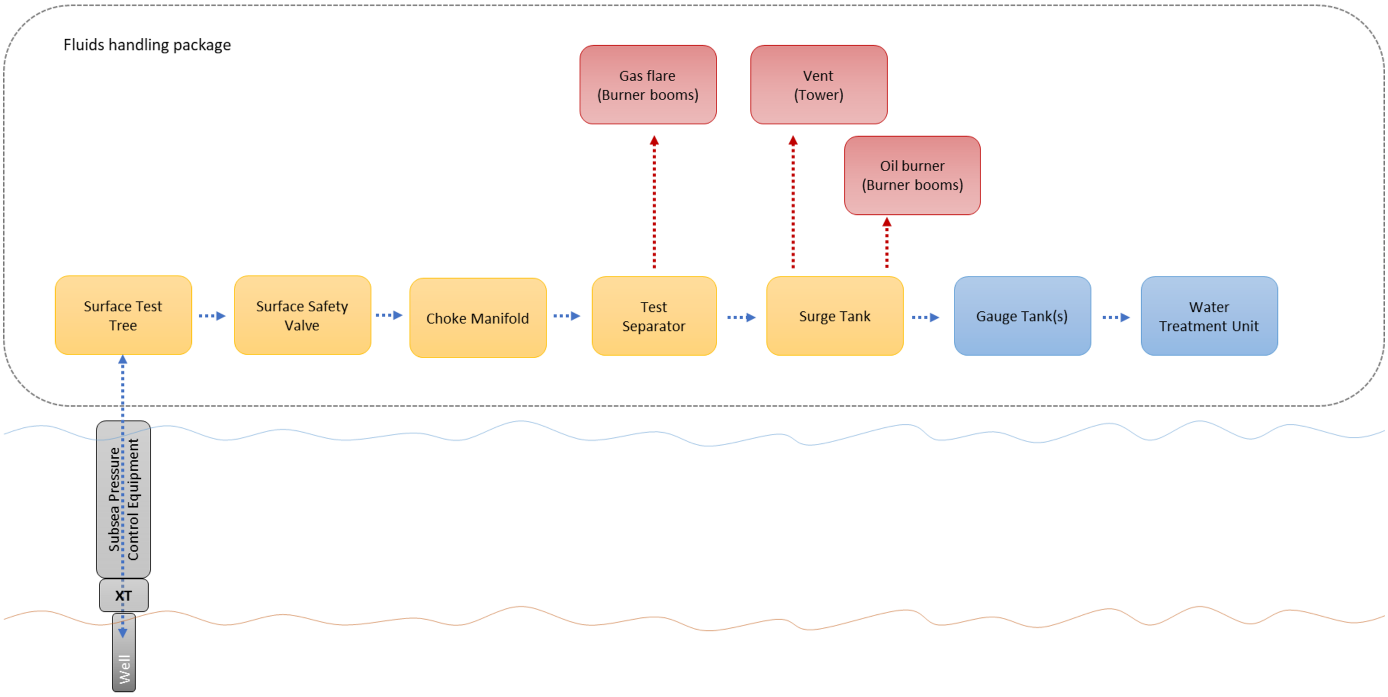


Figure 3-10 Indicative Fluids Handling Package

<u>Well Returns Management Philosophy</u>

The disposal and treatment approach for well returns that may be contaminated with formation fluids, is, in order of preference:

- Dispose of fluids into the well / reservoir (bullheading), or where bullheading cannot safely be achieved;
- Circulate fluids to the MOU for separation and treatment via the fluids handling package to ≤30ppm oil in water prior to overboard disposal, or where discharge criteria cannot be met;
- Flare (separated gas/oil) from the MOU, or
- Send contaminated returns to shore for treatment.

<u>Gas Management at Surface</u>

Well fluids returned to the MOU will pass through a pressure reduction arrangement and fluid handling system for treatment. Gas will be directed to flare or vent, depending on flow rates, volumes, and pressures.

Evaluations indicate that some of the wells have retained gas within the annuli from gas lift operations during the production phase. Gas could also enter the well via influx from the formation; this would be bullheaded back into the formation or circulated out in a controlled manner via subsea well control equipment to surface. All gas returned to the MOU will be managed via the fluids handling package.

Brines and Lost Circulation Materials

Brines are specially formulated to adequate density to control influx from the formations, and also serve to displace production tubing and annuli to clean fluid in preparation for certain well abandonment steps such as cementing. Brines are reconditioned and reused throughout the campaign, disposed of overboard if outside required technical specification, and at the end of the program. The brines utilised for the BMG P&As are expected to be sodium chloride based; this will be supplemented with seawater. Specialised chemicals including surfactant may be used to clean the well of hydrocarbons in preparation for setting cement plugs.

Lost circulation materials (LCM) may be used to plug the formation if brines begin being lost downhole. LCMs may be pumped until losses are under control, with excess LCM circulated to surface and disposed overboard to avoid obstructing P&A operations.

Incumbent well fluids

The tubing of each well is full of reservoir fluids. The current contents of well annuli are standard fluids used for well construction including:

- Either seawater or brine inhibited with Hydrosure @ 650 ppm, between the tubing and production casing,
- Water based fluids including polymer / partially hydrolysed polyacrylamide (PHPA) mud and potassium chloride brine inside the 9 5/8” x 13 3/8” annulus space.

Well fluids will be displaced during well kill and clean-up. Fluids within the well annular spaces will be displaced following cut/perforation of tubing and casing in preparation for setting cement plugs. Tubing cut/perforations will also target cutting of downhole control lines which are attached to be backside of the tubing. This will release control fluids into the well which will be displaced as above.

Mud Pits and Cleaning

There are typically mud pits (tanks) on the MOU that provide a capacity to mix, maintain and store fluids required for well activities. The mud pits and associated equipment are cleaned out during and at the completion of operations; contents and washings are discharged overboard where discharge criteria (i.e. ≤30ppm oil in water) is met.

3.8.2 Vessel Operations

A construction support vessel (CSV) will be in field following MOU, assisting the well abandonment and structure removal activities, in particular carrying out heavy lift activities. Support vessels may be in field at the same time as the MOU, assisting the well abandonment and structure removal activities. Types of vessels used to support the project works may include platform supply vessels (PSV), dive support vessels (DSV) and/or anchor handling and tow support vessels (AHTS).

Maximum presence in the field at any one time will be the MOU plus two vessels.

Vessels selected for the campaign will be managed in line with relevant International and Australian requirements.

Vessels will:

- Tow the MOU to/from and round the field if the MOU is not self-propelled;
- Arrange MOU moorings and/or similar activities such as installing tethering systems for well intervention equipment;
- Standby and support the MOU as required;
- Supply provisions (food, fuel, bulk materials) and equipment to the MOU and remove waste, equipment, and other materials from the MOU to shore base.; and
- Undertake inspection, survey, and preparatory activities (e.g., testing, cleaning, dismantling) with an ROV or towed survey equipment.

Vessels will undertake some operations and hold position using DP. Support vessels are not planned to anchor inside the operational area.

Vessel and MOU lighting is dictated by class, safety navigational and working requirements. Vessels will operate 24/7, requiring well-lit deck spaces for work activities.

Refuelling between vessels at sea will not occur during the activity. Bunkering of fuel and other fluids to the MOU will be managed by the MOU.

It is likely that vessels involved in preparation and removal activities will operate concurrently with well abandonment operations.

Vessels in transit are deemed to be operating under the Commonwealth *Navigation Act 2012* and not performing a petroleum activity, and are therefore not within the scope of this EP.

3.8.3 Helicopters

Personnel will changeout primarily by helicopter. Helicopter flights between the shore and offshore MOU are expected 5-7 times each week.

Helicopter activities will result in underwater noise, particularly when at lower altitudes for landing/take-off at the MOU.

3.8.4 Remote operated Vehicles (ROVs)

ROVs will be deployed from the MOU and support vessel/s during the activity. ROVs will be used to:

- Provide a visual feed to project teams of subsea operations and conditions.
- Dismantle and recover infrastructure.
- Locate, record, remove equipment and debris.
- Pumping of fluids including sealant and calci-wash.
- Provide subsea intervention capability, assisting in the running of the well control equipment, intervention equipment (such as tethering system clump weights, subsea transponders for DP and deployed equipment, and wellhead cutting tools) and umbilicals from the MOU to the subsea infrastructure.
- Valve manipulations on the subsea infrastructure from the MOU and support vessel.
- Perform seabed surveys as required (refer to Section 3.6.2).

3.8.4.1 Decommissioning tools

Decommissioning tools will include standard ROV tools including manipulators, brushes, and high-pressure water jets. In addition, the activity will require cutting and grinding, and flow excavation or similar to uncover buried equipment and allow access. A summary of indicative decommissioning tools are provided within Table 3-9. The tools will be used frequently (intermittent) throughout the activity.

Table 3-9 Decommissioning Tools

Tool	Application	Duration
Grinders, circular and mechanical cutters, hydraulic shears, diamond wire cutter	Subsea equipment removal above mudline.	Intermittent
Flow excavator, suction dredge	Deburial and burial operations	Intermittent
Abrasive cutting tool	Wellhead removal, above mudline via high-energy jet of water-borne abrasive particles.	Continuous, 12 hrs per well
High pressure water jet	Subsea equipment cleaning	Intermittent

3.9 Contingency and Alternative Operations

Aside from the activities described in Section 3.6 – 3.8, additional activities may be required as contingency or alternatives. These have been addressed as planned activities in the impact assessment.

3.9.1 MOU Emergency Disconnection

An emergency disconnect may be implemented if the MOU is required to rapidly disengage from the well, e.g. in the event the MOU drifts off station due to a loss of power and/or DP, or loss of multiple moorings in the case of a moored MOU. The pressure control equipment is retained on the well and automatically shuts-in the well via sealing and shearing rams.

The contents of the riser system at the time (above the sealing rams) would be retained by the riser retainer valve in the event of an emergency quick disconnect (EQD).

3.9.2 Milling Operations

Milling may be required where cement behind the well casing is not adequate to provide formation (reservoir) isolation for abandonment purposes. In this situation a section of the casing may be milled out of the well to provide access to the formation before proceeding with setting the permanent barrier.

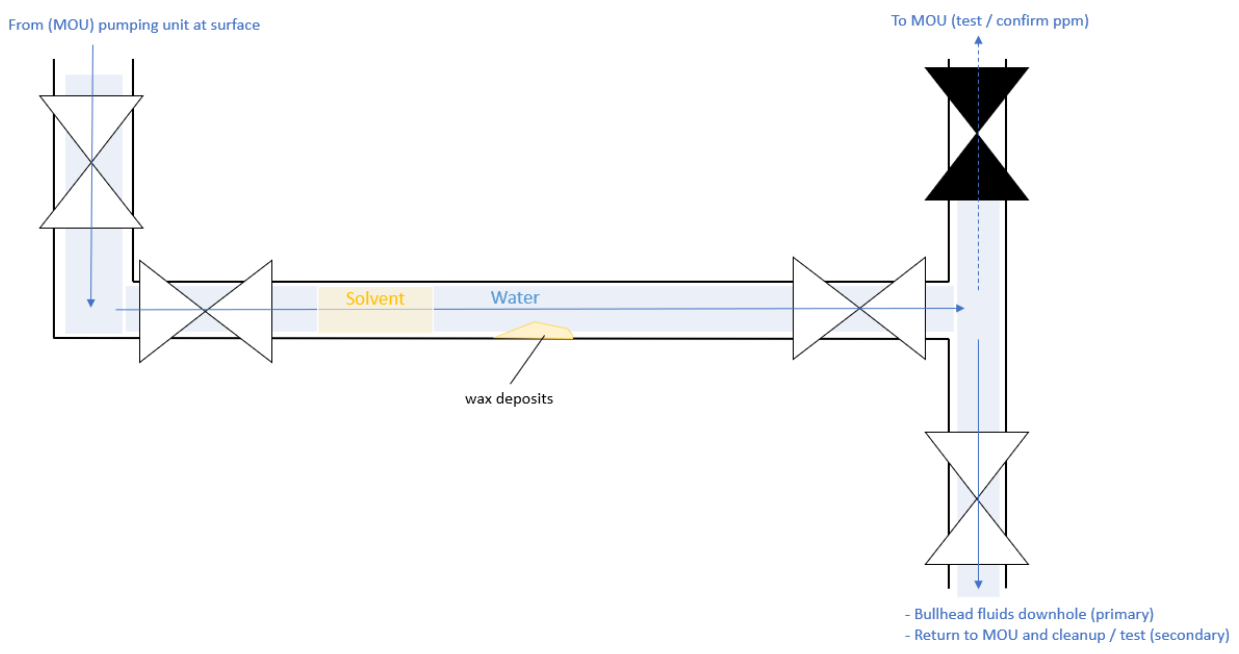
Milling operations would be undertaken with water-based muds (WBM) down hole, of suitable density and viscosity to allow circulation of metal swarf to the surface.

A swarf handling unit or similar solids control will be installed on the MOU. The swarf handling unit separates metal shavings from fluid and directs it to storage skid. The metal shavings will be sent ashore. Recovered WBM will be circulated as part of the brine system with intermittent discharges during and at the end of the activities. Alternatively, depending on technology readiness final operational plans swarf may be directed and retained downhole below the milled section.

Alternative technologies that may be used to replace milling are Perf/Wash/Cement whereby the casing is perforated using high shot perforating guns and the broken-down cement behind the casing is washed out via jetting nozzles. New cement is then squeezed into the perforations restoring the barrier. Thermite technology may be used to remove all tubulars and poor-quality cement to be replaced by the thermite plug and fresh cement.

3.9.3 Wax Management

BMG crude has a waxy component with a relatively high pour point, particularly at B6. The wax has an appearance temperature of around 35-45°C hence at Bass Strait temperatures it solidified as production fluids cooled with distance from the well. During the production phase this led to blockages in the B6 flowline which were resolved (ROC, 2010), though wax is predicted to remain within some of the oil flowlines and production tubing. Wax build-up was managed during the production and cessation phase using pour point depressant and solvents; these are hydrocarbon-based products. Records from the production and cessation phase indicate diesel was the most successful solvent at dissolving wax. Hydrocarbon-based products may be utilised during the Phase 1 campaign to clean wax from flowlines and production tubing; this reduces handling risks at surface during future processing. To manage the risk of retaining hydrocarbon-based products within the flowline hydrocarbon-based solvents will only be applied after clear circulation is demonstrated. The flush fluids will be managed in line with the well returns management philosophy whereby liquid hydrocarbons (including hydrocarbon-based products) will be separated from aqueous fluids to ≤30ppm via the fluids handling package.



3.9.4 Drilling out Cement

Coiled tubing may be used during the activities to drill out cement. This is planned at the Basker-5 well which was suspended in 2012 with cement plugs. The cement suspension plugs are likely to be drilled out prior to setting new abandonment plugs. Cement cuttings generated by the activity will be returned to surface where they will be separated from the well fluids. Well fluids will be run through the MOU fluids handling package. Cement cuttings will be disposed of downhole or returned to shore for disposal.

3.9.5 Emergency Response

The MOU and support vessels will provide site-based emergency response support including, but not limited to:

- Fire-fighting support,
- Fast rescue activities,
- Over-the-side watch,
- Oil spill response. Where available, the MOU and support vessels may support oil spill response strategies such as:
    - Monitor and evaluate,
    - Source control,
    - Offshore containment and recovery.

Further description of the campaign oil spill response strategies are included within Section 7.

3.10 Summary of Disturbance, Discharges and Emissions

Table 3-10 describes the expected planned disturbance, discharges and emissions from the activity. Environmental Aspects are described in detail in Section 6.

Table 3-10 Summary of Planned Disturbance, Discharges and Emissions

Activity	Planned Disturbance, Discharge or Emission	Environmental Aspect (Refer to Section 6)	Details (includes indicative volumes where relevant)
Phase 1a Activities			
Facility cleaning and preparation	Liquid scale dissolver / calci-wash used for equipment cleaning	Subsea Operational Discharges	10 m^3 Varying batches approx. 320L
	Disturbance from cutting and removing to enable clear access	Seabed Disturbance	Within the existing infrastructure footprint
	Preparation work may include subsea bracing structures or pile for tethering system, adjusting umbilicals to allow for piles or clump weight placement; mooring pre-lays (if needed).	Seabed Disturbance	Within the existing infrastructure footprint
		Underwater sound emissions	Transponders will emit impulsive sound.
	Gravity anchors or suction piles for seabed tethering	Seabed Disturbance	Gravity anchor footprint = 20 m^2. Four anchors required per well (seven wells total). Footprint will be within 100 m of the well.
Seabed Survey	Survey equipment used during seabed survey will result in underwater sound emissions.	Underwater Sound Emissions	Maximum expected sound level will be 235 dB re 1 µPa RMS from sidescan sonar.
Well Abandonment	Inhibited seawater trapped behind tree cap	Subsea Operational Discharges	Per tree: 60 L

Activity	Planned Disturbance, Discharge or Emission	Environmental Aspect (Refer to Section 6)	Details (includes indicative volumes where relevant)
Well intervention and suspension	Trapped gas within the SST	Subsea Operational Discharges	Per tree: 60L (6 m^3 std cond) equivalent to 0.001 MMscf
	Actuation of tree valves	Subsea Operational Discharges	1 m^3 control fluid per well. Varying batches
	Under normal conditions the riser system is displaced to clean brine or seawater prior to disconnection.	None	Displaced fluids are returned to the fluids handling package and not discharged subsea
	Riser flush with MEG prior to opening well, on well entry / exit	Surface Operational Discharges	Up to 2.5 m^3 discharged per flush.
	Downhole safety valve function	Subsea Operational Discharges	5 L control fluid per function of the SSSV
	Pressure control equipment function testing	Subsea Operational Discharges	Up to 2.1 m^3 per landout then each test period (14 – 21 days)
	Where possible, flowline flushing will result in downhole discharges, with no discharges to the marine environment. However, if bullheading is obstructed, fluid will be return to the MOU fluids handling package.	Surface Operational Discharges	Flowline volumes as per Table 3-2.
	Gas within the flowline system will be returned to the MOU and managed via the fluids handling package. Gas is flared where possible.	Atmospheric Emissions Light Emissions	Flaring / venting equivalent to 1.624 MMscf (total)
	Surface returns of incumbent liquid and gas from tubing and annular spaces will be processed by a fluids handling package and / or tested to ensure ≤30ppm prior to discharge. Gas is flared where possible.	Atmospheric Emissions Light Emissions	Flaring / venting (0.4 MMscf per well)
		Surface Operational Discharges	Incumbent fluids include: • 30 m^3 per well of brine / formation fluids from the production tubing. • 90 m^3 per well of inhibited water / formation fluids from the production tubing annular spaces and wellbore preparation fluids. • 30 m^3 per well of brine / formation fluids / WBM and 0.5 m^3 of control fluid from the surface casing annular spaces. Will be discharged per well returns management philosophy.
	An ROV will cut or disconnect the flowline jumpers, flowlines, electrical and hydraulic leads from the SST and lay them on the seabed. Once lines are disconnected small quantities of line contents will begin to disperse into the sea.	Subsea Operational Discharges	Maximum 10 m^3 of inhibited fluids (total), and a potential 0.2 m^3 diesel; based on UK offshore industry rule of thumb that 10% of volume is discharged during disconnection of lines. Residual

Activity	Planned Disturbance, Discharge or Emission	Environmental Aspect (Refer to Section 6)	Details (includes indicative volumes where relevant)
	Content may include residual quantities of chemicals and hydrocarbons including liquids and/or gas.		gas volumes in the order of 0.16m^3 at seafloor pressure.
	When removed, SST may be wet parked on the seabed.	Seabed Disturbance	Each SST has a footprint of approximately 20 m^2.
Restoring Cap Rock	Testing and operation of the pressure control equipment will result in discharges of control fluids.	Subsea Operational Discharges	Up to 2.1 m^3 per landout and subsequent test. Test period (14 – 21 days). Smaller discharges (up to 700L) during functioning, deployment and recovery.
	The wells are circulated clean before pulling tubing to surface, checking well contents are ≤30ppm oil in water.	Surface Operational Discharges	Well kill and clean-up fluid (brines, seawater, viscous pills) with a total volume of 500 m^3 per well. Lost circulation material (LCM) of 6m^3 per well. Fluids circulated to storage tank for re-use where required on next wells and to specification. Will be discharged per well returns management philosophy.
	Cementing to install permanent reservoir barriers	*Refer to Cementing below*	*Refer to cementing below*
Logging	Downhole drift runs and data acquisition logging activities	*None*	*No discharges or emissions*
Cementing	Cement spacer fluid and/or cement contaminated with incumbent well fluids (e.g. mud / brine) will be discharged at the surface.	Surface Operational Discharges	Mix of cement, wellbore preparation fluids / spacer and freshwater / seawater, approximately 3 m^3 per cement job
	Cement tank washing	Surface Operational Discharges	3 m^3 per cement job
	Cement slurry returns from well (contingency)	Surface Operational Discharges	11m^3 cement slurry and brine displaced from well in case of instability in the plug placement phase
	Excess dry cement	Atmospheric Emissions	10 MT per well of dry cement bulk
	Dry bulk transfer losses	Surface Operational Discharges	12 m^3 of cement per well
Transponders	Transponders may be deployed on a frame or ballast	Seabed Disturbance	Frame / ballast has a footprint of 1.5 m^2
Phase 1b Activities			
Subsea well infrastructure removal	Seabed excavation and wet parking	Seabed Disturbance	Footprint will be within the existing PSZ.
	Cutting tools required to remove wellhead and manifold pile will generate	Seabed Disturbance	Grit: 1.7 Mt per hour (3 – 7 hours to complete per operation)

Activity	Planned Disturbance, Discharge or Emission	Environmental Aspect (Refer to Section 6)	Details (includes indicative volumes where relevant)
Wellhead and Manifold pile removal	metal swarf and some cement cuttings at the seabed and inside the steel pipe. Cutting may also involve subsea discharges of grit and flocculent		Flocculent: 150 L per operation Metal swarf and cement cuttings: 0.5 Mt per operation
		Underwater sound emissions	Cutting tools will generate continuous noise when in use
	Excavation / suction pile dredging for access	Seabed Disturbance	Within the existing footprint
As-left Survey	Survey equipment used during seabed survey will result in underwater sound emissions.	Underwater Sound Emissions	Maximum expected impulsive sound level will be 235 dB re 1 µPa RMS from sidescan sonar.
Support Operations			
MOU Operations	Planned marine discharges from the MOU will include: • Sewage and grey water • Putrescible waste • Cooling water and brine • Deck drainage and bilge	Planned Vessel Discharges	For the duration of the activity (130 days either as a single or split campaign)
	Dynamic Positioning System (if used)	Underwater Sound emissions	Continuous; noise levels may vary with environmental conditions and operating requirements, within defined safety parameters.
	MOU mooring system (if used)	Seabed Disturbance	Anchor footprint of 30 m^2 per anchor, 8-12 anchors. 3 different locations (well centres).
	Well displacement fluids management and disposal	Surface Operational Discharges	*[included in descriptions above]*
	Fluid pit washing	Surface Operational Discharges	Brines, WBM, wash water. Approximately 1000 m^3 at the end of the campaign.
	Safety flaring and venting	Atmospheric Emissions	*[included under well abandonment descriptions above]*
Vessel Operations	Planned marine discharges from the vessels will include: • Sewage and grey water • Putrescible waste • Cooling water • Brine and treated ballast • Deck drainage and bilge	Planned Vessel Discharges	For the duration of the activity (130 days either as a single or split campaign)
	Dynamic Positioning System / thrusters	Underwater Sound emissions	Continuous; noise levels may vary with environmental conditions and operating requirements, within defined safety parameters.
Helicopter	Helicopter will result in some level of underwater noise, particularly when at	Underwater Sound emissions	Continuous noise level, limited to tens of metres from the source.

Activity	Planned Disturbance, Discharge or Emission	Environmental Aspect (Refer to Section 6)	Details (includes indicative volumes where relevant)
	lower altitudes for landing/take-off at the MOU (Richardson et al. 1995).		
ROVs	Control fluids are used within a closed system	None	*None*
Contingency and Alternative Operations			
MOU Emergency Disconnection	The contents of the riser system at the time (above the sealing rams) would be retained by the riser retainer valve in the event of an emergency quick disconnect (EQD).	*None*	*None*
Milling Operations	Milling will be undertaken by a reverse milling tool, or any solids will be captured and returned to shore.	*None*	*None*
Wax Management	Wax build-up within the production tubing may need to be managed using wax dissolvers.	Surface Operational Discharges	Fluids will be treated to meet discharge criteria and discharged overboard or captured and disposed onshore
Drilling out cement	Cement cuttings will be returned to the MOU, separated from well fluids and disposed downhole / shipped to shore.	None	*None*
Emergency Response	The MOU and support vessels will provide site-based emergency response support	Further description of the campaign oil spill response strategies are included within Section 7.	

4 Description of the Environment

A detailed description of the environment is provided in Addendum 1 for all physical, ecological and social receptors. This section provides regulatory context, description of the environment that may be affected (EMBA), regional setting and a summary of the key ecological and social receptors.

Threatened species recovery plans, threat abatement plans and species conservation advices relevant to the receptors identified in this section are detailed in Table 2-4.

4.1 Regulatory Context

The OPGGS(E) Regulations 2009 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 Regulation 13(2) of the OPGGS(E), this section (and associated appendices) describes the physical setting, ecological receptors, and social receptors, of the receiving environment relevant to the described Activity.

A greater level of detail is provided for certain receptors, as defined by Regulation 13(3) of the OPGGS(E) Regulations 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. a Commonwealth marine area within the meaning of that Act; or
    ii. a Commonwealth land within the meaning of that Act.

With regards to 13(3)(d) and I more detail has been provided where threatened or migratory species have a spatially defined biologically important area (BIA) – as they are spatially defined areas where aggregations of individuals of a regionally significant species may display biologically important behaviours such as breeding, foraging, resting or migration.

With regards to 13(3)(f) more detail has been provided for:

- Key Ecological Features (KEFs) as they are considered a conservation value under a Commonwealth Marine Area (CMA), and
- Australian Marine Parks (AMPs) as they are enacted under the EPBC Act.

4.2 Environment that May be Affected (EMBA)

The EMBA by the activity has been defined as an area where a change to ambient environmental conditions may potentially occur as a result of planned activities or unplanned events. It is noted that a change does not always imply that an adverse impact will occur; for example, a change may be required over a particular exposure value or over a consistent period of time for a subsequent impact to occur. Table 4-1 and Figure 4-1 detail the Project Areas associated with the activity that are used to describe the environmental context relevant to the activity and to support the impact and risk assessments.

Table 4-1 BMG Closure Project (Phase 1) specific Project Area descriptions

Project Area	Description
Operational Area	For the activity, the Operational Area is a 2 km area surrounding the BMG facilities (as described in Section 3.1.1). Planned operational discharges, physical presence and seabed disturbance that occur during the activity will be within the operational area. The EPBC Protected Matters Report for the Operational Area is in Appendix 2.1

Project Area	Description
Spill EMBA	The boundary of the EMBA is defined using the hydrocarbon exposure (low) thresholds (see Table 6-21) for the accidental release of marine diesel oil (MDO) from a vessel collision and the release of light crude oil from a loss of well control (LOWC) event (see Section 6.7). Based on stochastic modelling results (RPS, 2020), the EMBA covers waters from Victoria and Tasmania, through to south-eastern Queensland and out to Lord Howe Island (Figure 4-1). The EMBA overlaps four State water boundaries (Victoria, Tasmania, New South Wales and Queensland), six IMCRA Provincial Bioregions (Central Eastern Shelf Province, Central Eastern Province, Southeast Shelf Transition, Southeast Shelf Transition, Bass Strait Shelf Province, Tasmanian Shelf Province) and three international economic Exclusive Zones (EEZ) [New Caledonian, New Zealand and Norfolk Island], which are described further in Addendum 1. The EPBC Protected Matters Report for the EMBA is in Appendix 2.3

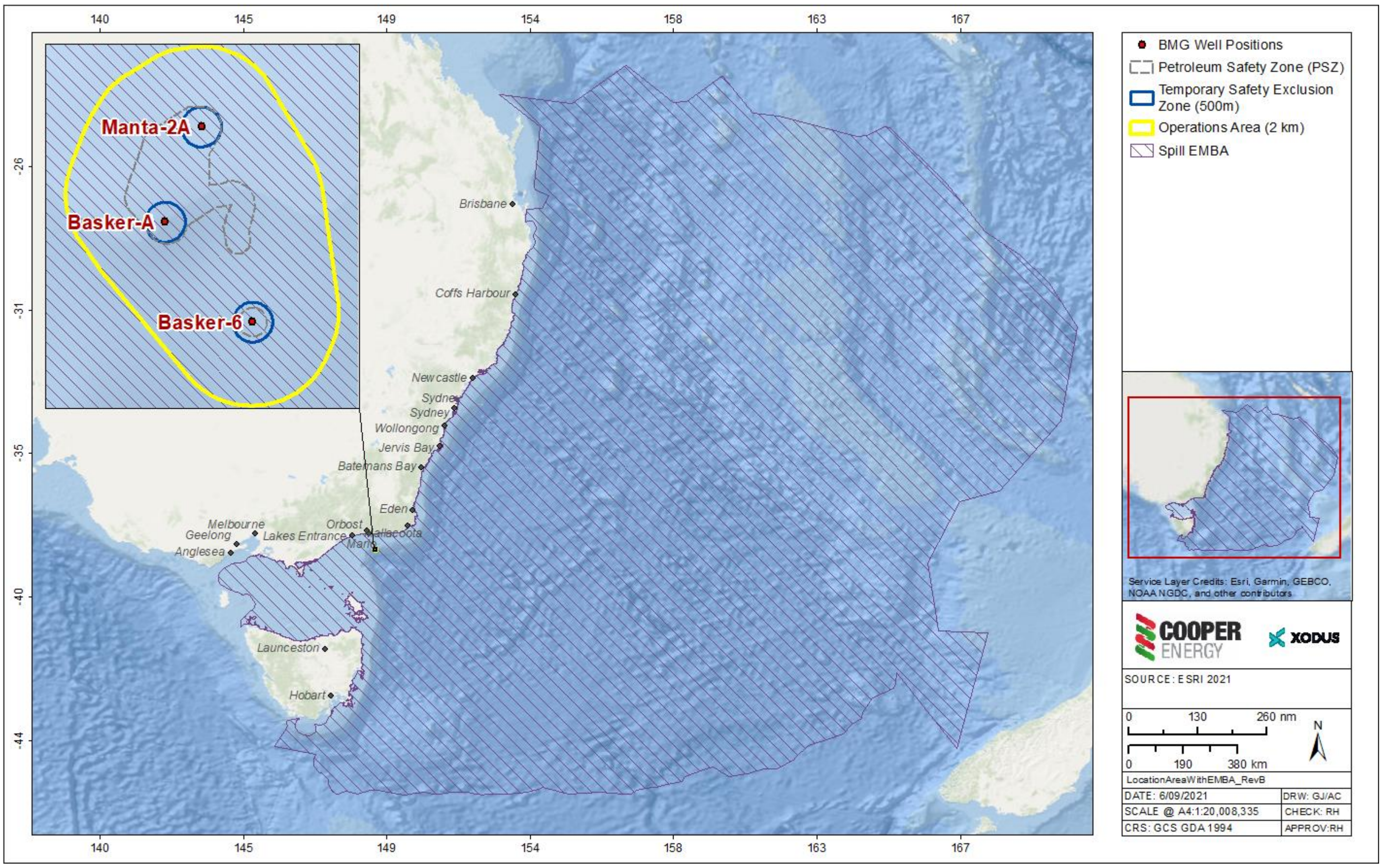


Figure 4-1: BMG EMBA and Operational Area

4.3 Regional Setting

The BMG wells are in Commonwealth waters off Victoria's south-east coast in the Bass Strait.

The BMG wells are in water depths ranging from 135 m to 270 m within the Gippsland Basin, approximately 55 km south of Marlo and 80 km southwest of Point Hicks in Victoria. The Gippsland Basin occurs within the Commonwealth south-east Marine Bioregion and the Twofold Shield Meso-scale Bioregion. The continental shelf within the Twofold Shelf region has a very steep inshore profile (0–20 m), with a less steep inner (20–60 m) to mid (60–120 m) shelf profile, and a generally flatter outer shelf plain (120–160 m) south-west of Cape Howe (IMCRA 1998). The wide shelf area is relatively featureless and flat (Santos 2015). The sediments on Twofold Shelf are poorly sorted, with a median of 92% sand and 8% gravel; they are composed of organic material, with a median of 64.5% calcium carbonate (IMCRA 1998). The seabed is comprised of fine to coarse sand and areas of shell (CEE Consultants 2003).

In 2020, Deakin University and the Australian Institute of Marine Science (AIMS) undertook a desktop study into the Marine Communities of Cooper Energy Offshore Facilities (Ierodiaconou et al., 2021). The study utilised historical industry remotely operated vehicle (ROV) imagery to describe fish, mobile invertebrate, mammals, and epibenthic communities along flowlines and umbilicals, and around three wells and the manifold. The imagery was collected over multiple years of operation between 2009–2020 but was available only in high definition for flowline and umbilical surveys undertaken in 2020.

The study identified:

- a total of 15,664 mobile animals from 70 taxa were observed on ROV video collected around infrastructure during this study. These represent bony and cartilaginous fishes, Australian fur seal (*Arctocephalus pusillus doriferus*) and mobile invertebrates.
- epibenthic communities on the surface of flowline structures were found to be primarily sand, biofilm (thin layer of epibenthos) and shells. Black corals/octocorals and encrusting sponges were observed on wells in more recent surveys.
- Fish assemblages present along wells and flowlines generally reflect those known to occur in the region, however many species common to the region were missing in this study, likely related to the use of industry ROV and its effect on fish behaviour.
- Noteworthy observations include Australian fur seals (*A. pusillus doriferus*) (EPBC Listed threatened species), long-lived western foxfish (*Bodianus frenchii*) more typically known to occur in Western Australia and a tentative identification of handfish (*Brachionichthyidae* spp.).

Outcomes of the study are provided in the remainder of this EP where relevant.

Water quality is expected to be good quality and typically of offshore marine environment. Gippsland Basin is well mixed given it is a higher-energy environment exposed to frequent storms and significant wave. Average current speeds observed at BMG range between 0.18 m/s to 0.24 m/s, with maximum current speeds 0.59 m/s (Dec) to 0.96 m/s (Mar) (RPS, 2020). Monthly average sea surface temp 14.1°C (Sept) to 20.5°C (Mar) (RPS, 2020). Salinity is expected to be relatively consistent throughout the year ranging at 35.4-35.6 psu (RPS, 2020).

Wave energy in this bioregion is relatively low compared to the Otway and central Bass Strait regions. Water temperatures are also generally warmer than elsewhere on the Victorian open coast due to the influence of the East Australian Current (Parks Victoria 2003).

Upwelling zones are important for marine ecosystems due to the elevated primary and secondary productivity associated with upwelling systems (Huang & Hua Wang, 2019). Upwelling conditions are common along the eastern and southern coastlines of Australia, with a recent study identifying upwelling in the southern NSW / eastern Victoria area throughout the year, with a stronger upwelling event in the autumn. The NSW upwelling system is formed of several interconnecting upwelling events, the closest of which to the Gippsland area is the East of Eden Upwelling. The NSW coastal upwelling system is a persistent/semi-persistent system occurred continuously from austral spring to autumn, although during mid to late autumn the upwelling may be either lacking or isolated and restricted to the coast (Huang & Hua Wang, 2019).

The coast is dominated by dunes and sandy shorelines, with occasional rock outcrops; and there are extensive areas of inshore and offshore soft sediments habitat (Barton et al. 2012). This region also has occasional low-relief reef immediately beyond the surf zone (Parks Victoria 2003).

4.4 Ecological and Social Receptors

The following tables show the presence of ecological (Table 4-2) and social (Table 4-3) receptors that may occur within the Operational Area and spill EMBA. Further descriptions and maps of these ecological and social receptors are provided in the Cooper Energy Description of the Environment: Cape Jaffa (South Australia) to Gladstone (Queensland) (COE-EN-EMP-0001) [Addendum 1].

Examples of values and sensitivities associated with each of the ecological or social 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 identified in the EPBC Protected Matter searches (Appendix 2).
- 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 searches (Appendix 2).
- They provide an important link to other receptors (e.g. nursery habitat, food source).
- They provide an important human benefit (e.g. recreation and tourism, aesthetics, commercial species, economic benefit).

4.4.1.1 Ecological Receptors

Table 4-2 Presence of ecological receptors within the Operational Area and EMBA

Receptor Group	Receptor Type	Receptor Description	Values and Sensitivities	Operational Area[1]		Spill EMBA[2]	
Habitat	Shoreline	Rocky	• Foraging habitat • Nesting or Breeding habitat • Haul-out sites	-	**Not present** The Operational Area does not include the coastal environment.	✓	**Present** The coastal environment within the spill EMBA is comprised predominately of sandy shores with sections of rocky outcrops. Each of these shoreline types has the potential to support different flora and fauna assemblage due to the different physical factors (e.g. waves, tides, light etc.) influencing the habitat; for example: • Australian fur-seals are also known to use rocky shores for haul-out and/breeding. • Birds species may use rocky and sandy areas for roosting and breeding sites. • Marine turtles use sandy beaches for nesting. • Rocky coasts can provide a hard substrate for sessile invertebrate species (e.g., barnacles, sponges etc) to attach to; and • Artificial structures (e.g., groynes, jetties) while built for other purposes (e.g. shoreline protection, recreational activities) can also provide a hard substrate for sessile invertebrates to attach to. Detailed existing environment descriptions of these shoreline habitats within the spill EMBA is described in Addendum 1, Section 3.1.
		Sandy	• Foraging habitat • Nesting or Breeding habitat • Haul-out sites	-		✓	
		Artificial structure	• Sessile invertebrates	-		✓	
	Mangroves (Dominant Habitat)	Intertidal/ subtitle habitat, mangrove communities	• Nursery habitat • Breeding habitat	-	**Not present** The Operational Area does not include the coastal environment.	✓	**Present** Mangrove dominated habitat exists within Bass Strait, Gippsland, Central NSW and South East Queensland within the spill EMBA. • Mangroves have been recorded in all Australian states except Tasmania. One species, *Avicennia marina*, occurs in Victoria; typically, in inlets or estuaries (e.g. Corner Inlet). Species diversity increasing as they occur further to the north in NSW and Queensland. Mangrove habitats nearshore along the Victorian coast are distributed in South Gippsland around the French Island National Park and coast around Port Welshpool. • Dominant mangrove habitat based on NISB Habitat Classification Scheme are present in the spill EMBA within Victoria, NWS and Queensland. Detailed existing environment descriptions of these mangrove habitats within the spill EMBA is described in Addendum 1, Section 3.2.
	Saltmarsh (Dominant Habitat)	Upper intertidal zone, Salt marsh habitat, habitat for fish and benthic communities	• Nursery habitat • Breeding habitat	-	**Not present** The Operational Area does not include the coastal environment.	✓	**Present** Saltmarsh are identified in the spill EMBA. • Saltmarsh habitats are widespread along the Australian coast and mostly occur in the upper intertidal zone. • Saltmarsh environments are much more common in northern Australia (e.g. Queensland), compared to the temperate and southern coasts (i.e. New South Wales, Victoria, Tasmania) (Boon et al. 2011). • Saltmarsh dominated habitat with greater than 10% coverage of saltmarsh occurs along most of the coastline of the spill EMBA in Victoria. • In the broader region within the spill EMBA, extensive saltmarsh occurs within the Corner Inlet-Nooramunga complex, and behind the sand dunes of Ninety Mile Beach in Gippsland (Addendum 1, Section 3.3). Detailed existing environment descriptions of these shoreline habitats within the spill EMBA is described in Addendum 1, Section 3.3.
	Soft Sediment	Predominantly unvegetated soft sediment substrates	• Key habitat	✓	**Present** The Operational Area is located on the mid-outer continental shelf and upper slopes of the Bass Canyon. The benthic habitat within the Operational Area is expected to be largely featureless, with the seabed comprising of silty sand and limited availability of hard substrate (Addendum 1, Section 3.5).	✓	**Present** • Unvegetated soft sediments are a widespread habitat in both intertidal and subtidal areas, particularly in areas beyond the photic zone. • The Gippsland Basin is composed of a series of large sediment flats, interspersed with small patches of reef, bedrock and consolidated sediment.

Receptor Group	Receptor Type	Receptor Description	Values and Sensitivities	Operational Area[1]		Spill EMBA[2]	
					During habitat studies conducted within the Operational Area, Ierodiaconou et al (2020) described the seafloor as a region where a muddy sand biotope dominates and is quite different to the upper inner shelf. Detailed existing environment descriptions of soft sediment habitats within the Operational Area is described in Addendum 1 Section 3.5		• The biodiversity and productivity of soft sediment habitat can vary depending upon depth, light, temperature and the type of sediment present. Detailed existing environment descriptions of soft sediment habitats within the spill EMBA is described in Addendum 1, Section 3.5.
	Seagrass	Seagrass meadows (Dominant Habitat)	• Nursery habitat • Food source	-	**Not present** The Operational Area is in deep water (135 m – 270 m) and beyond the expected photic zone. Studies undertaken have not identified seagrass in the Operational Area (Ierodiaconou et al, 2021). The closest seagrass dominated habitat is present around Lakes Entrance in nearshore waters.	✓	**Present** • Seagrass dominated habitat occurs around Melbourne and extends along the Gippsland coast along NWS and to South Eastern Queensland (Addendum 1, Section 3.6). • Seagrass generally grows in soft sediments within intertidal and shallow subtidal waters where there is sufficient light. • In East Gippsland, seagrass meadows are common in sheltered bay environments or around small offshore islands. • There is a distinction between tropical and temperate seagrasses, and the approximate latitude for the change occurs at Moreton Bay (southern Queensland) (Kirkman, 1997). As such the spill EMBA is expected to include largely temperate species, with some tropical species within northern extent of the spill EMBA. Food source function of seagrass within the spill EMBA is expected to reflect similar tropical/ temperate species diversity. Detailed existing environment descriptions of seagrass habitats within the spill EMBA is described in Addendum 1, Section 3.6.
	Algae	Macroalgae (Dominant Habitat)	• Nursery habitat • Food source	-	**Not present** The Operational Area does not include the nearshore intertidal and tidal zones where macroalgal communities may be present (Addendum 1, Section 3.7.2). The Operational Area is not a dominant macroalgae habitat based on the national mapping available from OzCoasts (2015), and macroalgae was not identified in the Operational Area during recent studies (Ierodiaconou et al, 2021).	✓	**Present** • Benthic microalgae are ubiquitous in aquatic areas where sunlight reaches the sediment surface. Macroalgae communities are generally found on intertidal and shallow subtidal rocky substrates. They are not common as a dominant habitat type in East Gippsland, NSW or Queensland but do occur in mixed reef environments. • Dominant habitat identified within the spill EMBA include east of Melbourne and near Mallacoota. Species may include bull kelp and other brown algae species. Detailed existing environment descriptions of algae habitats within the spill EMBA is described in Addendum 1 Section 3.7.2.
	Coral	Hard and soft coral communities (Dominant Habitat)	• Nursery habitat • Breeding habitat	✓	**Present** The Operational Area is in deep water (135 m – 270 m) and beyond the photic zone, therefore hard corals are unlikely. Soft corals can occur beyond the photic zone. During a recent study, soft corals were identified on BMG infrastructure, with black / octocorals making up 22% of the epibenthic communities at Manta-2A (Ierodiaconou et al, 2021). Black / octocorals were not identified on the flowlines during this study.	✓	**Present** • Hard corals typically only occur as a dominant benthic habitat in warmer Queensland waters, with the southern limit of reef development around Lord Howe Island. However, hard coral species have also been recorded in south-eastern Australia (e.g. Kent Group Marine Protected Area near Flinders Island; Freycinet Commonwealth Marine Park, eastern Tasmania; and Wilsons Promontory National Park, Victoria). • Soft corals can be found at most depths throughout the continental shelf, slope and off slope regions, to well below the limit of light penetration. Soft corals (e.g. sea fans, sea whips) occur as part of mixed reef environments in waters along the East Gippsland coast and can occur in a variety of water depths. Detailed existing environment descriptions of coral habitats within the spill EMBA is described in Addendum 1, Section 3.8.
	Threatened Ecological Communities (TECs)	Native plants, animals and other organisms interacting with unique habitats	• Provides habitat for flora and fauna • Coastal buffer against erosion • Nursery habitat • Breeding habitat	-	**Not present** There are no TECs located within the Operational Area (Appendix 2.1).	✓	**Present** 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). • 25 TECs were identified to occur within the spill EMBA (Appendix 2.4). Detailed existing environment descriptions of these TECs within the spill EMBA is described in Addendum 1, Section 3.
Marine Fauna	Plankton	Phytoplankton and zooplankton	• Food Source	✓	**Present** Phytoplankton and zooplankton are widespread throughout oceanic environments and is expected to occur within the Operational Area.	✓	**Present** Phytoplankton and zooplankton are widespread throughout oceanic environments and is expected to occur within the spill EMBA.

Receptor Group	Receptor Type	Receptor Description	Values and Sensitivities	Operational Area[1]		Spill EMBA[2]	
					Increased abundance and productivity can occur in areas of upwelling e.g. Upwelling East of Eden KEF, which intersects the Operational Area (Addendum 1, Section 3.9). Detailed existing environment descriptions of plankton within the Operational Area is described in Addendum 1, Section 3.9.		• Increased abundance and productivity can occur in areas of upwelling e.g. Upwelling East of Eden KEF, upwelling off Fraser Island which both intersect the spill EMBA (Addendum 1, Section 3.9) Detailed existing environment descriptions of plankton within the spill EMBA is described in Addendum 1, Section 3.9.
	Marine Invertebrates	Benthic and pelagic invertebrate communities	• Food Source • Commercial Species	✓	**Present** A variety of marine invertebrate species may occur within the Operational Area. • Epifauna is expected to be sparse given the water depths. Studies of infauna in shallower waters of East Gippsland has indicated a high species diversity and abundance. Infauna may also be present within the sediment profile of the Operational Area (Addendum 1, Section 3.11). • Ierodiaconou et al (2021) described invertebrate communities around the infrastructure and flowlines, and concluded that differences is assemblages across the site are mostly driven by species habitat and depth preferences. • Invertebrates of commercial importance identified in the study included the Tasmanian giant crab (*Pseudocarcinus gigas*), cuttlefish (*Sepiidae* spp.), octopus (*Octopodidae* spp.), arrow squid (*Nototodarus gouldi*), and Balmain bug (*Ibacus peronii*) (Ierodiaconou et al, 2021). • A report prepared by SETFIA (2020) did not identify any fisheries which target invertebrate species (i.e. crab and rock lobster fishery) as actively fishing within the Operational Area. • The threatened marine invertebrate species, Tasmanian live-bearing seastar, is not present in the Gippsland and therefore is not expected to be present within the Operation Area (Appendix 2.1). Detailed existing environment descriptions of marine invertebrates within the Operational Area is described in Addendum 1, Section 3.11.	✓	**Present** A variety of marine invertebrate species may occur within the spill EMBA (Appendix 2.4). • Invertebrate species present include sponges and arthropods. Studies of infauna along the Victorian coast have shown high species diversity, particularly in East Gippsland. • Commercially important species (e.g. rock lobster, giant crab) may occur within the spill EMBA. • The Tasmanian live-bearing seastar is a threatened marine invertebrate species that is present within the Spill EMBA (Appendix 2.4). Detailed existing environment descriptions of marine invertebrates within the spill EMBA is described in Addendum 1, Section 3.11.
	Fish	Fish	• Commercial species	✓	**Present** Commercial fish species may occur within the Operational Area. • Given the presence of subsea infrastructure and commercial fishing operations in the vicinity, they are expected to be present. • Fish species of potential commercial interest were identified by Ierodiaconou et al (2021) within the Operational Area • SETFIA (2020) describes several commercial fish species as active within the BMG Operational Area, including SESSF Commonwealth Trawl sector, SESSF shark gillnet and shark hook sectors, and SESSF hook sectors. Detailed existing environment descriptions of commercial fish species within the Operational Area is described in Addendum 1, Section 3.12.	✓	**Present** Commercial fish species may occur within the spill EMBA. • Ray finned fish are known to occur within the spill EMBA, given the diversity of habitats and large geographical area. • Species that may be present include Pink Ling, and species of wrasse, flathead and warehou. Detailed existing environment descriptions of commercial fish species within the spill EMBA is described in Addendum 1, Section 3.12.
			• Listed Threatened species	-	**Not present** No threatened fish species were identified within the Operational Area PMST search (Appendix 2.1). Ierodiaconou et al (2021) describes two potential species of conservation value (*Brachionichthyidae* spp., handfish; and *Bodianus frenchii*, foxfish); although these are tentative identifications unable to be verified without higher resolution imagery. Through consideration of available literature (e.g., Stuart-Smith-et al 2020), it is concluded that the more likely species of handfish observed by Ierodiaconou et al (2021) is the Australian handfish based on recorded distributions. The Australian handfish is not EPBC listed threatened, and is listed by the IUCN as 'least concern'. No EPBC listed threatened handfish species are expected to be found within the Operational Area, due to the depth (listed species are found in water depths up to 60 m) and the location (listed species have been observed in Tasmania only).	✓	**Present** Two critically endangered and three endangered fish species were identified within the spill EMBA (Appendix 2.4): • Spotted handfish • Red handfish • Clarence river cod • Macquarie perch • Oxleyan pygmy perch Four vulnerable fish species were also identified within the spill EMBA: • Ziebell's handfish • Black rockcod • Eastern dwarf galaxias • Australian grayling Detailed existing environment descriptions of threatened fish species within the spill EMBA is described in Addendum 1, Section 3.12.

Receptor Group	Receptor Type	Receptor Description	Values and Sensitivities	Operational Area[1]		Spill EMBA[2]	
		Sharks and Rays	• Listed Migratory Species • Listed Threatened species • Biologically Important Areas (BIAs) and habitat critical to the survival of the species	✓ ✓ ✓	**Present** Five shark species (or species habitat) are known and may occur within the Operational Area (Appendix 2.1) (Figure 4-2). • White shark • Whale shark • Oceanic whitetip shark • Shortfin mako • Porbeagle No rays were identified within the Operational Area (Appendix 2.1). **Threatened Species** Two listed threatened shark species were identified by the EPBC PMST Report as known to occur within Operational Area: • White shark (vulnerable) • Whale shark (vulnerable) Ierodiaconou et al (2021) describes potential species of conservation value (Urolophus spp., stingaree); although these were tentative identifications unable to be verified without higher resolution imagery. **BIA** The Operational Area is within a distribution BIA for the white shark (Addendum 1, Section 3.12.1) (Figure 4-2). No habitats critical to the survival of the species or behaviours have been identified. Detailed existing environment descriptions of sharks and rays within the Operational Area are described in Addendum 1, Section 3.12.1.	✓ ✓ ✓	**Present** Seven shark species (or species habitat) may occur within the spill EMBA, of which the grey nurse shark and white shark have known occurrences (Appendix 2.4). The white shark has a known breeding behaviour, while the green sawfish may have a breeding behaviour within the spill EMBA. • Grey nurse shark (east coast population) • White shark • Whale shark • Oceanic whitetip shark • Shortfin mako • Porbeagle • Green sawfish Two ray species were identified within the spill EMBA which have known occurrences (not linked with biologically important behaviours). • Reef manta ray • Giant manta ray **Threatened Species** One critically endangered and three vulnerable shark species occur within the spill EMBA, of which the grey nurse shark and white shark have known occurrences, with the white shark linked to breeding behaviours. • Grey nurse shark (east coast population) • White shark • Whale shark • Green sawfish There are no threatened ray species identified within the spill EMBA (Appendix 2.4) **BIA** The grey nurse shark has a foraging and migration BIA and the white shark has a distribution, foraging, breeding and aggregation BIAs within the spill EMBA (Addendum 1, Section 3.12.1). No habitats critical to the survival of the species has been identified within the spill EMBA. No BIAs were identified for ray species within the spill EMBA. Detailed existing environment descriptions of sharks and rays within the spill EMBA is described in Addendum 1, Section 3.12.1.
		Syngnathids (Pipefish, seahorse, seadragons)	• Listed Marine Species	✓	**Present** 26 listed marine syngnathids may occur within the Operational Area (Appendix 2.1). • No important behaviours, BIAs or threatened species were identified. Detailed existing environment descriptions of syngnathids within the Operational Area is described in Addendum 1 Section 3.12.2.	✓	**Present** 67 listed marine syngnathids were identified within the spill EMBA (Appendix 2.4). • One syngnathids species had a known occurrence within the spill EMBA; White's seahorse. • No important behaviours, BIAs or threatened species were identified. Detailed existing environment descriptions of syngnathids within the spill EMBA is described in Addendum 1, Section 3.12.2.
	Seabirds and shorebirds	Birds that live or frequent the coast or ocean	• Listed Marine Species • Listed Threatened Species • Listed Migratory Species • Biologically Important Areas (BIAs)	✓ ✓ ✓ ✓	**Present** 33 seabird and shorebird species (or species habitat) may occur within the Operational Area (Appendix 2.1) (Figure 4-3). **Threatened species** 25 threatened bird species may occur within the Operational Area. • There was one important foraging behaviour identified within the Operational Area for the Australian fairy tern but is not linked a with biologically important area. **BIA** The operational area intersects nine foraging BIAs (Figure 4-3): • Antipodean albatross	✓ ✓ ✓ ✓	**Present** 119 seabird and shorebird species (or species habitat) may occur within the spill EMBA, with breeding, foraging and roosting behaviours identified (Appendix 2.4). **Threatened species** 38 threatened bird species may occur within the spill EMBA, with 25 of the threatened seabird and shorebird species having important behaviours (roosting, breeding, migration, foraging) identified. **BIA** The spill EMBA intersects 41 seabird and shorebird BIAs. The identified BIAs within the spill EMBA include foraging, breeding, aggregation and migration.

Receptor Group	Receptor Type	Receptor Description	Values and Sensitivities	Operational Area[1]		Spill EMBA[2]	
					• Black-browed albatross • Buller's albatross • Campbell albatross • Common diving petrel • Indian yellow-nosed albatross • Shy albatross • Wandering albatross • White-faced storm petrel Detailed existing environment descriptions of seabirds and shorebirds within the Operational Area is described in Addendum 1, Section 3.10.		Detailed existing environment descriptions of seabirds and shorebirds within the spill EMBA is described in Addendum 1, Section 3.10.
	Marine Reptiles	Turtles	• Listed Marine Species	✓	**Present** Three marine turtle species (or species habitat) are likely to occur within the Operational Area (Appendix 2.1). • Loggerhead turtle • Green turtle • Leatherback turtle **Threatened Species** All three turtle species identified are listed as threatened. • Loggerhead turtle- Endangered • Green turtle- Vulnerable • Leatherback turtle- Endangered **BIA** No BIAs or Habitat Critical areas are within the Operational Area. Detailed existing environment descriptions of marine turtles within the Operational Area is described in Addendum 1, Section 3.13.	✓	**Present** Six marine turtle species were identified within the spill EMBA, of which the occurrence of five is linked to important behaviours (breeding, foraging) (Appendix 2.4). • Loggerhead turtle • Green turtle • Leatherback turtle • Hawksbill turtle • Olive Ridley turtle • Flatback turtle **Threatened Species** All six turtle species identified are listed as threatened. • Loggerhead turtle- Endangered • Green turtle- Vulnerable • Leatherback turtle- Endangered • Hawksbill turtle- Vulnerable • Olive Ridley turtle- Endangered • Flatback turtle- Vulnerable **BIA** The loggerhead turtle has an internesting and nesting BIA and the green turtle has a foraging, internesting and nesting BIA within the spill EMBA. No habitats critical to the survival of the species has been identified within the spill EMBA. Detailed existing environment descriptions of marine turtles within the spill EMBA is described in Addendum 1, Section 3.13.
			• Listed Threatened Species	✓		✓	
			• Listed Migratory Species	✓		✓	
			• Biologically Important Areas (BIAs) and habitat critical to the survival of the species	-		✓	
		Crocodiles	• Listed Marine Species	-	**Not present** No crocodile species were identified within the Operational Area PMST search (Appendix 2.1).	✓	**Present** One crocodile species is likely to occur within the spill EMBA with no important behaviours identified (Appendix 2.4). • Salt-water crocodile Detailed existing environment descriptions of crocodiles within the spill EMBA is described in Addendum 1, Section 3.13.
		Seasnakes	• Listed Marine Species	-	**Not present** No seasnake species were identified within the Operational Area PMST search (Appendix 2.1).	✓	**Present** 10 seasnake species (or species habitat) were identified that may occur within the spill EMBA (Appendix 2.4). No important behaviours identified within the spill EMBA. Detailed existing environment descriptions of seasnakes within the spill EMBA is described in Addendum 1, Section 3.13.
	Marine Mammals	Seals and Sealions (Pinnipeds)	• Listed Marine Species	✓	**May be present** The EPBC PMST search tool does not identify any listed threatened or marine pinniped species as occurring within the Operational Area (Appendix 2.1)	✓	**Present**
			• Listed Threatened Species	✓		✓	
			• Listed Migratory Species	-		-	

Receptor Group	Receptor Type	Receptor Description	Values and Sensitivities	Operational Area[1]		Spill EMBA[2]	
			• Biologically Important Areas (BIAs) and habitat critical to the survival of the species	-	However, anecdotal sightings of pinnipeds has occurred at the BMG facilities, including a sighting of an Australian fur seal foraging around a BMG flowline during an offshore facility inspection (Ierodiaconou et al, 2021).	-	Three pinniped species (or species habitat) may occur within the spill EMBA. All three pinniped species present have important behaviours (breeding) identified (Appendix 2.4). • Long-nosed fur-seal • Australian fur-seal • Southern eastern seal **Threatened Species** Of the identified pinniped species within the spill EMBA, one species (southern elephant seal) is listed threatened (Vulnerable). **BIA** No BIAs or habitats critical to the survival of the species has been identified within the spill EMBA. Detailed existing environment descriptions of pinnipeds within the spill EMBA is described in Addendum 1, Section 3.14.1.
		Dugong	• Listed Marine Species	-	**Not present** No dugong species were identified within the Operational Area EPBC PMST report (Appendix 2.1).	✓	**Present** One dugong species (or species habitat) is known to occur within the spill EMBA (Appendix 2.4). **Threatened Species** No identified dugong species are threatened species within the spill EMBA (Appendix 2.4). **BIA** No BIAs or habitats critical to the survival of the species has been identified within the spill EMBA. Detailed existing environment descriptions of dugongs within the spill EMBA is described in Addendum 1, Section 3.14.
			• Listed Threatened Species	-		-	
			• Listed Migratory Species	-		✓	
			• Biologically Important Areas (BIAs) and habitat critical to the survival of the species	-		-	
		Whales	• Listed Marine Species	✓	**Present** 20 whale species (or species habitat) may occur within the Operational Area (Appendix 2.1) (Figure 4-4 and Figure 4-5). Of which eight are listed as migratory and three have important behaviours (foraging) that are not linked to biologically important behaviours (Appendix 2.1). **Threatened Species** ~~Five~~ Four whales are identified as threatened species, of which two have known occurrence within the operational area: • Sei whale- Vulnerable • Blue whale- Endangered • Fin whale- Vulnerable • Southern right whale- Endangered ~~• Humpback whale- Vulnerable~~ **BIA** The Operational Area intersects a possible foraging BIA for the pygmy blue whale (Figure 4-4), where 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. Consultation advice has indicated that if blue whale are sighted within the Gippsland region it would be reasonable to assume that they are foraging (Peter Gill pers comms July 2021). Based on their migration patterns and acoustic detection of blue whale within the Bass Strait (McCauley et al., 2018), blue whales may be more likely to be moving through the region in April, May and June. Recent sightings data during a 2020 offshore seismic survey indicated presence within the region in June (CGG pers comms July 2021).	✓	**Present** 27 whale species (or species habitat) may occur within the spill EMBA (Appendix 2.4). Foraging behaviours were identified for some species (sei, fin and pygmy right whales), no other important behaviours were identified. **Threatened Species** ~~Five~~ Four whales are identified as threatened, of which two have known occurrences within the EMBA. • Sei whale- Vulnerable • Blue whale- Endangered • Fin whale- Vulnerable • Southern right whale- Endangered ~~• Humpback whale- Vulnerable~~ **BIA** The spill EMBA intersects a possible foraging and distribution BIA for the pygmy blue whale, a migration, breeding, connecting habitat and known core range BIA for the Southern right whale and a breeding, foraging, migration and resting on migration BIA for the humpback whale. No habitats critical to the survival of the species has been identified within the spill EMBA. Detailed existing environment descriptions of whales within the spill EMBA is described in Addendum 1, Section 3.14.2.
			• Listed Threatened Species	✓		✓	
			• Listed Migratory Species	✓		✓	
			• Biologically Important Areas (BIAs) and habitat critical to the survival of the species	✓		✓	

Receptor Group	Receptor Type	Receptor Description	Values and Sensitivities	Operational Area[1]		Spill EMBA[2]	
					The Operational Area also intersects a known core range BIA for the Southern right whale (Figure 4-5). No habitats critical to the survival of the species has been identified within the Operational Area. Detailed existing environment descriptions of whales within the Operational Area is described in Addendum 1, Section 3.14.2.		
		Dolphins	• Listed Marine Species	✓	**Present** Seven dolphin species (or species habitat) may occur within the Operational Area. • Of which two are listed as migratory. No dolphin species are known to occur within the Operational Area. **Threatened Species** No identified dolphin species are threatened species within the Operational Area. **BIA** No identified dolphin species have BIAs or habitat critical areas within the Operational Area. Detailed existing environment descriptions of marine dolphins within the Operational Area is described in Addendum 1, Section 3.14.3.	✓	**Present** 18 dolphin species (or species habitat) may occur within the spill EMBA (Appendix 2.4). • Of which 5 are listed as migratory and one has an important behaviour (breeding), which is linked to a BIA. **Threatened Species** No identified dolphin species are threatened species within the spill EMBA (Appendix 2.4). **BIA** The spill EMBA intersects a foraging and breeding BIA for the Indo-pacific humpback dolphin and a foraging, breeding and connecting habitat for the Indo-pacific/spotted bottlenose dolphin. No habitats critical to the survival of the species has been identified within the spill EMBA. Detailed existing environment descriptions of marine dolphins within the spill EMBA is described in Addendum 1, Section 3.14.3.
			• Listed Threatened Species	✓		✓	
			• Listed Migratory Species	✓		✓	
			• Biologically Important Areas (BIAs) and habitat critical to the survival of the species	-		✓	
	Invasive Marine Species (IMS)	Established and Exotic	• Introduced marine species	✓	**Present** Multiple IMS are identified as established within Victorian waters. Analysis of high resolution ROV footage across the entire BMG facility did not identify any invasive species on or around the BMG subsea infrastructure (Ierodiaconou et al 2020).	✓	**Present** The introduced conical New Zealand screw shell (*Maoricolpus roseus*) was common in the Sole and PB pipeline corridors, generally in water depths greater than 40 m (Addendum 1, Section 3.15)

Notes:
1. Combination of an EPBC Protected Matters Search of the Operational Area, and characteristics of the Gippsland environment sector described in Addendum 1, have been used to describe ecological receptors that may occur within the Operational Area.
2. Combination of an EPBC Protected Matters Search for the spill EMBA area, and characteristics of the Gippsland environment sector described in Addendum 1, have been used to describe ecological receptors that may occur within the spill EMBA.

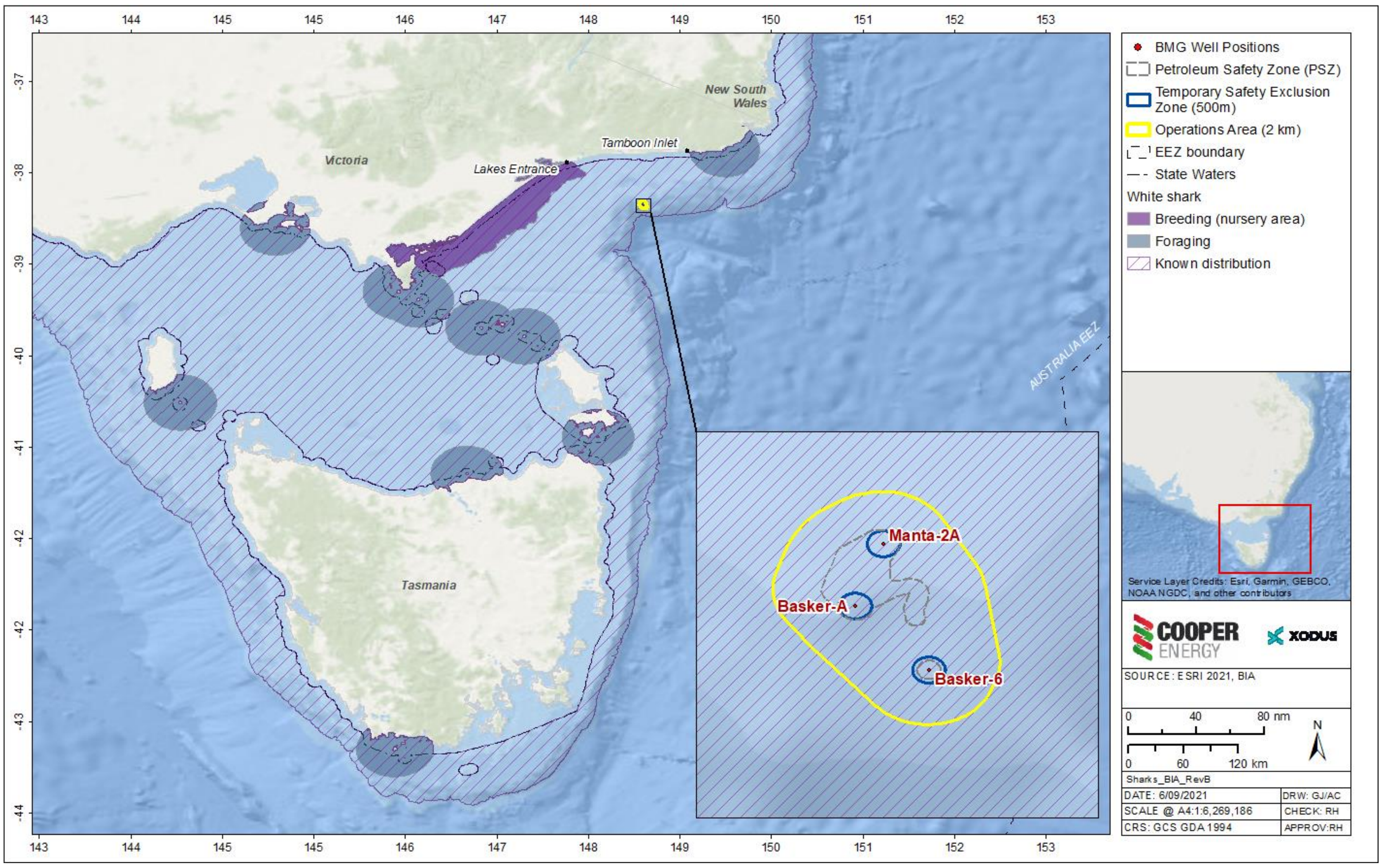


Figure 4-2: White shark BIAs within the Operational Area

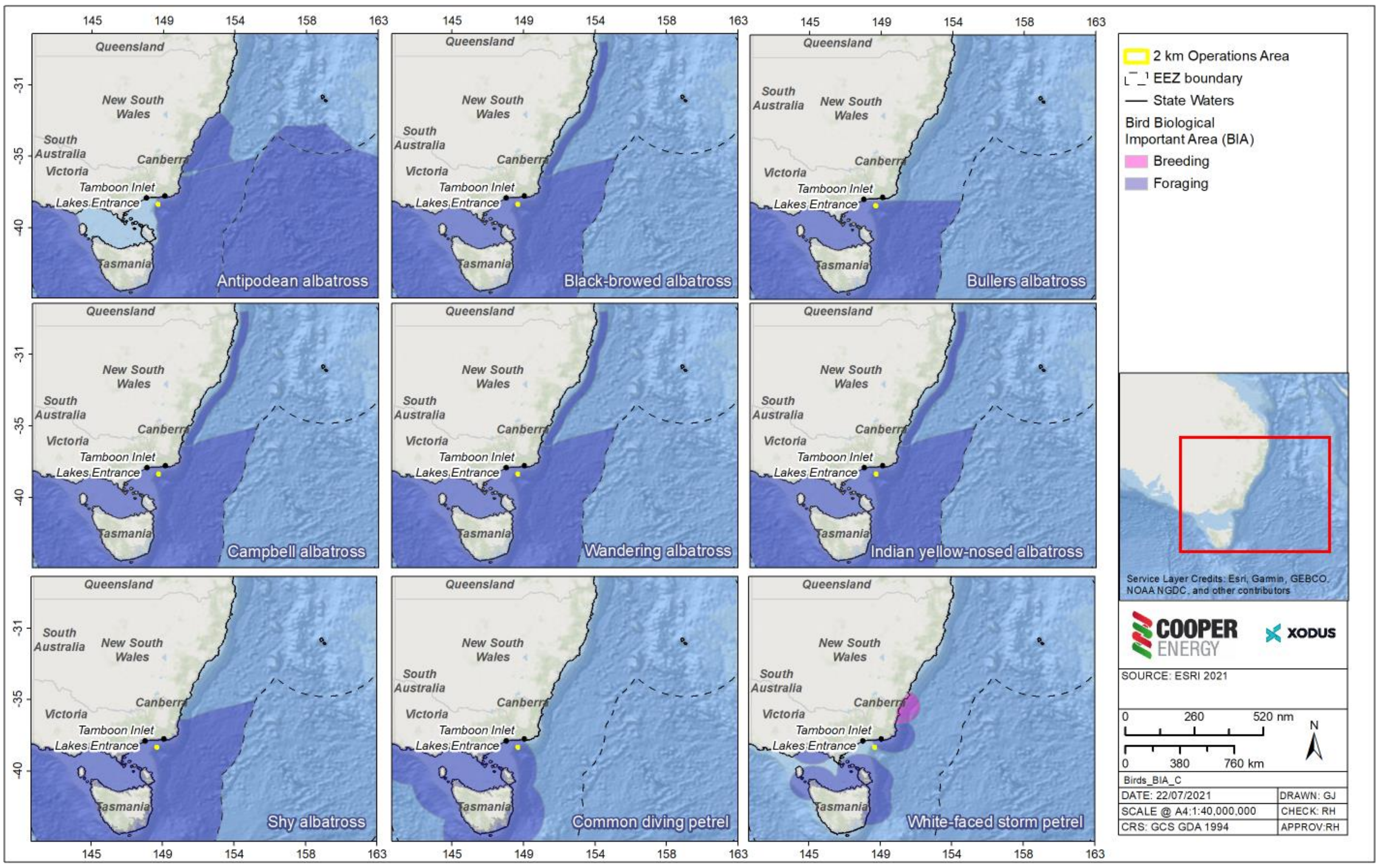


Figure 4-3: Bird BIAs within the Operational Area

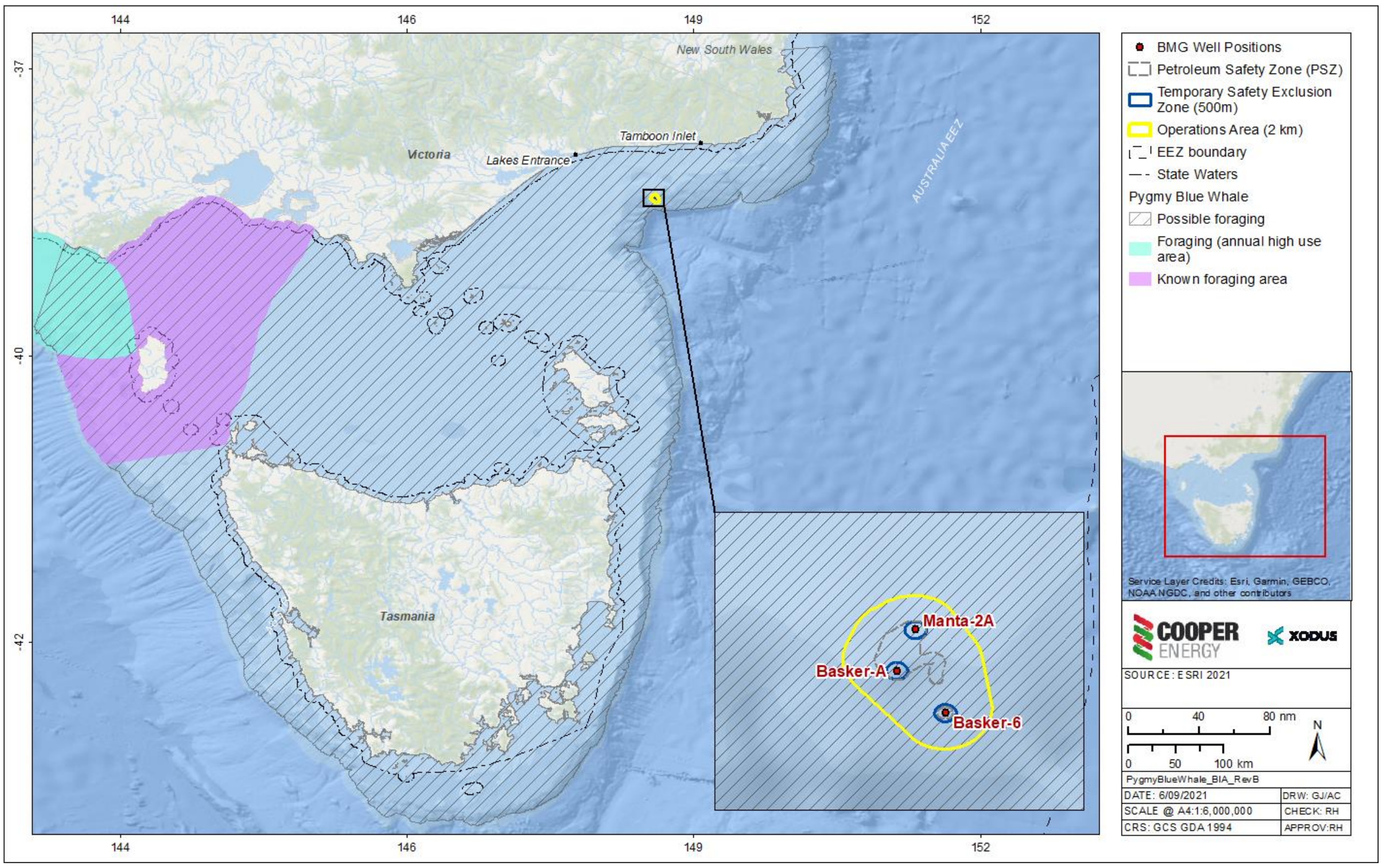


Figure 4-4: Pygmy Blue Whale BIA within the Operational Area

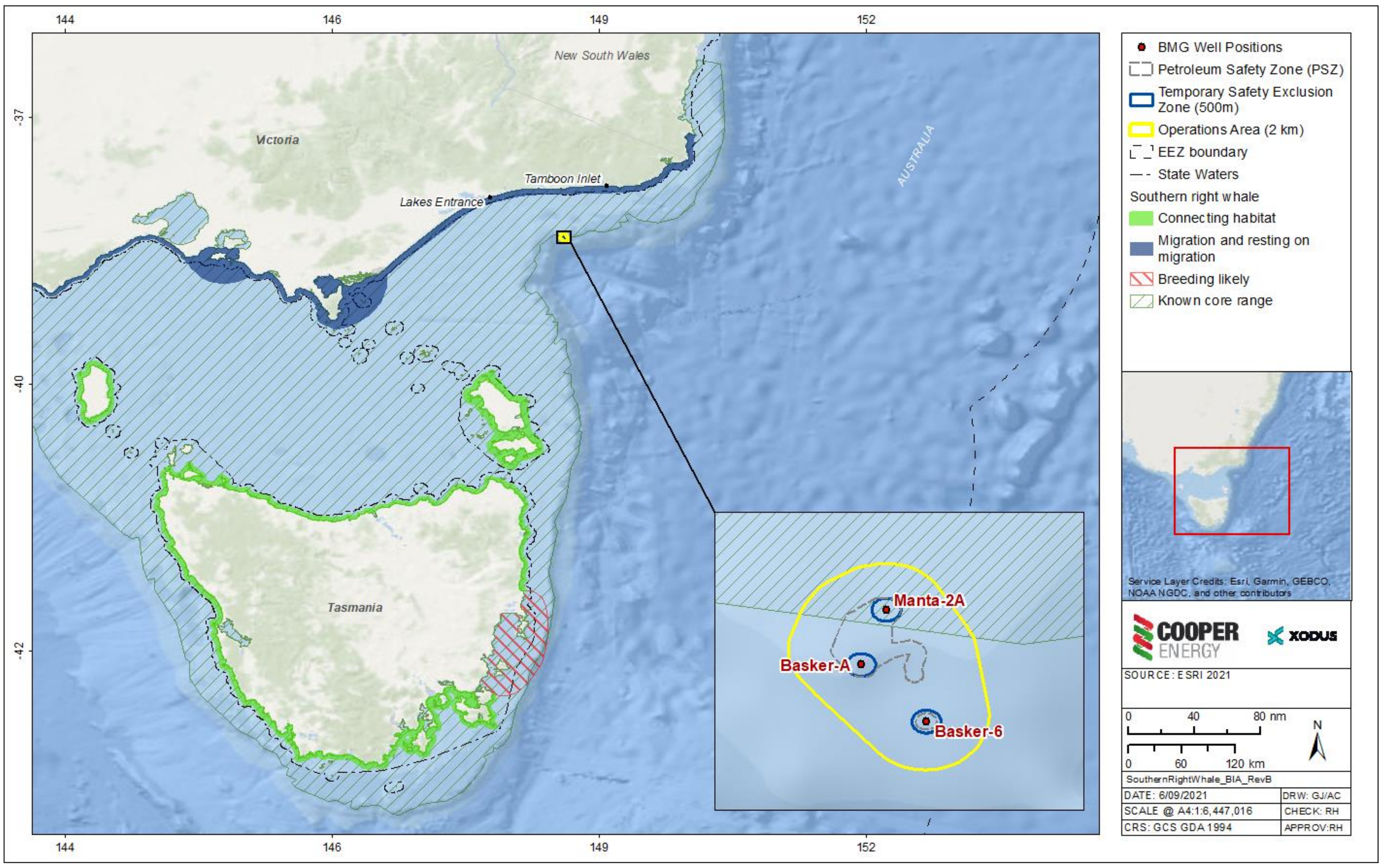


Figure 4-5: Southern Right Whale BIA within the Operational Area

4.4.1.2 Social Receptors

Table 4-3 Presence of social receptors within the Operational Area and the EMBA

Receptor Group	Receptor Type	Receptor Description	Values and Sensitivities	Operational Area[1]		Spill EMBA[2]	
Socio-ecological System	Commonwealth Marine Area	Key Ecological Features (KEF)	• High productivity (includes episodic productivity)	✓	**Present** The Operational intersects the Upwelling East of Eden KEF (Appendix 2.1) (Figure 4-6). • The Upwelling East of Eden KEF is an area of episodic upwelling known for high productivity and aggregations of marine life, including whales, seals, sharks and seabirds (Addendum 1, Section 4.6). Detailed existing environment descriptions of KEFs within the Operational Area is described in Addendum 1, Section 4.6	✓	**Present** The spill EMBA intersects eleven KEFs. Detailed existing environment descriptions of KEFs within the spill EMBA is described in Addendum 1, Section 4.6
			• Aggregations of marine life	-		✓	
			• High biodiversity	✓		✓	
			• High level of endemism	-		✓	
			• Unique Habitat	-		✓	
		Australian Marine Parks	• Aggregations of marine life • High productivity and biodiversity • Unique habitat	-	**Not Present** No Australian Marine Parks were identified within the Operational Area (Appendix 2.1)	✓	**Present** 37 Australian Marine Parks were identified within the spill EMBA (Appendix 2.4). Detailed existing environment descriptions of these Australian Marine Parks within the spill EMBA is described in Addendum 1, Section 4.3
	State Parks and Reserves	Marine Protected Areas	• Aggregations of marine life • High productivity • Biodiversity	-	**Not Present** The Operational Area does not overlap Marine Protected Areas (Appendix 2.1)	✓	**Present** The spill EMBA intersects 39 Marine Protected Areas (Appendix 2.4): • 14 Victorian MPAs • 11 Tasmanian MPAs • 10 NSW MPAs • Four Queensland MPAs Detailed existing environment descriptions of these Marine Protected Areas within the spill EMBA is described in Addendum 1, Section 4.2.1.
		Terrestrial Protected Areas	• Aggregations of terrestrial life • High productivity • Biodiversity	-	**Not present** The Operational Area does not include the onshore environment (Appendix 2.1).	✓	**Present** Detailed existing environment descriptions of Terrestrial Protected Areas within the spill EMBA is described in Addendum 1, Section 4.2.2.
	Wetlands of International Importance	Ramsar wetlands (International Importance)	• Aggregation, foraging and nursery habitat for marine life	-	**Not present** The Operational Area does not include coastal or onshore environments (Appendix 2.1).	✓	**Present** The spill EMBA intersects with the 15 Ramsar wetlands (Appendix 2.4). Detailed existing environment descriptions of these Ramsar wetlands within the spill EMBA is described in Addendum 1, Section 4.3.1.
		National Importance Wetlands	• Aggregation, foraging and nursery habitat for marine life	-	**Not present** The Operational Area does not include coastal or onshore environments (Appendix 2.1).	✓	**Present** The spill EMBA intersects 117 National Important Wetlands (Appendix 2.4) • Three (QLD) • 63 (NSW) • 18 (Vic) • 32 (Tas) • One (External Territory) Detailed existing environment descriptions of these National Important Wetlands is described in Addendum 1, Section 4.3.2.
	Heritage	Underwater Heritage (wrecks and aircraft)	• Historic significance	-	**Not present** One historic shipwreck, the Result (shipwreck ID 6550), which was shipwrecked in 1880 recorded to have occurred within the Bass Strait, in the vicinity BMG at latitude -38.29, longitude 148.71. Note, on further enquiry with DAWE, the location of this shipwreck has been confirmed as unknown, and is therefore considered to be no more likely to be near BMG than anywhere else off the coast of Victoria.	✓	**Present** Detailed existing environment descriptions of the present underwater shipwrecks within the spill EMBA is described in Addendum 1, Section 5.6.1
		Cultural	• World Heritage Properties	-	**Not present**	✓	**Present**
			• Commonwealth Heritage Places	-		✓	

Receptor Group	Receptor Type	Receptor Description	Values and Sensitivities	Operational Area[1]		Spill EMBA[2]	
			• National Heritage Places	-	The Operational Area does not overlap any World Heritage Properties, Commonwealth Heritage Places or National Heritage Places.	✓	13 World Heritage Properties, 98 Commonwealth Heritage Places and 21 National Heritage Place exist within the spill EMBA. Detailed existing environment descriptions of the culture within the spill EMBA is described in Addendum 1, Section 5.6.2
		Indigenous	• Indigenous use or connection	-	**Not present** The Operational Area does not include the coastal or onshore environments.	✓	**Present** The coastal area of south-east Australia was amongst the most densely populated regions of pre-colonial Australia. Through cultural traditions, Aboriginal people maintain their connection to their ancestral lands and waters. The Gunaikurnai, Monero and the Bidhawel (Bidwell) Indigenous people are recognised as the traditional custodians of the lands and waters within the East Gippsland Shire. The Gunaikurnai people have an approved non-exclusive native title area extending from West Gippsland in Warragul, east to the Snowy River and north to the Great Dividing Range; and 200 m offshore. Detailed existing environment descriptions of the indigenous heritage within the spill EMBA is described in Addendum 1, Section 5.6.3
Socio-economic Systems	Commercial Fisheries	Commonwealth managed	• Economic benefit	✓ ✓ ✓	**Present** The Operational Area overlaps with seven Commonwealth managed fisheries, of which one (Southern and Eastern Scalefish and Shark Fishery) is known to actively fish within the Operational Area (Boag and Koopman, 2021) (Figure 4-7 to Figure 4-9). According to research undertaken by Boag and Koopman 2021, though multiple different fisheries have rights to fish around BMG, it is only the SESSF managed fisheries that actively fish around BMG; these are: • SESSF Commonwealth Trawl sector (Otter trawl and Danish seine) • SESSF Shark Gillnet and Shark Hook sectors • SESSF Scalefish Hook sector Detailed existing environment descriptions of the Commonwealth fisheries within the Operational Area is described Addendum 1, Section 5.1.1	✓ ✓ ✓	**Present** The spill EMBA overlaps with eight Commonwealth managed fisheries, of which six are known to actively fish within the EMBA. Detailed existing environment descriptions of the Commonwealth fisheries within the spill EMBA is described Addendum 1, Section 5.1.1
		State Managed – Vic	• Economic benefit	✓	**Present** 13 Victorian state managed fisheries area overlap the Operational Area, of which none are confirmed to actively fish within the Operational Area (see Stakeholder Engagement Register, Section 10). Note 11 fisheries active fishing areas are unknown due to limited data available and/or fisher confidentiality. Detailed existing environment descriptions of the State fisheries within the Operational Area is described Addendum 1, Section 5.1.2.	✓	**Present** 46 state managed fisheries area overlap the EMBA, of which 35 are known to actively fish. Note eight fisheries active fishing areas are unknown due to limited data available and/or fisher confidentiality. Detailed existing environment descriptions of the State fisheries within the spill EMBA is described Addendum 1, Section 5.1.2.
		State Managed – NSW		-		✓	
		State Managed – QLD		-		✓	
		State Managed – Tas		-		✓	
	Recreational Fisheries	State-managed	• Community • Recreation	✓	**Present** • Most recreational fishing typically occurs in nearshore coastal waters (shore or inshore vessels) and within bays and estuaries. Recreational fishing activity is expected to be minimal in the Operational Area. • Note, any existing PSZs around operational infrastructure would preclude fishing activity within the direct area. Detailed existing environment descriptions of the recreational fisheries within the Operational Area is described Addendum 1, Section 5.2	✓	**Present** • Most recreational fishing typically occurs in nearshore coastal waters, and within bays and estuaries; offshore (>5 km) fishing only accounts for approximately 4% of recreational fishing activity in Australia. The East Gippsland waters have a moderate fishing intensity (relative to other areas within the South-East Marine Region). Detailed existing environment descriptions of the recreational fisheries within the spill EMBA is described Addendum 1, Section 5.2.
	Recreation and Tourism	Victoria	• Economic benefit • Community • Recreation	-	**Not present** Many marine-based recreation and tourism are unlikely to occur within the Operational Area, given approximately distance (50km) offshore, existing PSZs and water depths ranging between 135 m to 270 m. Thought not expected within the operational area, sailing does occur through the Gippsland basin offshore; in 2018 the Far Saracen which was in field supporting offshore drilling activities in the Sole gas field, was involved in a rescue operation of sailors adrift offshore. Detailed existing environment descriptions of the recreation and tourism within the Operational Area is described Addendum 1, Section 5.4	✓	**Present** The Australian coast provides a diverse range of recreation and tourism opportunities, including scuba diving, charter boat cruises, and surfing. In East Gippsland, primary tourist locations include Marlo, Cape Conran, Lakes Entrance and Mallacoota. The area is renowned for its nature-based tourism, recreational fishing and water sports. Detailed existing environment descriptions of recreation and tourism within the spill EMBA is described Addendum 1, Section 5.4.

Receptor Group	Receptor Type	Receptor Description	Values and Sensitivities	Operational Area[1]		Spill EMBA[2]	
	Coastal Settlements	Victoria	• Economic benefit • Community engagement • Recreation	-	**Not present** The Operational Area does not include coastal and onshore environments.	✓	**Present** The communities of Lakes Entrance, Mallacoota and Marlo (within the Shire of East Gippsland) are the closest coastal settlements to the BMG assets. Other coastal communities, such as Eden (NSW) and Flinders Island (TAS) are important towns which support a number of communities. The closest heavily populated Victorian urban area, is Melbourne.
	Industry	Shipping	• Community engagement • Economic benefit	✓	**Present** • The south-eastern coast is one of Australia's busiest in terms of shipping activity and volumes. However, the BMG assets do not coincide with major routes; with higher volumes of traffic located to the south of the wells. Detailed existing environment descriptions of shipping within the Operational Area is described Addendum 1, Section 4.8.1.	✓	**Present** • The south-eastern coast is one of Australia's busiest in terms of shipping activity and volumes. However, the BMG assets do not coincide with major routes; with higher volumes of traffic located to the south of the EMBA. • There are several important ports within the EMBA, including major ports such as Sydney and Newcastle, and also regional ports such as Lakes Entrance, Eden and Barry Beach which support commercial and recreational fishing industries. Detailed existing environment descriptions of shipping within the spill EMBA is described Addendum 1, Section 5.5.1
		Energy Development Areas	• Economic benefit	-	**Not Present** The petroleum Activity is within Cooper Energy PSZ (Figure 4-10)	✓	**Present** • Petroleum infrastructure in Gippsland Basin is well developed, with a network of pipelines transporting hydrocarbons produced offshore to onshore petroleum processing facilities at Longford and Orbost. • The Area to Be Avoided is located within the EMBA. • Renewable energy exploration licence has been granted to Star of the South within Australian Commonwealth waters about 8 to 13 kilometres off the Gippsland coast in Victoria. Detailed existing environment descriptions of energy development areas within the spill EMBA is described Addendum 1, Section 5.5.2
		Submarine Cables and Pipelines	• Economic benefit • National utilities	-	**Not present** No cables or pipelines occur within the Operational Area	✓	**Present** • Submarine cables located in Bass Strait are limited to the subsea floor between Tasmania and the Australian mainland. Three communication cables also extend offshore from Sydney. Detailed existing environment descriptions of the submarine cables and pipelines within the spill EMBA is described Addendum 1, Section 5.5.3
		Defence	• Protection and surveillance	-	**Not present** There are no military areas within the Operational Area.	✓	**Present** • The Australian Defence Force conducts a range of training, research activities, and preparatory operations within the EMBA. The closest major base to the BMG assets is the multi-purpose wharf at Twofold Bay; and closest primary training ground is the East Australia Exercise Area in southern NSW. Detailed existing environment descriptions of defence areas within the spill EMBA is described Addendum 1, Section 5.5.4

Notes:
1. Combination of an EPBC Protected Matters Search of the Operational Area, and characteristics of the Gippsland environment sector described in Addendum 1, have been used to describe ecological receptors that may occur within the Operational Area.
2. Combination of an EPBC Protected Matters Search for the spill EMBA area, and characteristics of the Gippsland environment sector described in Addendum 1, have been used to describe ecological receptors that may occur within the spill EMBA.

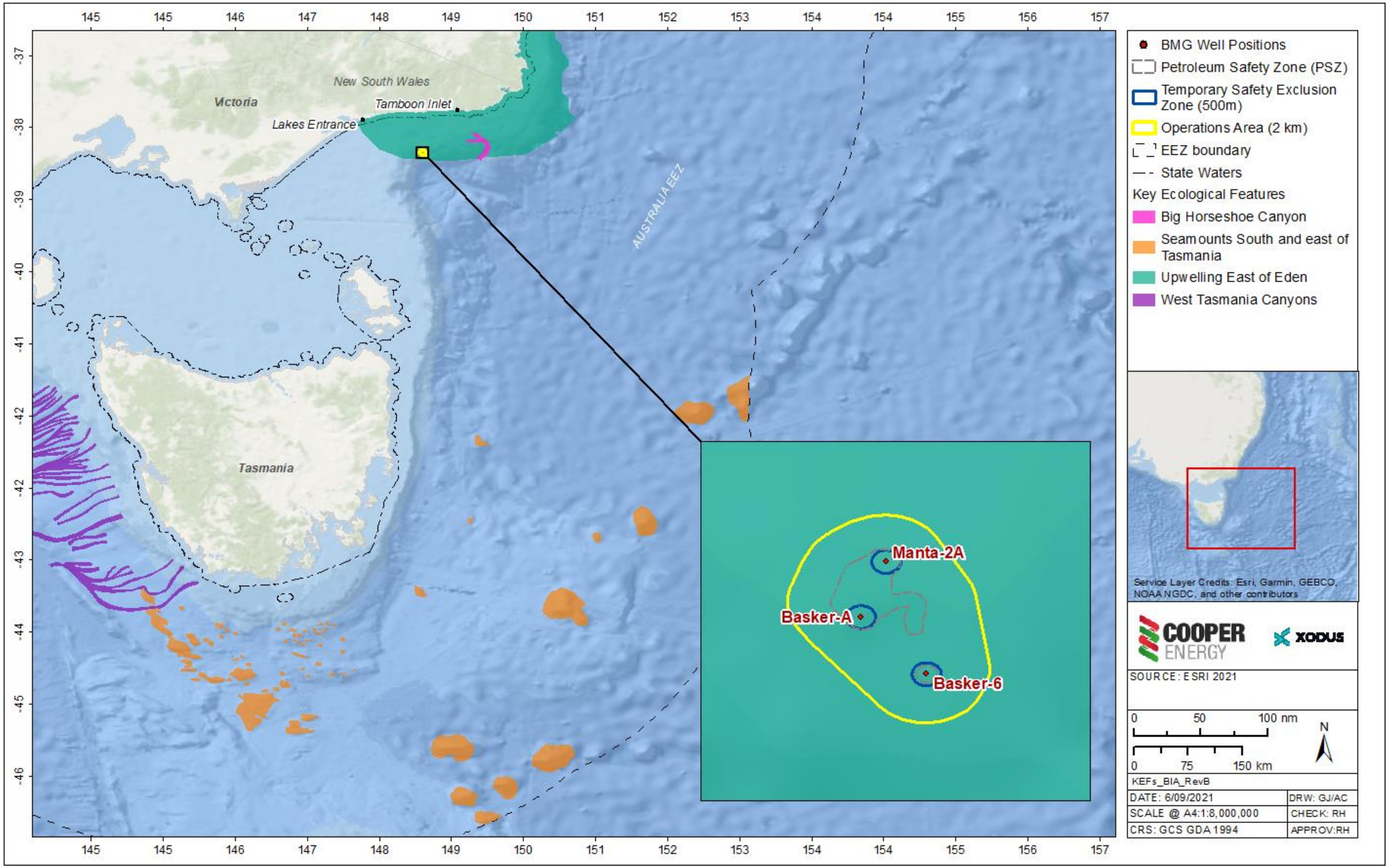


Figure 4-6:Key Ecological Features within the Operational Area

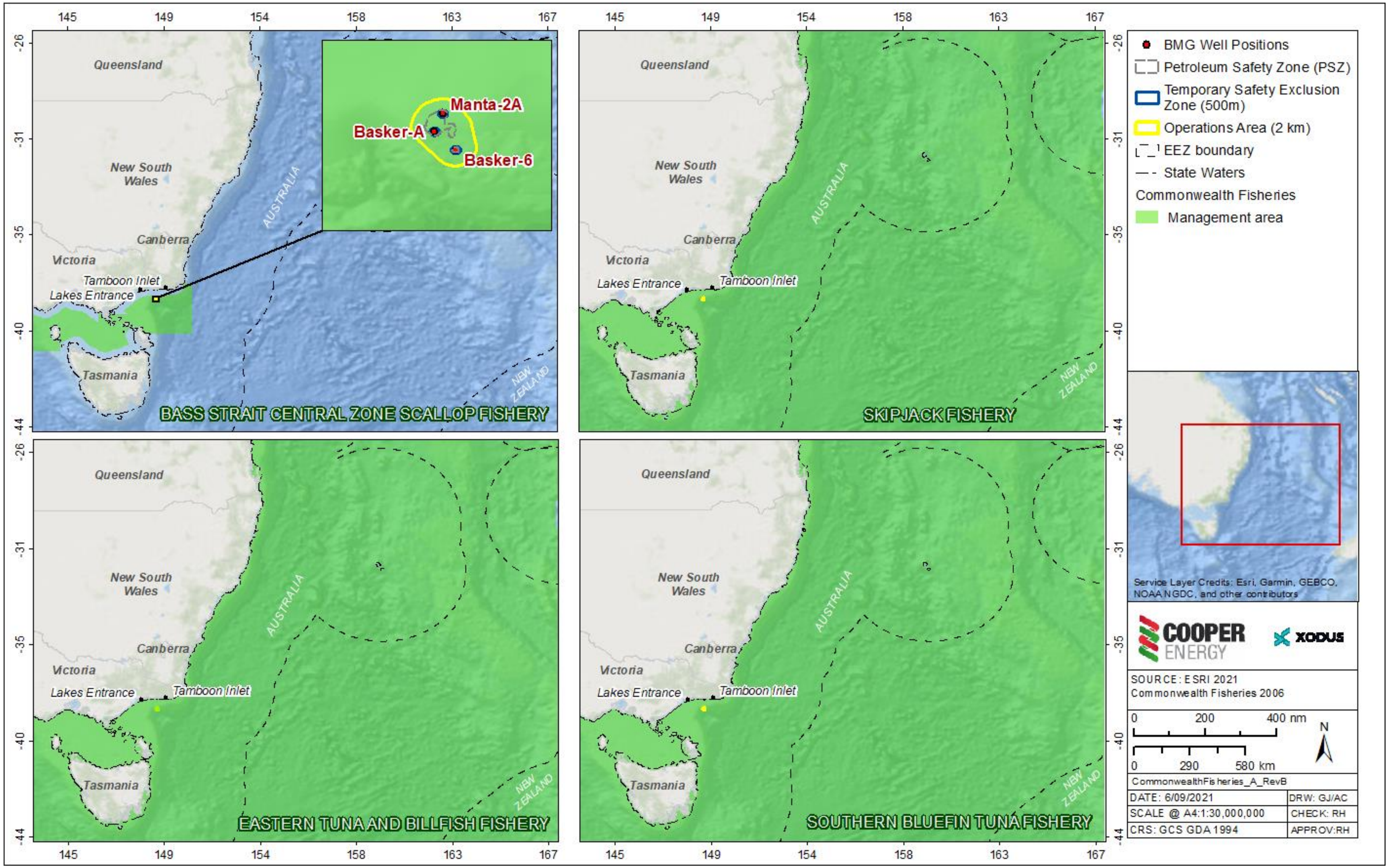


Figure 4-7: Bass Strait Central Zone Scallop Fishery, Skipjack Tuna Fishery, Eastern Tuna and Billfish Fishery and the Southern Bluefin Tuna Fishery within the Operational Area

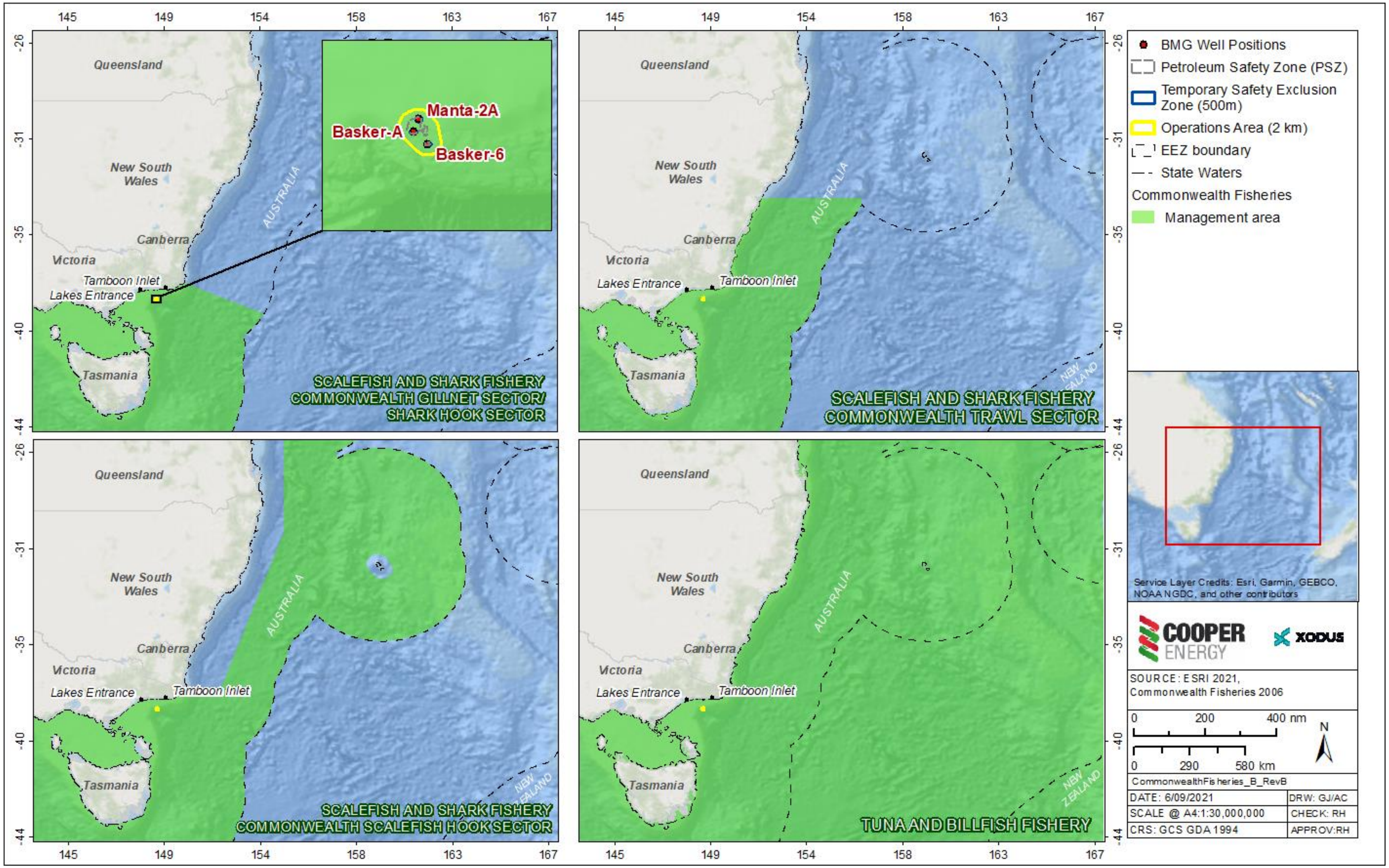


Figure 4-8: Scalefish and Shark Fishery (gillnet sector, shark hook sector, trawl sector) and the Tuna and Billfish fishery within the Operational Area

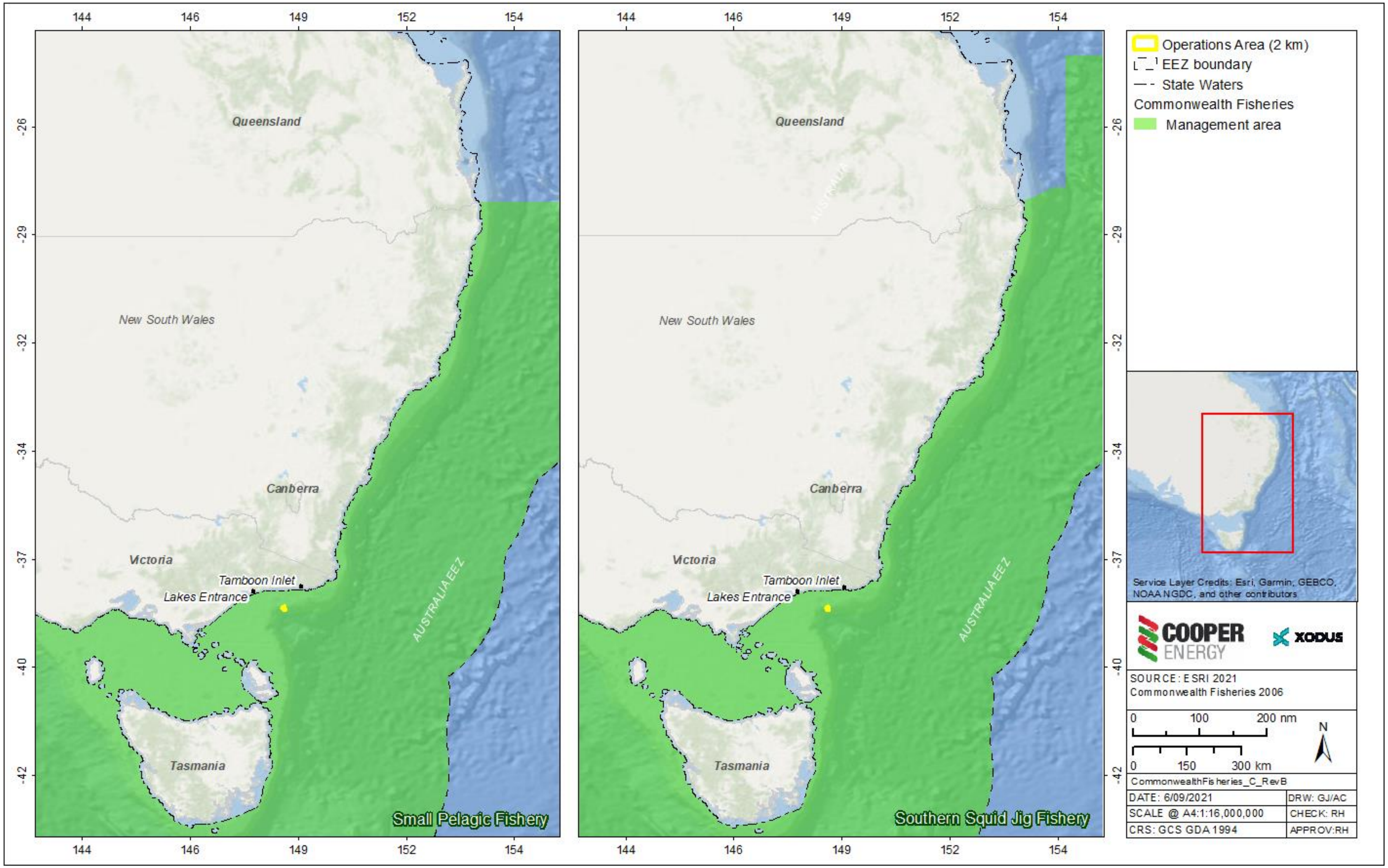


Figure 4-9: Small pelagic fishery and the Southern Squid Jig Fishery within the Operational Area

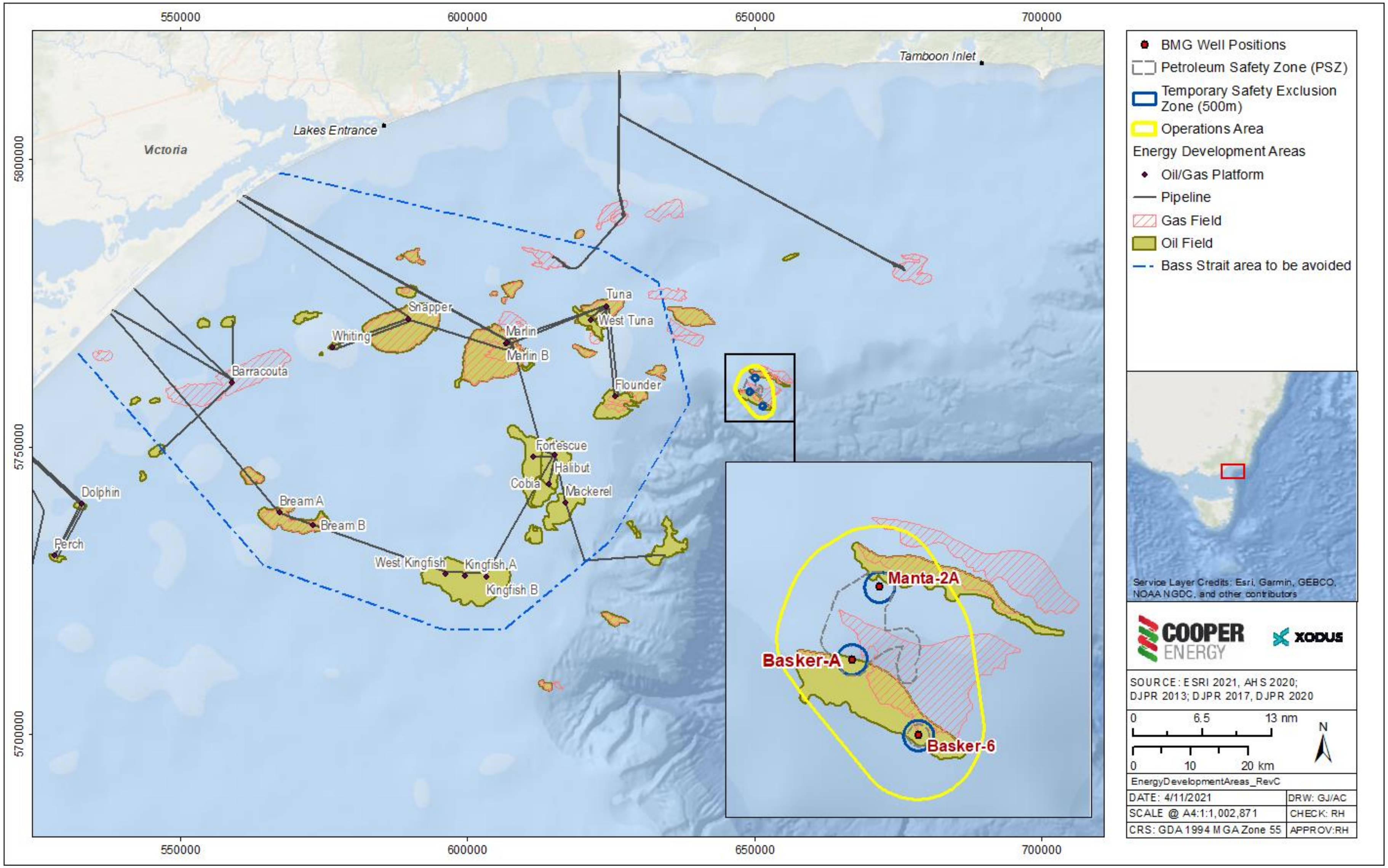


Figure 4-10: Energy Development Areas within the Operational Area

Table 4-4 Seasonality of key sensitivities within the Operational Area

Key Sensitivity	Significance Status	Presence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Marine megafauna														
White shark	LT (V), BIA(d)	Seasonal			Distribution (low density)									
Whale shark	LT (V)	Occasional	Species or species habitat may occur											
Loggerhead turtle	LT I	Occasional	Species or species habitat likely to occur											
Green turtle	LT (V)	Occasional	Species or species habitat likely to occur											
Leatherback turtle	LT I	Occasional	Species or species habitat likley to occur											
Sei whale	LT (V)	Seasonal	Foraging likely to occur (Nov – May)											
Blue whale	LT I, BIA(pf)	Seasonal				Distribution (Apr – June)								
Fin whale	LT (V)	Seasonal	Foraging likely to occur (Dec – May)											
Southern right whale	LT I, BIA (kcr)	Seasonal					Migration				Migration			
Humpback whale	Listed Migratory	Seasonal				Migration					Migration			
Seabirds and shorebirds														
Antipodean albatross	LT (V), BIA(f)	Transitory	Species or species habitat likely to occur											
Australian fairy tern	LT (V)	Transitory	Foraging, feeding or related behaviour likely to occur											
Black-browed albatross	LT (V), BIA(f)	Seasonal				Foraging BIA (known to occur)								
Blue petrel	LT (V)	Seasonal							Species may occur					
Buller's albatross	LT (V), BIA(f)	Seasonal	Foraging BIA and species may occur											
Campbell albatross	LT (V), BIA(f)	Seasonal	Foraging BIA and species likely to occur											
Chatham albatross	LT I	Transitory	Species or species habitat likely to occur											
Common diving petrel	BIA(f)	Transitory	Not present in PMST, however foraging BIA with birds present year round											
Curlew sandpiper	LT (CE)	Seasonal									May occur Sept – Mar			
Eastern curlew	LT (CE)	Transitory	Species or species habitat may occur											
Fairy prion	LT (V)	Seasonal				Species or species habitat may occur								
Gibson's albatross	LT (V)	Transitory	Species or species habitat likely to occur											
Gould's petrel	LT I	Seasonal	Species or species habitat may occur											
Grey-headed albatross	LT I	Seasonal	Species may occur											
Indian yellow-nosed albatross	BIA(f)	Seasonal			Foraging BIA, birds present Mar – Jun									
Northern giant petrel	LT (V)	Seasonal					Species or species habitat may occur (May – Oct)							
Northern royal albatross	LT I	Transitory	Species or species habitat likely to occur											
Red knot	LT I	Seasonal	Species or species habitat may occur							Arrive in Australia late Aug and leave by late Apr				
Salvin's albatross	LT (V)	Seasonal				Species likely to occur (Apr – Aug)								
Shy albatross	LT I, BIA(f)	Transitory	Species or species habitat likely to occur, Foraging BIA											
Sooty albatross	LT (V)	Transitory	Species or species habitat may occur											
Southern giant petrel	LT I	Seasonal				Species or species habitat may occur								
Southern royal albatross	LT (V)	Transitory	Species or species habitat likely to occur											
Wandering albatross	LT (V), BIA(f)	Transitory	Species or species habitat likely to occur, Foraging BIA											
White-bellied storm petrel	LT (V)	Transitory	Species or species habitat likely to occur											
White-capped albatross	LT (V)	Transitory	Species or species habitat likely to occur											
White-faced storm petrel	BIA(f)	Seasonal	Foraging BIA											
Conservation														
Unwelling East of Eden KEF														

Key Sensitivity	Significance Status	Presence	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Social receptors														
Southern and Eastern Scalefish and Shark Fishery	Active commercial fishers	Boats present throughout the year												

Legend Significance Status: LT – Listed Threatened BIA – Biologically Important Area	Theatened status: (V) – Vulnerable I – Endangered (CE) – Critically endangered	Type of BIA: (f) – foraging (pf) – possible foraging (kcr) – known core range (d) – distribution
Data Sources EPBC PMST Report (Operational Area) Department of Environment (2021a) DAWE (2021)	Definitions Seasonal – presence is seasonal i.e. based on overwintering or breeding seasons, Transitory – presence is likely to be due to species moving through the area on transit to another location Occasional – presence has been recorded	

5 Environmental Impact and Risk Assessment Methodology

The Regulations require an EP be prepared which details the environmental impacts and risks associated with the Activity; and that the EP comprises an evaluation of all the impacts and risks, appropriate to the nature and scale of each impact or risk.

This EP provides the environmental impact and risk evaluation for the BMG Closure Project (Phase 1) activities, by adopting the Cooper Energy Risk Management Protocol (CMS-RM-PRO-0001.02.IFU). This Protocol is consistent with the approach outlined in ISO 14001 (Environmental Management Systems), ISO 31000:2009 (Risk Management) and HB203:2012 (Environmental Risk Management – Principles and Process).

Figure 5-1 provides the six-step process adopted for the evaluation of impacts and risks associated with the activity.

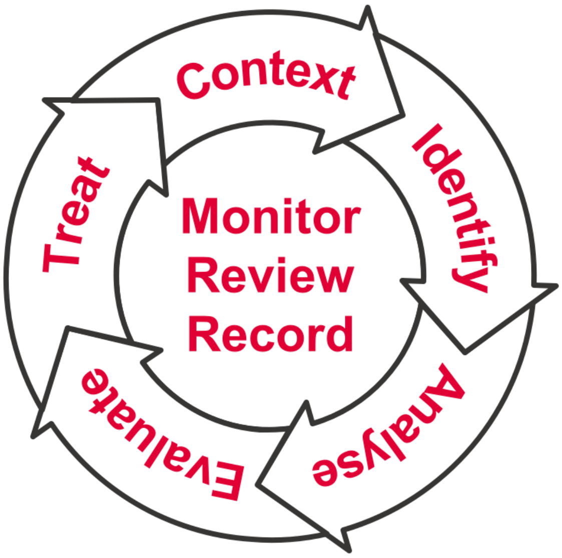


Figure 5-1: CEMS Risk Management Protocol – Six Step Process

The steps detailed in Figure 5-1 are integrated into the Cooper Energy risk assessment methodology. Further details of the environmental impact and risk assessment methodology are provided in the following sections, including criteria for assessment and risk ratings.

A Risk Register is 'the managed repository of key risk information maintained by each Business Area'. It is a living part of risk management that is continually reviewed and updated. In accordance with the CEMS Risk Management Protocol, each Business Area must maintain a Risk Register and conduct risk management as an integral activity within all business processes to help manage uncertainty in achieving objectives and to aid in decision making. Section 6 expands on the project risk register; showing all identified risks, impacts, preventative and mitigative controls.

5.1 Definitions

OPGGS(E)R 13(5) requires that the EP details the environmental impacts and risks for the Activity; and that the EP comprises an evaluation of all the impacts and risks, appropriate to the nature and scale of each impact or risk.

In this section, Cooper Energy has provided a list of terminology and definitions that will be meet the requirements of OPGGS(E)R 13(5).

- **Activity** – An activity refers to a component or task within a project which results in one or more environmental aspects.
- **Aspect** – An environmental aspect is an element or characteristic of an activity, product, or service that interacts or can interact with the environment. Environmental aspects can cause environmental impacts, or may create a risk to one or more environmental receptors.

- **Impact** – An environmental impact is a change to one or more environmental receptors that is caused either partly or entirely by one or more environmental aspects. An impact is something which is certain to occur. An environmental aspect can have either a direct impact on the environment or contribute only partially or indirectly to a larger environmental change. An environmental aspect may result in a change which puts one or more receptors at risk of being impacted. The relationship between environmental aspects and environmental impacts is one of cause and effect. The term 'impact' is associated with planned activities and known outcomes,
- **Risk** – An environmental risk (or risk event) is a change which could occur to one or more environmental receptors, that is caused either partly or entirely by one or more environmental aspects. A risk event has a degree of likelihood, it is not certain to occur. The term 'risk' is associated with both planned and unplanned activities where the change elicited on or by a particular receptor is uncertain.
- **Consequence** – The consequence of an impact (or risk event) is the outcome of the event on affected receptors. Consequence can be positive or negative.
- **Likelihood** – The likelihood (or probability) of the consequence occurring. Likelihood only applies to risk (and risk events).
- **Risk Severity** – the risk severity level is determined from the point on the risk matrix where the consequence intersects the likelihood.
- **Residual Risk** – Residual risk is the risk remaining after additional control measures have been applied (i.e. after impact or risk treatment).

5.2 Risk Management Process Steps

This section provides a detailed overview of the risk management process steps.

5.2.1 Establish the Context

All components of the petroleum activity relevant to this scope were identified and described in Section 3 of this EP.

After describing the petroleum activity, an assessment was carried out to identify aspects. The outcomes of stakeholder consultation over a number of years also contributed to aspect identification. The environmental aspects identified for the petroleum activity are detailed in Section 3 and Table 6-1.

5.2.2 Risk Identification

Risk identification involved the documentation of risks as they relate to the context established in step 1 (Section 5.2.1). An Environmental Workshop (ENVID) was held to identify environmental impacts and risks associated with the petroleum activity. The workshop was attended by environmental consultants and project personnel spanning well engineering, subsea and HSEC disciplines.

5.2.3 Risk Analysis

All impacts and risks identified during the ENVID were analysed. Impact and Risk analysis requires a level of consequence to be assessed for each impact or risk event. For each risk event, the likelihood of occurrence is determined.

Impacts and risks are evaluated using the Cooper Energy Risk Matrix, which includes:

- A six-level likelihood table to assess the probability of risk occurrence
- A five-level consequences table to assess the risk impact against business objectives
- A matrix of likelihood versus consequence that defines four levels of risk severity and allows a risk to be assessed and plotted. The outcome of the plotted risks is termed a 'Heat Map' and provides a graphic representation of the risks, their respective severities and likelihood.
- A four-level risk severity table that defines the actions and escalation required for risks at different severity levels.

The Cooper Energy Risk Matrix is provided in Table 5-2, with definitions of the level of consequence provided in Table 5-1 below.

Table 5-1: Consequence Assessment Criteria

Consequence Level	Environmental Consequence Description
1	Minor local impacts or disturbances to flora/fauna, nil to negligible remedial/ recovery works on land/ water systems.
2	Localized short-term impacts to species or habitats of recognized conservation value not affecting local ecosystem function; remedial, recovery work to land, or water systems over days/weeks.
3	Localized medium-term impacts to species or habitats of recognized conservation value or to local ecosystem function; remedial, recovery work to land/water systems over months/year.
4	Extensive medium to long-term impact on highly valued ecosystems, species populations or habitats; remedial, recovery work to land/ water systems over 1 – 10 years.
5	Severe long-term impact on highly valued ecosystems, species, or habitats. Significant remedial/ recovery work to land/ water systems over decades.

The Risk Severity can be:

- Extreme (Red) – Inherent risk at this level is not within the Company's risk appetite. The activity does not proceed until the Board approves the treatment plans to bring the residual risk to an acceptable level
- High (Orange) – Inherent risk at this level requires involvement of the Managing Director who will approve the treatment plans before the activity proceeds. The Board must also be informed of the risk and its treatment
- Moderate (Yellow) – Inherent risk at this level is tolerable if it is also ALARP. Business Area Managers must approve treatment plans and risks should be reported to the Executive Leadership Team during regular reporting
- Low (Green) – This level of risk is largely acceptable. Review of control procedures should be delegated by the risk owner, and the risk should be regularly monitored for deterioration.

Table 5-2: Cooper Energy qualitative risk matrix

LIKELIHOOD						CONSEQUENCE				
	Qualitative				Quantitative					
Rating	Level	Probability	Time Period	Description		1	2	3	4	5
A	Almost certain	> 80%	More than once a year	Expected to occur in most circumstances and/or morethan once a year, or repeatedly during the activity.	$>10^{-2}$	Moderate	Moderate	High	Extreme	Extreme
B	Likely	> 50%	Every 1 – 2 years	Not certain to happen but an additional factor may resultin an occurrence. Expected to occur from time to time during the activity.	$\leq 10^{-2}$	Low	Moderate	Moderate	High	Extreme
C	Possible	> 20%	Every 4 – 5 years	Could happen when additional factors are present. Easy to postulate a scenario for the occurrence but considereddoubtful. Expected to occur once during the activity.	$\leq 10^{-3}$	Low	Moderate	Moderate	High	High
D	Unlikely	> 5%	Every 5 – 20 years	A rare combination of factors would be required for anoccurrence. Conceivable and could occur at some time.Could occur during the activity.	$\leq 10^{-4}$	Low	Low	Moderate	Moderate	High
E	Remote	> 1%	Every 20 - 100 years	A freak combination of factors would be required for anoccurrence. Not expected to occur during the activity. Occur in exceptional circumstances.	$\leq 10^{-5}$	Low	Low	Moderate	Moderate	High
F	Hypothetical	< 1%	Not in 100 years	Generally considered hypothetical or non-credible. BlackSwan.	$\leq 10^{-6}$	Low	Low	Low	Low	Moderate

5.2.4 Risk Evaluation

5.2.4.1 Identify and Evaluate Controls

Controls are any measures exercised that modify the impact or risk. Controls act on an impact cause to reduce the consequence of the impact. Controls that act on the risk cause to reduce the likelihood of the risk occurring are termed preventative controls. Reactive controls are those that modify the consequence once the risk event has occurred. For each risk, all controls should be captured.

Risk Evaluation requires each control to be assessed for its effectiveness in managing the risk causes and consequences. This may be different from the effectiveness of the control to deliver its original designed purpose.

5.2.4.2 Determine ALARP Status

The ALARP status of each impact and risk is assessed based on the sufficiency of the controls already established and the opportunity for new controls to be implemented. A cross-functional team is assembled to ensure the risks and controls are assessed from different perspectives and to identify the possibility of additional controls that can reduce the risk. If no additional realistic and feasible controls are identified for the risk, then it is considered ALARP.

In alignment with NOPSEMA's ALARP Guidance Note (N-04300-GN0166, June 2020), Cooper Energy have adapted the approach developed by Oil and Gas UK (OGUK) (formerly UKOOA) (OGUK, 2014) for use in an environmental context to determine the assessment technique required to demonstrate that potential impacts and risks are ALARP (Figure 5-2).

Specifically, the framework considers impact consequence and several guiding factors:

- Activity type;
- Risk and uncertainty; and
- Stakeholder influence.

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 but additional assessment is required, and the precautionary approach is 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, Cooper Energy has considered the above decision context in determining the level of assessment required. This is applied to each aspect described in Section 6.

The assessment techniques considered include:

- Good practice;
- Engineering risk assessment; and
- Precautionary approach.

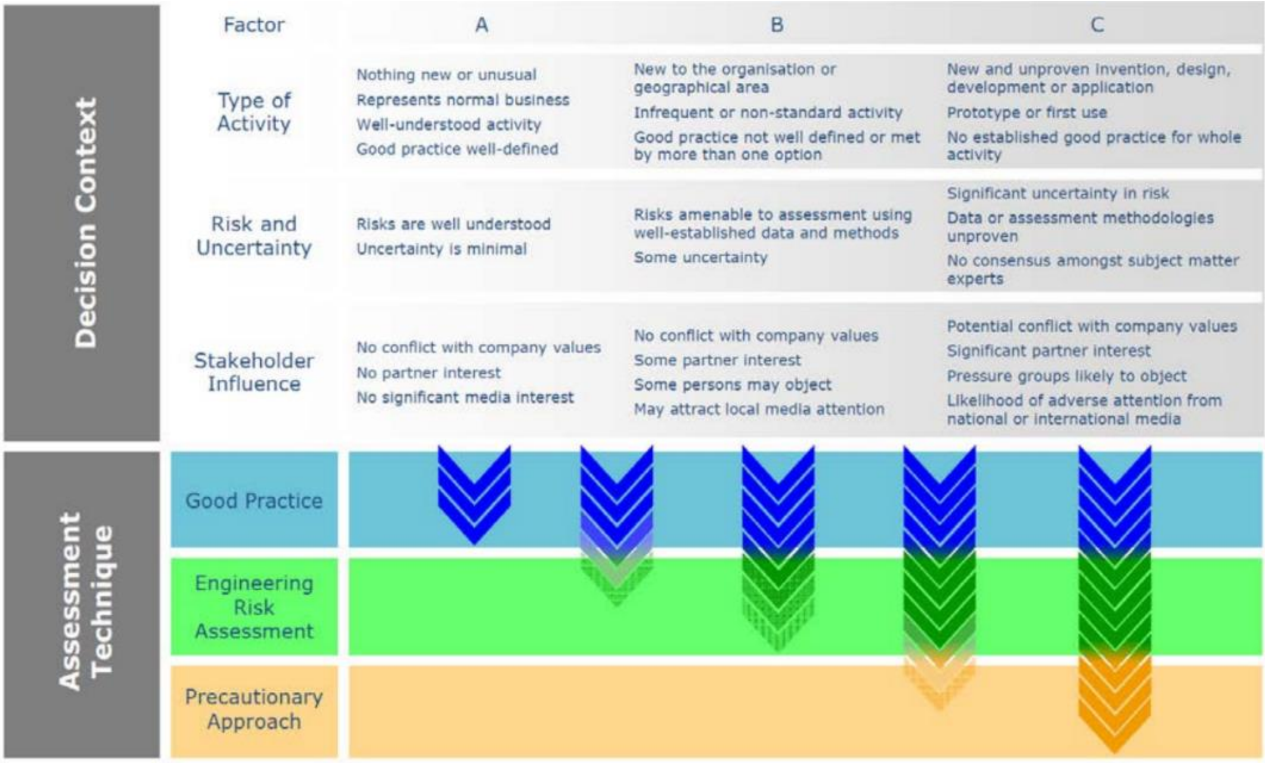


Figure 5-2 ALARP risk related Decision Support Framework (Source: Oil & Gas UK 2014)

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 hazards 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;
- Relevant international conventions; and
- Changing regulator expectations and / or continuous improvement.

If the ALARP technique determines the controls 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 may be identified.

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), Cooper Energy 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 risk reduction measure can be seen and the reason for the benefit understood.

Precautionary Approach

OGUK (2014) state that if the assessment, considering all available engineering and scientific evidence, is insufficient, inconclusive, or uncertain, then a precautionary approach to hazard management is needed. A precautionary approach will mean that uncertain analysis is replaced by conservative assumptions that will result in control measures being more likely to be implemented.

That is, environmental considerations are expected to take precedence over economic considerations, meaning that a control measure that may reduce environmental impact is more likely to be implemented. In this decision context, the decision could have significant economic consequences to an organisation.

5.2.4.3 Evaluate the Acceptability of the Potential Impact and Risk

Cooper Energy considers a range of factors when evaluating the acceptability of environmental impacts or risks associated with its activities. This evaluation is based on NOPSEMA's Guidance Notes for EP Content Requirement (N04750-GN1344, September 2020, NOPSEMA, 2020) and guidance issued in Guideline – Environment plan decision making (N-04750-GL1721, June 2021) (NOPSEMA, 2021).

The acceptability evaluation for each aspect associated with this activity is undertaken in accordance with Table 5-3.

Table 5-3 Cooper Energy Acceptability Evaluation

Factor	Criteria / Test
Cooper Energy Risk Management Protocol	Is the risk severity Extreme (i.e. not within the Company's risk appetite), or High (i.e. requires involvement from the Managing Director to approve the treatment plan)?
Principles of Ecologically Sustainable Development (ESD)	Is there the potential to affect biological diversity and ecological integrity? (Consequence Level 4 and 5) Do activities have the potential to result in serious or irreversible environmental damage? If yes: Is there significant scientific uncertainty associated with aspect? If yes: Has the precautionary principle been applied to the aspect?
Legislative and Other Requirements	Are there any good practice control measures which have not been adopted, including those identified in relevant EPBC listed species recovery plans or approved conservation advices? If no, have alternate control measures been adopted that provide equal or better levels of protection?
Internal Context	Is the impact or risk provided for within Cooper Energy MS Standards and Processes? If no, what additional provisions will be made?
External Context	Are there any objections and claims regarding this aspect which have not been resolved? If yes, is there anything which precludes reaching a resolution?

Table 5-4 Principles of Ecologically Sustainable Development (ESD)

ESD Principle		Relevance to Acceptability
A.	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 assessment process.* *This principal is not considered separately for each acceptability evaluation.*
B.	If there are threats of serious or irreversible environmental damage, lack of full scientific certainty	*An evaluation is completed to determine if the activity will result in serious or irreversible environmental damage. Where the activity has*

ESD Principle		Relevance to Acceptability
	should not be used as a reason for postponing measures to prevent environmental degradation.	*the potential to result in serious or irreversible environmental damage, an assessment is completed to determine if there is significant uncertainty in the evaluation.*
C.	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.	*Where the potential impacts and risk are determined to be serious or irreversible the precautionary principle is implemented to ensure the environment is maintained for the benefit of future generations.*
D.	The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision making	*An assessment is completed to determine if there is the potential to impact biological diversity and ecological integrity.*
E.	Improved valuation, pricing and incentive mechanisms should be promoted	*Not relevant to this EP.*

5.2.5 Risk Monitoring, Review and Record

Risks, risk treatments and controls require continual monitoring and review to determine whether assumptions and decisions remain valid. The risk environment and risk continually change, and treatment plans can also alter the risk. Stakeholders (which may be internal and external to the company) need to be consulted and kept informed.

The monitor, review and recording activities provide assurance that:

- Emerging risks are identified, and existing risks remain relevant and managed
- Controls continue to be effective and efficient in design and operation
- Controls required for the risk to be ALARP are effectively implemented and operating as expected
- Risk management objectives remain appropriate and are supported by effective treatment activities
- The process for managing risk is operating effectively and efficiently
- Information on risk changes and treatment activities are documented
- Stakeholders are consulted and informed regularly of risk management progress and performance.

Additional aspects of monitoring and review are described in the Implementation Strategy in Section 9.12 of this EP include:

- Analysing and lessons learnt from events (including near-misses), changes, trends, successes and failures;
- Detecting changes in the external and internal context (e.g. new conservation plans issued); and
- Chemical selection and discharge process.

6 Risk and Impact Evaluation

To meet the requirements of the OPGGS(E)R 13(5) and 13(6)– Evaluation of environmental impacts and risks, and 13(7) – Environmental performance outcomes and standards, this section evaluates the impacts and risks associated with the Petroleum Activity appropriate to the nature and scale of each impact and risk, and details the control measures that are used to reduce the risks to ALARP and an Acceptable level.

Environmental Performance Outcomes (EPO), Environmental Performance Standards (EPS), and Measurement Criteria have been developed, described and summarised in Section 8.

6.1 Impact and Risk Scoping

Interactions between activities and aspects are shown in Table 6-1. Where no disturbance, discharge of emission are identified in Table 3-10, then no planned interactions are shown. If no planned or unplanned aspects are identified for an activity, then no impacts or risks are identified, and it is not included in the subsequent section.

Impacts and risks resulting from each of these identified interactions were discussed at the project ENIVD and analysed further outside of the workshop where necessary to reduce uncertainty. The outcomes of this process, including consequence and likelihood evaluation, control measures identified, risk ranking and ALARP and acceptability determination, are provided in the following sections. EPOs, EPSs and measurement criteria are summarised in Section 8.

Within this section, impacts are framed as either a “Lower Order Impact” or a “Higher Order Impact”. All impacts are evaluated at the lower level until one or more factors trigger the impact to be evaluated at a higher level. These factors are:

- Uncertainty in the impact or risk assessment which requires further analysis, for example where modelling is required to understand the nature and scale of an impact.
- ALARP decision context B and above (refer to Section 5.1.5).
- Residual Risk Severity Moderate and above (refer to Section 5.1.7).
- Stakeholder concerns.

Higher order impacts require a higher order of evaluation, as described in the NOPSEMA Environment Plan decision making guideline (N-04750-GL1721 A524696 June 2021).

Impacts and risks determined to be lower order (as per Section 5.1.3) are presented in Section 6.2, whilst higher order impacts and risks are evaluated in more detail in Section 6.3 onwards. The differentiation between higher and lower order impacts and risks is colour coded in Table 6-1.

Table 6-1 Activity-Aspect Interactions

Activity	Aspect																
	Physical Presence		Planned Emissions			Planned Discharges			Unplanned interaction				Accidental Release				
Lower Order Impacts and Risks – yellow Higher order Impacts and Risks – green	Displacement of other marine users	Seabed Disturbance	Light Emissions	Underwater Sound Emissions	Atmospheric Emissions	Subsea Operational Discharges	Surface Operational Discharges	Routine Vessel Discharges	Marine Fauna Interaction	Introduction, Establishment and Spread of IMS	Dropped object	Waste (Hazardous and Non-hazardous)	LOC – Minor	LOC -Refuelling	LOWC – Subsea	LOC – Vessel Collision	LOC – Subsea infrastructure
Phase 1a Activities																	
Facility cleaning and preparation		X				X				X	X						X
Seabed Survey				X													
Well Abandonment: • well intervention and suspension		X	X		X	X	X								X		
• Restoring Cap Rock						X	X										
Cementing					X		X										
Phase 1b Activities																	
Subsea well infrastructure removal		X								X	X						
Wellhead and Manifold Pile Removal		X								X	X						
As-left Survey				X													
Support Activities																	
MOU	X	X	X	X	X			X	X	X	X	X	X	X		X	X
Vessels	X		X	X	X			X	X	X	X	X	X	X		X	X
Helicopters				X													
Contingency and Alternative Activities																	
MOU Emergency Disconnection						X							X		X		
~~Wax Management~~							~~X~~										

6.2 Lower Order Impact Evaluations

6.2.1 Planned Activities

Table 6-2 Lower Order Planned Activities Impact and Risk Evaluation

Aspect	Predicted Impacts	Consequence Evaluation	Consequence	ALARP Decision Context	Control Measures	Likelihood	Residual Risk Severity	Acceptability Outcome
Physical Presence								
Displacement of other Marine Users • MOU • Vessels	Changes to the functions, interests and activities of other marine users	**Commercial fisheries (State and Commonwealth)** For the duration of the activity (130 days, single or split campaign), other marine users will be temporarily displaced from the sea area surrounding the activity by the presence of a 500 m exclusion zone around the MOU (requested via a notice to mariners). This exclusion zone will mostly include the existing gazetted PSZs, and will result in a slight increase to the exclusion area (from 360 m to 500 m) around the Basker-6 and Manta 2A locations. State and Commonwealth commercial fisheries have been identified to be the main marine users within the Operational Area. There are two Commonwealth and no State fisheries that overlap the Operational Area and are actively fished (see Addendum 1, Section 4.4.2). Considering current fishing effort data and the depth range of the area, the presence of fishers within the Operational Area is expected to be low. During stakeholder consultation, concerns were raised by commercial fisheries around potential long-term (multi-generational) (legacy) disruption for some in-situ decommissioning concepts. These mostly relate to flowline removal, and will be discussed in future EP(s). Given the total PSZs area is small in comparison to the larger fishing grounds of the region and no significant impact to commercial operations is expected the consequence of impacts to commercial fisheries will be **Level 1.** **Shipping** The Operational Area does not coincide with major shipping routes (see Addendum 1, Section 4.8.1). Therefore, it is expected that a relatively small number of shipping vessels may be encountered within the Operational Area, with the most credible impact to shipping being minor deviations around MOU 500 m safety exclusion zone and pre-existing PSZ. Historically there have been no interactions with shipping. Cooper Energy has also maintained ongoing stakeholder consultation with relevant stakeholders and no stakeholder objections have been raised by the shipping industry for this or previous Cooper Energy campaigns in the region. Given the Operational Area is within no major shipping routes, the consequence of any impacts to the shipping industry will be **Level 1**. **Recreational Fishers and Tourism** East Gippsland waters have a moderate recreational fishing intensity, but it is highly unlikely that recreational fishers and tourism will be present within the Operational Area due to the distance off the Victorian coastline (50 km) and the depth range (135 m-270 m) of the Operational Area being undesirable for recreational activities with the exception of recreational sailing boats which may occasionally pass through the Gippsland region in the vicinity of the operational area. No concerns were raised during stakeholder consultation. That interactions with divers and swimmers have not been considered, due to lack of appropriate sites within the Operational Area, the presence of the PSZ, the water depth and distance from shore. Given the unlikely chance of recreational fishers and tourism present within the Operational Area, the consequence of any impacts will be **Level 1.**	Level 1	A	C1: Marine exclusion and caution zones C2: Pre-start notifications C3: Marine Order 27: Safety of navigation and radio equipment C4: As-left seabed survey C5: Ongoing consultation C6: Fisheries Damage Protocol C39: Wet parking restricted to within the existing infrastructure PSZs	N/A	N/A	Acceptable, based on: • Impacts well understood. • Consequence Level is Level 1 and below 4, therefore no potential to affect biological diversity and ecological integrity. • Activity will not result in serious or irreversible damage. • Good practice controls defined and implemented. • Legislative and other requirements have been identified and met: *OPGGS Act 2006* *Navigation Act 2012* • Cooper Energy MS Standards and Processes have been identified. • Stakeholder objections raised by commercial fisheries relevant to long term decommissioning (legacy) disruption. Phase 1 disruption and displacement is minor and temporary and has not significantly increased since initial PSZ (gazetted in 2012).

Aspect	Predicted Impacts	Consequence Evaluation	Consequence	ALARP Decision Context	Control Measures	Likelihood	Residual Risk Severity	Acceptability Outcome
		Energy Development Area The Gippsland Basin is recognised as one of Australia's premier hydrocarbon provinces, having continually produced oil and gas since the late 1960s (GA, 2020). Within the Operational Area the only activities reported are those related to BMG assets. Given this, the consequence of any impacts will be **Level 1.**						
Planned Emissions								
Light Emissions • Well Abandonment (flaring) • MOU • Vessels	• Change in ambient light Risk events: • Change in fauna behaviour (attraction, disorientation)	**Ambient light, marine turtles, seabirds and migratory shorebirds** Sources of light from the activity include navigation and safety lighting from MOU and vessels (continuous source for the duration of the activity), and light generated by flaring during well abandonment (intermittent source, predicted up to 3 hours per flare event). The flare boom on the MOU is expected to be located around the height of the main deck, and will be partially shielded by the MOU structure itself. Light emissions will result in a change in ambient light within the Light Exposure Area, with a **Level 2** consequence within that area. Light emissions may result in a localised change to marine fauna's behaviour. Species with the greatest sensitivity to light are marine turtles, seabirds and migratory shorebirds. The National Light Pollution Guidelines for Wildlife (Commonwealth of Australia, 2020a) has been reviewed and light sensitive species have been identified. The purpose of the guideline is to minimise the adverse impacts on marine fauna from artificial lighting. The guidelines recommend a 20km threshold as a precautionary limit based on observed effects of sky glow on marine turtle hatchlings demonstrated to occur at 15–18 km and fledgling seabirds grounded in response to artificial light 15 km away (Commonwealth of Australia 2020). Cooper Energy have adopted a 20km Light Exposure Area around the Operational Area. The PMST report for the Light Exposure Area identified three marine turtle species; loggerhead turtle, green turtle and the leatherback turtle, that are likely to have a habitat within the area. There are no known BIAs or habitats critical to the survival of marine turtle species within the Light Exposure Area, and no nesting sites or nesting behaviours identified in the Light Exposure Area. The PMST report for the Light Exposure Area identified 32 bird species that could potentially occur within the area. Eight bird species have been identified having foraging BIAs (short-tailed shearwaters, antipodean albatross, wandering albatross, common diving petrel, Buller's albatross, shy albatross, Indian yellow-nosed albatross, Campbell albatross, black-browed albatross) within the Light Exposure Area. No key nesting, roosting or resting areas are located within the Light Exposure Area. Given the absence of important behaviours by sensitive species within 20 km light exposure area, the impact of light emissions to marine turtles, seabirds and migratory shorebirds will be **Minor (2)**. The likelihood of this consequence occurring is **Unlikely (D)**, given the lack of key habitats within the Light Exposure Area and the short duration of the light events. Cooper Energy will engage Wildlife Victoria for advice regarding management of any avifauna found at the facilities.	Level 2	A	C7: Marine Order 30: Prevention of collision C8: Fluids Handling Package accepted under safety case regime C9: Well Returns Management Philosophy C14: Selection of high efficiency burner	Likelihood of risk event: Unlikely (D)	Low	Acceptable, based on: • Impacts well understood. • Residual risk of risk events is **Low**. • Consequence level is Level 2 and below 4, therefore no potential to affect biological diversity and ecological integrity. • Activity will not result in serious or irreversible damage. • Good practice controls defined and implemented. • Legislative and other requirements have been identified and met: *National Light Pollution Guidelines for Wildlife Including marine turtles, seabirds and migratory shorebirds (2020a)* *EPBC Act Policy Statement 3.21—Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species* • Activity will not impact the recovery of: Albatrosses and Giant Petrels as per National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 • Cooper Energy MS Standards and Processes have been identified. • Cooper Energy will engage Wildlife Victoria for advice regarding management of any avifauna found at the facilities. • No stakeholder objections or claims have been raised.
		Plankton and fish The National Light Pollution Guidelines for Wildlife (Commonwealth of Australia 2020a) does not identify plankton and fish as species which are sensitive to light emissions. Consequently, it is concluded that the consequence or impact of light emissions to plankton and fish will be **Level 1**, and the likelihood of the consequence level occurring is Remote I**.**	Level 1					

Aspect	Predicted Impacts	Consequence Evaluation	Consequence	ALARP Decision Context	Control Measures	Likelihood	Residual Risk Severity	Acceptability Outcome
Atmospheric Emissions • Well abandonment (venting) • Well abandonment (flaring) • Cementing • MOU • Vessels	• Change in air quality • Climate Change	**Ambient air quality** Atmospheric emissions will be generated by power generation by the MOU and vessels (continuous throughout the activity), flaring and venting (intermittent) and blow-down of dry excess cement (intermittent). The use of fuel (specifically marine-grade diesel) to power engines, generators and mobile and fixed plant (e.g., ROV, back-deck crane, generator), and the flaring and venting of natural gas, will result in emission of greenhouse gases (GHG) such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), along with non-GHG such as sulphur oxides (SO_X) and nitrous oxides (NO_X). Greenhouse gas emissions and non-greenhouse emissions are emitted into the atmosphere during continued operations of the MOU, vessel engines, helicopters, generators, and equipment. Emissions will occur for the duration of the activity (130 days). Flaring is necessary during well abandonment and will be done via a burner boom intermittently for a short duration (estimated up to 3 hours per flare event). When transferring dry bulk products (such as cement), tank venting is necessary for safety control. Any emissions will be negligible and limited to the immediate vicinity of the MOU, support vessels and CSV's. Potential receptors above the sea surface within the Operational Area that may be exposed to reduced air quality include seabirds and marine megafauna that surface for air (e.g. marine mammal and marine turtles). Emissions will be small in quantity and will dissipate quickly into the surrounding atmosphere, therefore any localised reduction in air quality is not expected to result in any measurable effect. Therefore, impacts to marine fauna and social receptors (e.g. commercial fisheries) from atmospheric emissions are not expected, and have not been evaluated further. Given the localised and temporary nature of the change in air quality, the consequence of any impacts will be **Level 1.** **Climate change** The use of fuel to power engines, generators and any mobile/fixed plant will result in gaseous emissions of GHG such as CO_2, methane (CH_4) and nitrous oxide (N_2O). Safety venting will occur as part of the well abandonment activity resulting in methane being released. While these emissions add to the GHG load in the atmosphere, which adds to global warming potential, they are relatively small on a state, national and global scale, representing an insignificant contribution to overall GHG emissions. Emissions will be small in quantity and short-term, and will not significantly contribute to climate change. Therefore, impacts to climate from atmospheric emissions are not expected.	Level 1	A	C8: Fluids Handling Package accepted under safety case regime C9: Well Returns Management Philosophy C12: Planned Maintenance System C14: Selection of high efficiency burner. C15: Drilling Fluids Reuse Assessment C17: NOPSEMA accepted safety cases and safety case revision C22: AMSA Discharge Standards	N/A	N/A	Acceptable, based on: • Impacts well understood. • Consequence level is Negligible (1) and below 4, therefore no potential to affect biological diversity and ecological integrity. • Activity will not result in serious or irreversible damage. • Good practice controls defined and implemented. • Legislative and other requirements have been identified and met: - *Protection of the Sea (Prevention of Pollution from Ships) Act 1983.* - *Navigation Act 2012 – Chapter 4 (Prevention of Pollution).* - *Marine Order 97 (Marine pollution prevention – air pollution) 2013* • Cooper Energy MS Standards and Processes have been identified. • No stakeholder objections or claims have been raised.
Planned Discharges (refer to section 6.4 for subsea operational discharges and surface operational discharges)								
Routine Vessel Discharges • MOU • Vessels	• Change in water quality	**Ambient water quality** Routine vessel discharges include: • Cooling water – seawater is used as a heat exchange medium for the cooling of machinery engines. The seawater goes through a heat exchanger that transfers heat from the vessel engines and machinery to the seawater. Once the seawater goes through the system it is discharged back into the ocean. • Brine – brine is generated from the water supply system. Brine is discharged to the open ocean at a salinity of approximately 10% higher than seawater. The volume of discharge is dependent on the amount of people on board the vessel that require fresh (or potable) water.	Level 1	A	C12: Planned Maintenance System C22: AMSA Discharge Standards	N/A	N/A	Acceptable, based on: • Impacts well understood. • Consequence level is Level 1 and below 4, therefore no potential to affect biological diversity and ecological integrity. • Activity will not result in serious or irreversible damage. • Good practice controls defined and implemented.

Aspect	Predicted Impacts	Consequence Evaluation	Consequence	ALARP Decision Context	Control Measures	Likelihood	Residual Risk Severity	Acceptability Outcome
		• Sewage and grey water- the volume of sewage and grey water discharge is dependent on the number of people on board the MOU and vessels. Approximately 0.04 and 0.45m^3 of sewage / grey water will be generated per person, per day (EMSA 2016). • Putrescible waste- food waste will be generated on board the MOU and vessels, approximately 1 L of food waste per person, per day is expected. • Deck drainage and bilge- Rainfall or wash-down can drain discharges that are on the deck into the marine environment. The deck drainage may contain particulate matter and residual chemicals. The volume of oily water after treatment discharged into the marine environment can be up to 15 parts per million (ppm). Routine vessel discharges will result in localised impact on water quality from increased temperature, salinity, nutrients, and chemical toxicity. Planned vessel discharges would be of low volume during in-water activities of short duration (up to 130 days). The MOU will be stationary within the Operational Area for extended durations, while other vessels will be transiting in and out of the area. **Increased Temperature and salinity** Modelling 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, 2014). Brine water will sink through the water column where it will be rapidly mixed with receiving waters and dispersed by ocean currents. As such, temperature and salinity impacts are expected to be limited to the source of the discharge where concentrations are highest. **Chemical Toxicity** Scale inhibitors are typically low molecular weight phosphorous compounds that are water-soluble, and only have acute toxicity to marine organisms about two orders of magnitude higher than typically used in the water phase (Black et al., 1994). The biocides typically used in the industry are highly reactive and degrade rapidly (Black et al., 1994). Scale inhibitors and biocide used in the heat exchange and desalination process to avoid fouling of pipework are inherently safe at the low dosages used; they are usually consumed in the inhibition process, so there is little or no residual chemical concentration remaining upon discharge. **Temporary and localised reduction in water quality (nutrients and BOD)** Monitoring of sewage discharges for another offshore project (Woodside, 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, 100, and 200 m downstream of the platform and at five different water depths confirmed that discharges were rapidly diluted and elevations in water quality monitoring parameters (e.g. total nitrogen, total phosphorous, and selected metals) were not recorded above background levels at any station. During the Activity, the amount of sewage and grey water to be discharged per day will be significantly lower than 10m^3. The Operational Area is located within the Upwelling East of Eden KEF, an area of episodic upwelling known for high productivity and marine life. Open marine waters are typically influenced by regional wind and large-scale current patterns resulting in the rapid mixing of surface and near surface waters and the low volume discharges, thus it is expected that any planned operational discharges would disperse quickly over a small area. Therefore, the consequence of impacts to water quality will be **Level 1**.						• Legislative and other requirements have been identified and met: *Marine Order 91 – Marine pollution prevention – oil (as relevant to vessel class)* *Marine Order 95 – Marine pollution prevention – garbage (as appropriate to vessel class)* *Marine Order 96 – Marine pollution prevention – sewage (as appropriate to vessel class)* • Activity will not impact on the values and functions of the Upwelling East of Eden KEF. • Cooper Energy MS Standards and Processes have been identified. • No stakeholder objections or claims have been raised.

Aspect	Predicted Impacts	Consequence Evaluation	Consequence	ALARP Decision Context	Control Measures	Likelihood	Residual Risk Severity	Acceptability Outcome
	• Injury / mortality	**Plankton** Mortality rates for plankton are naturally high with distribution often patchy and linked to localised and seasonal productivity that produces sporadic bursts in phytoplankton and zooplankton populations (DEWHA, 2008). The Operational Area is located within the Upwelling East of Eden KEF, an area of episodic upwelling known for high productivity. A change in water quality as a result of routine vessel discharges 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 (such as the Upwelling East of Eden KEF). Therefore, the consequence of any impacts to plankton from planned surface operational discharges have been evaluated as **Level 1.** Impacts to larger marine fauna (such as fish, seabirds, marine mammals and marine reptiles) are not expected.						

6.2.2 Unplanned Events

Table 6-3 Lower Order Unplanned Events Risk Evaluation

Aspect	Risks	Consequence Evaluation	Consequence	ALARP Decision Context	Control Measures	Likelihood	Residual Risk (Severity)	Acceptability Outcome
Unplanned interaction								
Marine Fauna Interaction • MOU • Vessels	• Change in fauna behaviour (avoidance) • Injury / mortality	**Marine mammals, marine reptiles, fish** Marine fauna interactions could occur as a result of movement of vessels within the Operational Area. Interactions could cause a change in marine fauna behaviour or injury / mortality. Megafauna that are within the surface waters and breach often are most at risk from marine fauna interactions within the Operational Area. Cetaceans are naturally inquisitive marine mammals that are often attracted to offshore vessels and facilities, however, the reaction of whales to the approach of a vessel is variable. Some species remain motionless when in the vicinity of a vessel, while others are curious and often approach ships that have stopped or are slow moving, although they generally do not approach, and sometimes avoid, faster-moving ships (Richardson et al., 1995). Cooper Energy has observed several large baleen whales during previous installation campaigns in the Gippsland area, which remained in the vicinity for a short time before moving on. All observations are reported to the Australian Marine Mammal Centre. Collisions between larger vessels with reduced manoeuvrability and large, slow-moving cetaceans occur more frequently where high vessel traffic and cetacean habitat occurs (Whale and Dolphin Conservation Society, 2003). Laist et al. (2001) identified that larger vessels with reduced manoeuvrability moving in excess of 10 knots may cause fatal or severe injuries to cetaceans, with the most severe injuries caused by vessels such as tankers travelling faster than 14 knots and with limited manoeuvrability. Vessels used to support these activities do not have the same limitations on manoeuvrability and would typically travel at economy speeds (or lower) when conducting activities within the scope of this EP, inside the Operational Area. Listed threatened and migratory marine fauna presence in the Operational Area includes: • two threatened shark species; white shark (Vulnerable) and whale shark (Vulnerable). A distribution BIA for white shark is within the Operational Area. • three listed threatened marine turtle species; loggerhead turtle (Endangered), green turtle (Vulnerable) and the leatherback turtle (Endangered). No BIA's, internesting buffer and critical habitats have been identified within the Operational Area for marine turtles. • ~~Five~~ Four threatened whale species have a known presence within the Operational Area; sei whale (Vulnerable), blue whale (Endangered), Fin Whale (Vulnerable) and Southern right whale (Endangered). ~~and humpback whale (Vulnerable)~~. Of these species only two have BIAs within the Operational Area; known foraging and distribution BIA for the pygmy blue whale and known core range BIA for the Southern right whale. The Operational Area has no threatened species presence or BIAs for pinnipeds, dugongs or dolphins, although Australian fur seal has previously been observed in the area during routine facility inspections (Ierodiaconou et al., 2021).	Level 2	A	C26: EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans. Caution zone extended to 500m between whales and project vessels. C27: Marine Mammal Adaptive Management	Impact is conceivable and could occur, however it would require a rare combination of factors and is therefore considered **Unlikely (D)**	Low	Acceptable, based on: • Impacts well understood. • Residual risk (severity) is Low. • Consequence level is below 4, therefore no potential to affect biological diversity and ecological integrity. • Activity will not result in serious or irreversible damage. • Good practice controls defined and implemented. • Legislative and other requirements have been identified and met: - *EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans* - *National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (CoA 2017b)* - *Section 229 of the EPBC Act* • Activity will not impact the recovery of: - Marine turtles as per the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017). - White Shark as per the Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC 2013). - Australian Sealion as per the Recovery Plan for the Australian Sealion (DSEWPC, 2013) - Blue Whale per the Conservation Management Plan for the Blue Whale, 2015-2025 - Southern Right Whale as per Conservation Management Plan for the Southern Right Whale, 2011-2021. - Conservation Advice for the Sei Whale (TSSC, 2015c); - Conservation Advice for the Fin Whale (TSSC, 2015d); and - Listing Advice for the Humpback Whale (TSSC, 2022).

Aspect	Risks	Consequence Evaluation	Consequence	ALARP Decision Context	Control Measures	Likelihood	Residual Risk (Severity)	Acceptability Outcome
		The following management plans and conservation advices identify vessel strike as a threat: • Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015); • Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012); • Conservation Advice for the Sei Whale (TSSC, 2015c); • Conservation Advice for the Fin Whale (TSSC, 2015d); and • Listing Advice for the Humpback Whale (TSSC, 2022). • Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017) The occurrence of physical interactions with marine fauna is very low with no incidents occurring during Cooper Energy activities in the region including previous construction campaigns for the Sole development through 2018 and 2019. If an incident occurred, it would be restricted to individual fauna and not have impacts to local population levels. The consequence of an impact is therefore predicted to be **Level 2**, as short-term impacts to species or habitats of recognized conservation value, not affecting local ecosystem function.						• Cooper Energy MS Standards and Processes have been identified. • No stakeholder objections or claims have been raised. • Additional controls that provide a suitable environmental benefit for an insignificant cost have also been identified and selected.
Waste (Hazardous and Non-hazardous) • MOU • Vessels	• Change in water quality • Change in fauna behaviour • Injury / mortality	**Seabirds and migratory Shorebirds, Marine Turtles and Marine Mammals** The handling and storage of materials and waste on board MOUs and vessels has the potential for accidental over-boarding of hazardous/non-hazardous materials and waste. Small quantities of hazardous/non-hazardous materials (solids and liquids) will be used and wastes created, handled, and stored on board until transferred to port facilities for disposal at licensed onshore facilities. However, accidental releases to sea are a possibility, such as in rough ocean conditions when items may roll off or be blown off the deck. Waste accidently released to the marine environment can cause a change in fauna behaviour, a change in water quality, and may lead to injury or death to individual marine fauna through ingestion or entanglement. Listed threatened and migratory marine fauna presence in the Operational Area includes: • 25 threatened seabird and shorebird species, including nine foraging BIAs • two threatened shark species; white shark (Vulnerable) and whale shark (Vulnerable). A distribution BIA for white shark is within the Operational Area. • three listed threatened marine turtle species; loggerhead turtle (Endangered), green turtle (Vulnerable) and the leatherback turtle (Endangered). No BIA's have been identified within the Operational Area for marine turtles, including internesting buffer and critical habitats. • Four threatened whale species have a known presence within the Operational Area; sei whale (Vulnerable), blue whale (Endangered), Fin Whale (Vulnerable) and Southern right whale (Endangered). Of these species only two have BIAs within the Operational Area; known foraging and distribution BIA for the pygmy blue whale and known core range BIA for the Southern right whale. The Operational Area has no	Level 1	A	C22: AMSA Discharge Standards C25: Garbage Management Plan	Impact is conceivable and could occur, however it would require a rare combination of factors and is therefore considered **Unlikely (D)**	Low	Acceptable, based on: • Impacts well understood. • Residual risk (severity) is Low. • Consequence level is below 4, therefore no potential to affect biological diversity and ecological integrity. • Activity will not result in serious or irreversible damage. • Good practice controls defined and implemented. • Legislative and other requirements have been identified and met: - *Marine Order 95 – Marine pollution prevention – garbage (as appropriate to vessel class)* - *Protection of the Sea (Prevention of Pollution from Ships) Act 1983.* - *Navigation Act 2012 – Chapter 4 (Prevention of Pollution).* • Activity will not impact the recovery of: - Albatross and Giant Petrel populations breeding and foraging as per the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC 2011). - Marine turtles as per the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017). • Cooper Energy MS Standards and Processes have been identified.

Aspect	Risks	Consequence Evaluation	Consequence	ALARP Decision Context	Control Measures	Likelihood	Residual Risk (Severity)	Acceptability Outcome
		threatened species presence or BIAs for pinnipeds, dugongs or dolphins. The following management plans and conservation advices identify marine debris as a threat: • National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC 2011) • Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017) • Draft Wildlife Conservation Plan for Seabirds (Commonwealth of Australia, 2019) • Threat Abatement Plan for the impacts of marine debris on vertebrate wildlife of Australia's coasts and oceans (Commonwealth of Australia, 2018) Waste will be handled in accordance with AMSA Discharge Standards and respective vessel Garbage Management Plans. Given this, and the limited impacts expected should waste be accidentally discharged, the consequence of any impacts from marine pollution will be **Level 1**.						• No stakeholder objections or claims have been raised.
Dropped object • Facility cleaning and preparation • Subsea well infrastructure removal • Wellhead and manifold pile removal • MOU • Vessels	• Change in habitat • Injury / mortality	**Benthic habitats, Birds, Marine Turtles and Marine Mammals** The handling and storage of materials and waste on board MOUs and vessels has the potential for accidental over-boarding of hazardous/non-hazardous materials and waste. Similarly, activities at the seabed such as those conducted by ROV can result in tools and equipment being dropped. MOU anchoring can result in anchor drag or dropped mooring components. The removal of large structures from the seabed also presents a dropped object risk during recovery to surface. Objects that have the potential to be accidentally dropped overboard include: • Personal protective gear (e.g. glasses, gloves, hard hats) • Small tools (e.g. spanners) • Hardware fixtures (e.g. riser hose clamp), • Intervention equipment (e.g. riser), • Lifting equipment • Infrastructure being recovered from seabed Dropped objects can cause smothering of benthic habitats as well as injury or death to marine fauna or seabirds through ingestion or entanglement (e.g., polymer rope entangling marine fauna or smaller plastic fragments or being ingested). For example, the TSSC (2015a) reports that there have been 104 records of cetaceans in Australian waters impacted by plastic debris through entanglement or ingestion since 1998 (humpback whales being the main species). Where practicable, dropped objects will be recovered and therefore impacts are expected to be temporary in nature. However, in some instances where it is unsafe to retrieve or impossible to find, objects may remain overboard. If individual dropped objects are unable to be recovered, the impact would be expected to be localised, and would be unlikely to have a discernible effect on benthic habitat or populations. The following management plans and conservation advices identify marine debris as a threat: • National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC 2011)	Level 2	A	C17: NOPSEMA accepted safety cases and safety case revision C25: Garbage Management Plans C24: Equipment deployment and recovery procedures.	Impact is conceivable and could occur, however it would require a rare combination of factors and is therefore considered **Unlikely (D)**	Low	Acceptable, based on: • Impacts well understood. • Residual risk (severity) is Low. • Consequence level is below 4, therefore no potential to affect biological diversity and ecological integrity. • Activity will not result in serious or irreversible damage. • Good practice controls defined and implemented. • Legislative and other requirements have been identified and met: - *SOLAS Chapters VI and VII, in relation to a Cargo Securing Manual* - *OPGGS Act 2006: Section 280(2) – No interference with seabed to a greater extent than is necessary for the exercise of the rights conferred by titles granted.* - *OPGGS Act 2006: Section 280(2) -Schedule 3 Occupational health and safety and OPGGS (Safety) Regulations 2009 (OPGGS(S)R).* • Activity will not impact the recovery of EPBC listed species. • Cooper Energy MS Standards and Processes have been identified. • No stakeholder objections or claims have been raised.

Aspect	Risks	Consequence Evaluation	Consequence	ALARP Decision Context	Control Measures	Likelihood	Residual Risk (Severity)	Acceptability Outcome
		• Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017) • Draft Wildlife Conservation Plan for Seabirds (Commonwealth of Australia, 2019) • Threat Abatement Plan for the impacts of marine debris on vertebrate wildlife of Australia's coasts and oceans (Commonwealth of Australia, 2018) Temporary or permanent loss of dropped objects is not expected to have a significant environmental impact, given the low sensitively of benthic communities within the Operational Areas, therefore the consequence of any impacts from will be **Level 2**.						
Accidental Release								
Loss of Containment Accidental release including: • LOC – Minor • LOC – Refuelling Cause of Aspect: • MOU • Vessels • MOU Emergency Disconnect	Change in water quality	**Ambient water quality** LOC scenarios include: • Hydraulic line failure (~1 m^3) • Refuelling / bunkering dry break couplings failure (~50 m^3) • Loss of containment from subsea infrastructure as a result of external forces (e.g. dropped objects from campaign activities) • Riser volume of 46.5 m^3 of well fluids released in the event of retention valve failure during MOU emergency disconnect. Hydraulic line failure is associated with small volume spill events – with the maximum volume based upon the loss of an intermediate bulk container ~1 m^3. AMSA (2015) 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. Fluids in subsea infrastructure are expected to include inhibited seawater, small volumes of gas, and diesel (approximately 2.3 m^3). The largest pipeline volumes of 101.07 m^3. A loss of 46.5 m^3 of fluids from the riser (if retaining valves failed) would be expected to result in changes to water quality in both surface waters and within the water column. The potential impacts to water quality are assessed consequence **Level 1**; minor local impacts with nil to negligible remedial recovery to water systems. This assessment considers the energetic offshore environment at BMG which would be expected to quickly disperse releases of this nature. Additional risk events include temporary irritation to species of recognised conservation value (Level 2 consequence); given there are no resident species of recognised conservation value within the water column around BMG, the chance of a spill event occurring, which then impacts an animal swimming nearby, for long enough to be irritated, is considered hypothetical.	Level 1	A	C12: Planned Maintenance System C34: MOU Material Transfer Procedures C31: Vessel compliant with MARPOL Annex I, as appropriate to class (i.e. SMPEP or equivalent)	Impact is conceivable and could occur, however it would require a rare combination of factors and is therefore considered **Unlikely (D)**	Low	Acceptable, based on: • Impacts well understood. • Residual risk (severity) is Low. • Consequence level is below 4, therefore no potential to affect biological diversity and ecological integrity. • Activity will not result in serious or irreversible damage. • Good practice controls defined and implemented. • Legislative and other requirements have been identified and met: - *AMSA's Marine Order Part 91 (Marine pollution prevention – oil Marine)* - *Guidelines for Offshore Marine Operations GOMO 0611-1401 (2013)* • Activity will not impact the recovery of EPBC listed species. • Cooper Energy MS Standards and Processes have been identified. • No stakeholder objections or claims have been raised.

6.3 Seabed Disturbance

6.3.1 Cause of Aspect

Seabed disturbance will occur as a result of the following activities.

6.3.1.1 Facility cleaning and preparation

Minor excavation is required to enable clear access for cutting. Preparation work for cutting including subsea bracing structures or pile for tethering system, adjusting umbilicals to allow for piles or clump weight placement; mooring pre-lays (if needed). All seabed disturbance for cleaning and preparation will occur within the existing infrastructure footprint.

Seabed tethering of well intervention equipment activities will require up to four gravity anchors or suction piles for each well. Each gravity anchor or pile will be located within approximately 25 m of the well and is attached to the intervention equipment via guide wires. Gravity anchors laid onto the seabed have a footprint of approximately 20 m^2 each, with a total project footprint for gravity anchors of 560 m^2. Suction piles penetrate the seabed and are expected to have a smaller footprint than gravity anchors. Removal of seabed tethering systems following activity completion will result in a similar footprint.

6.3.1.2 Subsea structures removal

During abandonment activities some infrastructure (i.e. wellheads, or SST) may be temporarily wet parked on the seabed to be retrieved later in the campaign, prior to the completion of activities within the scope of this EP. Wet parking will occur within the gazetted PSZs, and the footprint of wet parked infrastructure will be no larger than the infrastructure itself (Table 3-2).

If surface infrastructure is not able to be retrieved as planned, it will remain in situ until the next phase of decommissioning. Information gathered during this phase will be used to engineer alternate removal methods. Maintenance of property remaining in situ will be managed in accordance with the BMG Offshore Facility Integrity Management Plan.

6.3.1.3 Transponders

Transponders are typically deployed attached to equipment (e.g. gravity anchors), or to the seabed on a frame or ballast with an indicative footprint of 1.5 m^2 per frame.

6.3.1.4 Subsea cutting

Cutting tools required to remove structures cemented into the seabed will generate metal swarf and some cement cuttings at the seabed and inside the steel pipe. These solids will be discharged to the marine environment in the vicinity of the cutting activity resulting in localised seabed disturbance. Suction pile dredging may also be required to excavate sediment from within and around the pile and enable cutting below seabed level. All disturbance will be within the existing infrastructure footprint.

6.3.1.5 MOU Mooring (contingency)

If a moored MOU is used (contingency), some temporary disturbance to the seabed is expected associated with installing and arranging moorings. A moored MOU would require 8 – 12 anchors (approximately 30 m^2 disturbance area per anchor) which would be located within 2 km of MOU and within the boundary of the Operational Area. It is expected that the MOU will be positioned and repositioned multiple times at three locations within the BMG PSZ. These locations will be the Manta-2a well, Basker-6 ST1, and Basker-A drill centre where the MOU will skid between 5 wells around Basker-A well. Length of mooring chain is expected to be up to approximately 1225 m of 84 mm chain, and 550 m of 95 mm mooring wire (or similar combination); a disturbance corridor of 5 m for each mooring chain has been assumed allowing for lateral movement with currents and tension adjustments whilst in place. This gives a total disturbance footprint for MOU mooring of 0.01 km^2 per MOU mooring location.

6.3.2 Predicted Environmental Impacts (Consequence)

Seabed disturbance has the potential to result in direct and indirect impacts including:

- Smothering
- Change in benthic habitat (e.g. scouring, erosion); and

- Change in water quality resulting in localised and temporary smothering/ agitation due to increases in suspended sediments near the seabed.

Predicted impacts from seabed disturbance will be limited to the Operational Area. Receptors which may be affected by seabed disturbance within the Operational Area include:

- Benthic and pelagic invertebrate communities.
- Fish (including commercial fish species)

As identified in Table 4-2, benthic and pelagic invertebrate and communities within the Operational Area are characterised by a soft sediment and shell/rubble seabed, infauna communities, and sparse epibiotic communities (typically sponges) and located beyond photic zone (approximately 135 m to 270 m). Site specific surveys observed the area within the PSZ to be largely featureless, dominated by a mix of sand and pebble/gravel (Ierodiaconou et al, 2021) and widespread throughout the Gippsland region.

Epifauna communities are expected to be sparse compared to nearshore regions due to occurrence of silty sands and limited availability of hard substrates (subsea equipment excepted). Epibenthic communities are expected to consist primarily of sand, biofilm (thin layer of epibenthos), burrowing infauna and shells, with the presence of occasional black corals/octocorals and encrusting sponges associated with subsea infrastructure and limited areas of hard substrate (Ierodiaconou et al 2021).

A study of marine communities of Cooper Energy offshore facilities, undertaken by Deakin University and the Australian Institute of Marine Science (AIMS) in 2021 (Ierodiaconou et al (2021)), utilised current and historic ROV imagery from facility inspections; findings included:

- Species observed on and around the infrastructure were considered representative of the region.
- In general, flowlines had higher fish species richness than the wells and manifold but supported a lower density of fish.
- Invertebrate taxa were identified from four phyla with Arthropoda and Cnidaria dominating the assemblages.
- Wells had comparatively low numbers of invertebrates compared to flowlines, with 27 individuals observed from eight taxa across all wells and years
- Infauna burrows were observed beside all flowlines, generally in low densities
- Benthic community cover was predominantly biotic for all wells, dominated by biofilm. Black/octocorals, bryozoans and ascidians were also observed on structures.
- Communities observed on flowlines and umbilicals varied in productivity and diversity across the field, likely due to physical (flowline position, distance to structures, depth) and biotic factors (benthic cover).
- Handfish (Brachionichthyidae spp.) and stingaree (Urolophus spp.,) were observed on sediment which had backfilled over flowlines, although species identification has not been possible.

Handfish are relatively small (60–151 mm) marine fishes with distributions restricted to the temperate waters of south-eastern Australia, predominantly concentrated in Tasmania (Last and Gledhill, 2009). They are demersal, generally cryptic in nature. Lacking a swim bladder, they prefer to use their ‘hands’ to ‘walk’ across the sea floor, rather than swim (although can do so over short distances when disturbed).

The images captured of the handfish were done so by ROV camera flying over the known flowline routes. These particular sections of flowlines were trenched and buried in 2012 (or have been naturally buried since installation). The specimens observed at BMG were all seen on areas of seabed covering the B6 EHU and B6 Oil Flowline (Figure 6-1). The seabed appears sandy/shell/silty/muddy. There is evidence of infauna (burrows/mounds) and epifauna. It is no longer obvious that the seabed was trenched, or that a flowline is buried beneath. Whilst detailed footage was taken (and analysed by Deakin) of exposed sections of flowlines at similar depths; no specimens were observed on or around the exposed flowlines. This may indicate that the handfish specimens are not interacting with the flowline directly. The specimens observed were at least 200 m from the well centres.

Based on recorded distributions (Stuart-Smith et-al 2020), the more likely explanation as to what species of handfish were observed around BMG is the Australian handfish. This species is not EPBC listed threatened, and is listed by the IUCN as ‘least concern’. No listed threatened handfish species are expected to be found within the Operational Area, due to the depth (listed species are found in water depths up to 60 m) and the location (listed species are located around Tasmania only).

The combination of poor dispersal potential with highly localised distributions and generally low population numbers means that handfish are highly susceptible to local disturbance events and broader environmental change (Bruce et al., 1998; Last and Gledhill, 2009; Last et al., 1983). Threats to handfish are noted as ‘Prolonged Trawl and Dredge effort within its range possibly causing both habitat destruction and direct mortality’ (Stuart-Smith et al 2020). Though some of the decommissioning works will result in habitat modification, this will be localised, and short term. Recovery would be expected within a relatively short timeframe. Evidence of recovery from previous disturbances at BMG can be seen around the trenched B6 flowline where the handfish were observed.

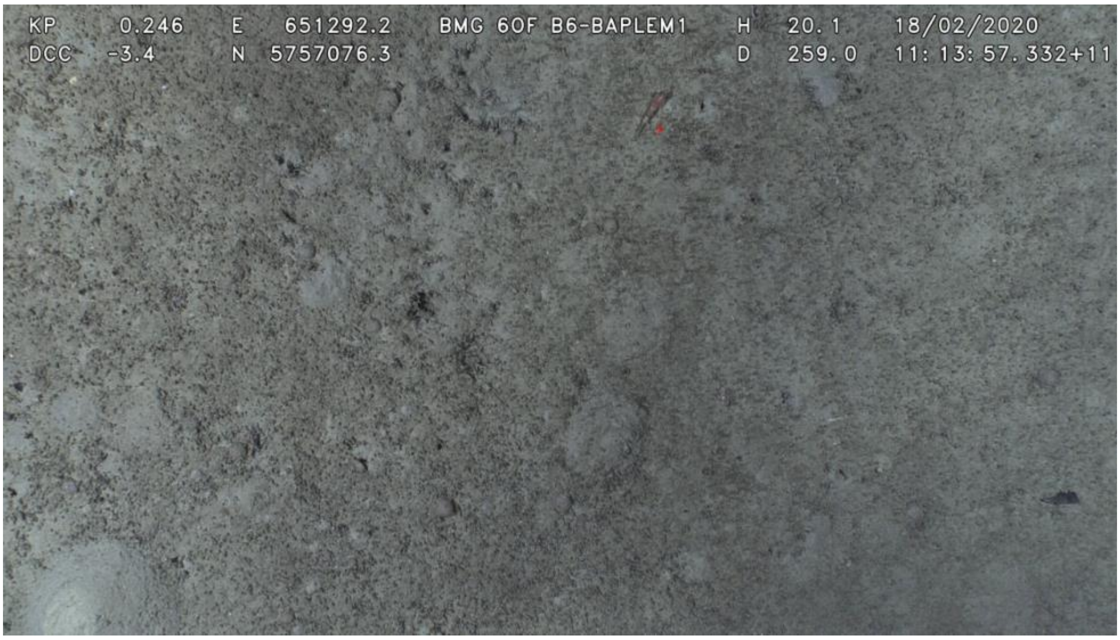


Figure 6-1 Suspected handfish sighting (Ierodiaconou et al (2021))

Following removal of equipment, sand and other material would be expected to begin to fill the area of disturbance and recolonization would be expected to occur. This could take months to a year or more but is unlikely to have lasting effects. Such recovery has been observed following the trenching of the B6 flowlines and umbilical, in 2012. Subsequent surveys have shown the flowline trenches have naturally backfilled and the previously disturbed areas now support species typical of the region (Ierodiaconou et al (2021) (Figure 6-2and Figure 6-3).

Figure 6-2 Image from 2020 GVI showing the B6 Oil flowline transitioning from above to below the seabed (Ierodiaconou et al (2021))

Figure 6-3 Image from 2020 GVI showing seabed above the B6 umbilical which was mechanically trenched in 2012. The trench was left to naturally backfill (Ierodiaconou et al (2021)).

Figure 6-4 Image from 2020 GVI showing seabed above the B6 oil flowline which was mechanically trenched in 2012. The trench was left to naturally backfill (Ierodiaconou et al (2021))

If infrastructure is left in situ for an extended period of time (i.e. beyond the extent of the campaign) there is the potential for continued seabed scouring as the currents erode sediments around the structure over time. Any such impacts are likely to be limited to the immediate vicinity of the infrastructure and include physical modification to the seabed and localised disturbance to soft sediments. From analysis of historical ROV footage within the BMG field, such scouring can in itself provide habitat (Figure 6-5), hence the temporary impacts (whilst the infrastructure remains) are not necessarily negative.

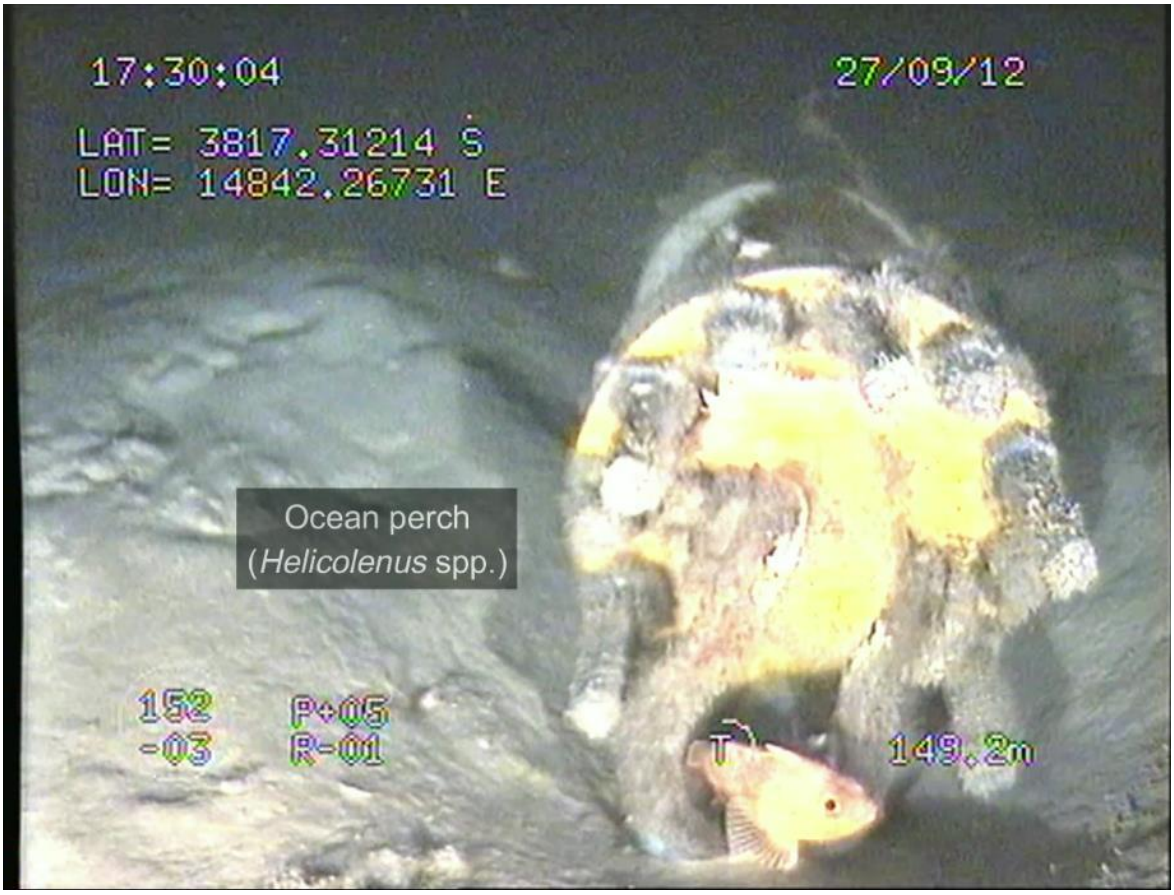


Figure 6-5 Image showing some localised scour around flowline midline end point, showing ocean perch within (Ierodiaconou et al (2021)).

If the MOU is moored, movements in mooring chain due to environmental conditions (e.g. currents) may occur, and cause localised sediment resuspension. Given the predominantly sandy nature of the substrate within the Operational Area, and the slow movement of a mooring chain, this material is expected to largely move (i.e. rather than go into suspension). Movement of mooring chains can occur throughout the Activity; however, the area of increased turbidity is still expected to be very localised within the PSZ.

Indirect impacts associated with the resuspension of sediment associated with mooring is expected to be small. The sediments in this area are regularly mobilised through natural processes; an example being the natural infill of trenches created in 2011 for the B6 flowline and umbilical. Given the silty sand (i.e. predominantly sand sized particles, with a proportion of finer material) nature of the substrate within the operational area, increased turbidity is likely to be temporary and localised around the disturbance points where mooring or wet-stored equipment sit on the seabed.

The extent of the area of impact is predicted to be small / within the existing infrastructure footprint for a duration of up to months to years while the disturbed area recolonises.

Any disturbance to benthic habitats and communities by the installation or removal of subsea structures is expected to be localised and likely to recover over a short period. Kukert (1991) showed that approximately 50% of the macrofauna on the bathyal sea floor were able to burrow back to the surface through 4-10 cm of rapidly deposited sediment. Dernie et al. (2003) conducted a study that showed the full recovery of soft sediment assemblages from physical disturbance could take between 64 and 208 days. Mobile invertebrates are generally less vulnerable than sessile taxa to sedimentation, as they are able to move to areas with less sediment accumulation or by more efficiently physically removing particles (Fraser 2017). Sessile invertebrates are particularly vulnerable to sedimentation because they are generally unable to reorientate themselves to mitigate a build-up of particulates. However, some sessile taxa, including species of sponges and bivalves, have the capacity to filter out or to physically remove particulates (Roberts et al. 2006, Pineda 2014 et al. 2016).

The steel manifold suction pile will be cut and recovered from above the seabed; leaving approximately 36m of the pile below the seabed; this will be left in situ. Feasibility studies have discounted full removal of the pile (17-033-RP001). Aerobically driven corrosion rates in the marine environment can be in the order of 17mm per year for a pile of this wall thickness; at this rate the pile would corrode through at around 200+ years (Galvin et al 2020). However, the pile will be beneath the shallow layers of sediment where aerobic mineralisation / corrosion will occur. Mineralisation processes may occur anaerobically at a much lower rate (Glud, 2008). Impacts to sediment quality and infauna are not expected to be discernible given the low rates of degradation / mineralisation of the steel and the absence of higher-level infauna at depth within the seabed.

Sediment-burrowing infauna and surface epifauna invertebrates (particularly filter feeders) which inhabit the seabed directly around subsea infrastructure locations and on infrastructure are expected to be most impacted by seabed disturbance activities. The sensitivity of such infauna and epibenthic communities to smothering, change in benthic habitat, and change in water quality are expected to be low given physical changes are expected to be temporary and localised recovering within weeks, as such consequence of seabed disturbance on infauna and epibenthic biota is expected to be **Level 2**. While indirect impacts associated with changes in water quality (i.e. increased turbidity) expected to recover within days, as such **Level 1** consequence has been assigned.

Commercially fished marine invertebrate and fish species are known to occur within Operational Area (Ierodiaconou et al, 2021). Given the mobile nature of commercial species of invertebrates and fishes, lack of ecologically significant benthic habitats (i.e. sponge gardens and limited hard substrates) and commonality the habitats in the wider region, impact associated with smothering, change in benthic habitat or water quality are expected to be consequence **Level 2**.

6.3.3 Control Measures, ALARP and Acceptability Assessment

Table 6-4 provides a summary of the control measures and ALARP and Acceptability Assessment relevant to seabed disturbance.

Table 6-4 Seabed Disturbance ALARP, Control Measures and Acceptability Assessment

Seabed Disturbance	
ALARP Decision Context and Justification	**ALARP Decision Context: Type A** Mooring activities in the offshore environment is a common occurrence both nationally (e.g. NERA Environment Plan Reference Case Anchoring of Vessels and Floating Facilities) and internationally with well-defined industry good practice. Locally, mooring is an activity commonly undertaken by multiple industries (e.g. shipping, fisheries, oil and gas) particularly given the well-developed nature of the shipping and petroleum industry within the Gippsland Basin. Seabed disturbance resulting from removal activities has not been as common an occurrence (Ierodiaconou et al (2021), though ROV inspection has provided evidence of seabed recovery following historical cessation and NPP preparation activities within the BMG field. The area of impact, and therefore the scale of the impact, is expected to be small, and the species present associated with the seabed expected to recover. Given this, Cooper Energy believes **ALARP Decision Context A** should apply.
Control Measure	**Source of good practice control measures**
C28: Mooring Plan	The mooring plan will identify the mooring spread and anchor locations based on MOU requirements and geotechnical properties of the seabed. It is common practice for moorings and mooring spreads to be pre-laid by contracted service providers. Pre-lay of equipment on the seabed prior to MOU arrival ensures laydown locations of mooring lines on the seafloor are pre-defined area so to limit the extent of disturbance to the seabed.
C37: Mooring analysis	As described by NOPSEMA (2015), the API Recommended Practice 2SK: Design and Analysis of Station keeping Systems for Floating Structures (API RP, 2005) is common industry practice for MOUs operating in Australian waters. Specifically, this recommended practice describes the approach for designing mooring systems.
C38: Monitoring mooring line tensions	ISO 19901-7:2013: Station keeping systems for floating offshore structures and mobile offshore units (ISO 19901-7, 2013) states that mooring line tensions should be measured and recorded during normal operations to ensure that drag is reduced.
C10: Tethering system plan & install procedure	Tethering system plan & install procedure will ensure that seabed installation and removal is undertaken as required.

Seabed Disturbance	
C13: Positioning Technology	Use of positioning technology to position equipment on the seabed with accuracy will reduce seabed disturbance
C12: Planned Maintenance System	Equipment on the MOU and vessels will be operated in accordance with manufacturer's instructions and ongoing maintenance to ensure efficient operation.
C39: Wet parking restricted to within the existing infrastructure PSZs	Planned wet parked locations will be within permanent PSZ.
Consequence	**Level 2:** Localized short-term impacts to species or habitats of recognized conservation value not affecting local ecosystem function; remedial, recovery work to land, or water systems over days/weeks.
Demonstration of Acceptability	
Principles of ESD	Seabed disturbance is evaluated as having **Level 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.
Legislative and conventions	The proposed activities align with the requirements of the: • API Recommended Practice 2SK: Design and Analysis of Station keeping Systems for Floating Structures (API RP, 2005 • ISO 19901-7:2013 Station keeping systems for floating offshore structures and mobile offshore units (ISO 19901-7, 2013)
Internal context	Relevant management system processes adopted to implement and manage hazards to ALARP include: • Risk Management (MS03) • Technical Management (MS08) • Health Safety and Environment Management (MS09) • Supply Chain and Procurement Management (MS11) • External Affairs & Stakeholder Management (MS05) Activities will be undertaken in accordance with the Implementation Strategy (Section 9).
External context	No stakeholder objections or claims have been raised related to these impacts. Consultation with DAWE Sea Dumping Section indicates a Sea Dumping Permit will be required to leave the un-retrievable portion of the manifold pile below the seabed. This has been captured within Section 8 as performance standard C40 Sea Dumping Permits.
Acceptability Outcome	**Acceptable**

6.4 Planned Discharges

6.4.1 Cause of Aspect

Discharges will occur as a result of the following Activities:

- Facility cleaning and preparation
- Well abandonment including
  - flowline flushing, flowline and umbilical disconnect
  - well kill and clean-up
  - cementing
- Wellhead and manifold pile removal
- MOU emergency disconnect

The type of fluids and expected discharge volumes are described Section 3 with further detail on constituents and discharge scenarios below. The chemicals described include those that are incumbent in the wells and subsea infrastructure, and examples of products that will be used during the campaign. These discharges are typical of offshore petroleum activities. Examples of similar discharges can be found in every offshore well construction project today and have occurred as part of the construction and partial deconstruction of the BMG facilities between 2005 and 2011 (ROC 2012). Planned discharges in the offshore environment are typically assessed as resulting in lower order impacts and accepted as either Minor or Negligible. For the BMG P&A campaign, planned discharges are evaluated within this EP as if it were a higher order impact to provide further analysis to better demonstrate the nature and scale of the potential impacts.

6.4.2 Discharge characterisation

For each activity identified above the following sections describe and analyse a nominal discharge scenario using conservative volumes and known, anticipated or proxy chemicals. The analysis will consider the nature and extent of each discharge. The following metocean characteristics apply at the BMG location (RPS, 2021):

- Wind and wave action is high in the region; wind speed averaged by month is a minimum 14 knots but is frequently higher; significant wave heights at BMG exceed 1m over 65% of the year. As a result, surface waters are well mixed.
- Surface currents are typically strong, ranging between 0.18 m/s and 0.96 m/s
- Subsea currents are lower (though still strong), ranging between 0.10 m/s and 0.65 m/s
- Thermoclines and haloclines are more apparent during summer indicating mixing may be less than in at other times of the year. Through winter and autumn temperature and salinity varies little from surface to seabed indicating the water column would be well mixed.

Quantitative discharge assessments have been undertaken to help characterise the environmental fate and effects. Discharge calculations consider chemical quantities (based on treatment rate unless otherwise stated) at the point of discharge, toxicities, dilution in the near vicinity of the discharge and the effect of current in dispersing the discharge (i.e. the Osborne Adams methodology[4]). Sensitivity testing is shown for select scenario's whereby a range of reduced mixing zones (0m to 500m) from the point of discharge are considered.

6.4.2.1 Facility Cleaning and Preparation

- **Nature and scale of the discharges**

[4] The Osborne-Adams assessment was jointly developed by the Centre for environment, fisheries and aquaculture science (Cefas) and Marine Scotland. The assessment compares the rate of discharge of a chemical subsea with the rate of water column refreshment and in doing so provides a high-level screen for whether the release is of environmental concern. An acceptable discharge is one where the time taken to completely refresh the 500 m radius water column is shorter than the time taken to discharge sufficient chemical to exceed PEC/PNEC = 1 in the 500 m radius column unless there are other local environmental sensitivities. The detailed methodology is described by Xodus (2021).

Planned Discharge	Discharge volumes	Known or proxy chemical details
Subsea discharge of liquid scale dissolver / calci-wash used for cleaning of subsea equipment.	Total use / discharge: 10 m^3 Varying batches approx. 320L applied over approximately 1 hour.	A typical chemical for this activity is Oceanic CW. Oceanic CW is categorised as E under the OCNS and all components of the product are PLONOR i.e. 'poses little or no risk' to the marine environment. The SDS for the product indicates an LC50 of 32mg/l (relates to a component comprising ≤10% of the product).

- **Environmental fate and effects**

Scale dissolver is applied neat within the subsea environment; hence dilution of the chemical first commences upon application. Discharge calculations utilising the details above and supplier toxicity data indicates predicted no effect (PNEC) levels are not exceeded beyond 500m at low current speeds (0.1m/s). Sensitivity analysis indicates PNEC levels would not be exceeded beyond 30m of the discharge (Figure 6-6). The discharge is short-term and is rapidly diluted to below PNEC levels. Marine life exists on and around the facilities; very small patches of sessile organisms encrusting subsea equipment will be directly impacted by these chemical discharges. Demersal plankton and fish in the very near vicinity could be irritated briefly; these discharges are not expected to be of any consequence to pelagic organisms.

The consequence level assigned to this discharge is **L1** i.e. Minor local impacts or disturbances to flora/fauna, nil to negligible remedial / recovery works on land/ water systems.

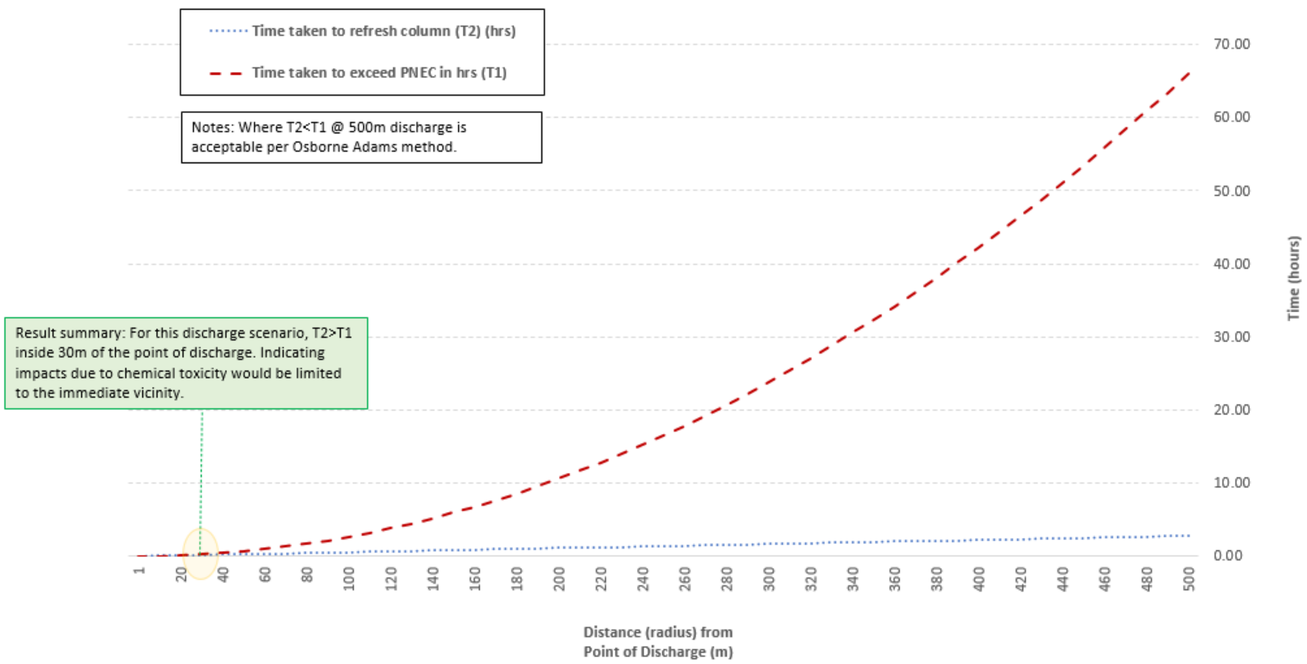


Figure 6-6 Discharge analysis – subsea scale remover

6.4.2.2 Well Abandonment and pit washing

- **Nature and scale of the discharges**

Planned Discharge	Discharge quantities	Known or proxy chemical details					
Inhibited seawater trapped behind tree cap	Per tree: 60 L	Chemical	Function	OCNS or HQ	Treatment rate	LC50 (product or WC component)	% of product
		Hydrosure 0-3670	Corrosion inhibitor	Gold (No SUB)	650 ppm	0.016 mg/l	30
Trapped gas within the SST	Per tree: 60L (6 m^3 std cond) equivalent to 0.001 MMscf	Methane gas					

Planned Discharge	Discharge quantities	Known or proxy chemical details					
Actuation of tree valves	1 m^3 control fluid per well. Varying batches approx. 20L	Chemical	Function	OCNS or HQ	Treatment rate	LC50 (product or WC component)	% of product
		Castrol Transaqua HT2 (2021)	Control Fluid (incumbent)	B (SUB) (recategorized from D in 2021)	N/a	4.14 mg/l	0.5
		In 2021 Castrol Transaqua HT2 picked up a substitution warning under the OCNS after a minor component (0.25% of the total product) was re-classed as bioaccumulative due to a change in regulatory interpretation. There are no changes to the product ingredients.					
Riser flush with MEG prior to opening well, on well entry / exit	Up to 2.5 m^3 discharged per flush.	Chemical	Function	OCNS or HQ	Treatment rate	LC50 (product or WC component)	% of product
		Monoethylene Glycol (MEG)	Hydrate inhibitor	E PLONOR	N/a	>1000	100
Flowline flush bullheaded downhole (primary) or returned to surface (contingency).	Flowline volumes are between 5.67m^3 and 101.7m^3 Discharge of water treated to ≤30ppm oil in water and inhibitor chemical @650ppm. B6 flowline may also contain residual PPD and 2.3m^3 diesel (solvent).	Chemical	Function	OCNS or HQ	Treatment rate	LC50 (product or WC component)	% of product
		Inhibitor: Hydrosure 0-3670	Corrosion inhibitor	Gold (No SUB)	650 ppm	0.095 mg/l	20
		Pour point depressant (Proxy 1) / Solvent	Asphaltene inhibition /Wax dissolution	Silver (No SUB) / N/a	≤30ppm after treatment	1 - 51 mg/l	100
		Notes: During the production phase PPD was applied at @1000ppm to production fluids at the well (Champion Technologies, 2008). In 2009 the B6 flowline was displaced with inhibited water, hence only traces of PPD may remain. PPD / solvent (Proxy 1) is hydrocarbon based and is insoluble in water. Upon return to surface the product is expected to partition with the oil phase and be removed from water (≤30ppm oil in water).					
Surface returns of incumbent liquid and gas from tubing and annular spaces will be processed by a fluids handling package prior to disposal. Gas is flared where possible.	Incumbent fluids include: • 30 m^3 per well of brine / formation fluids from the production tubing. • 30 m^3 per well of brine / formation fluids / WBM and 0.5 m^3 of control fluid from the surface casing annular spaces. • 90 m^3 per well of inhibited water / formation fluids from the	Chemical	Function	OCNS or HQ	Treatment rate	LC50 (product or WC component)	% of product
		Sodium Chloride	Carrier fluid / weighting agent	E PLONOR	N/a	-	-
		Hydrosure 0-3670	Corrosion inhibitor	Gold (No SUB)	650 ppm	0.095 mg/l	20
		Incumbent water-based mud (KCL brine based)					
		Barite	Weighting Agent	E	58,214 mg/l	-	-
		Soda Ash	Scale Dissolver	E	535 mg/l	-	-
		Caustic Soda	Acidity control	E	255 mg/l	33 mg/l	100

Planned Discharge	Discharge quantities	Known or proxy chemical details					
	production tubing annual spaces and wellbore preparation fluids.	Defoam A	Defoamer	None	0.002%	109.1 mg/l	100
		Duo-Vis	WBM	Gold	4,100 mg/l	420 mg/l	100
		Glute 25	Biocide	None	0.1%	0.8 mg/l	25
		Glydrill LC	WBM Additive	Gold	1.1%	391 mg/l	100
		Glydrill MC	WBM Additive	Gold	21,292 mg/l	391 mg/l	100
		Potassium Chloride (KCL)	Brine	E (PLONOR)	Ca. 50%	-	-
		Polyplus Dry	Viscosifier	N/a	2,292 mg/l	>100 mg/l	100
		Potassium Hydroxide	WBM	E	509 mg/l	22 mg/l	50
		Polypac UL	Viscosifier	E	3,184 mg/l	>100 mg/l	100
		OS-1	Oxygen scavenger	None	1,095 mg/l	0.4 mg/l	<1
		Abandonment chemicals					
		Proxy 1 Pour point depressant / Solvent	Asphaltene Inhibitor / Wax dissolution	Silver (No SUB) / N/a	1% on return mixed with clean-up fluids (≤30ppm after treatment)	1 - 51 mg/l	100
		Proxy 2	Downhole Scale Inhibitor	Silver (SUB)	1% on return mixed with clean-up fluids	1 mg/l	0.5%
		Proxy 3	H2S Scavenger	Gold	20 ppm	1.5 mg/l	<2%
Testing and operation of the pressure control equipment will result in discharges of control fluids.	Up to 2.1 m^3 per landout and subsequent test. Test period (14 – 21 days). Smaller discharges (up to 700L) during functioning, deployment and recovery.	Chemical	Function	OCNS or HQ	PLONOR	LC50 (product or WC component)	% of product
		Castrol Transaqua SP (proxy)	Control Fluid (MOU)	D	No	104 mg/l	0.001
The wells are circulated clean before pulling	Well kill and clean-up fluid (brines, seawater, viscous pills) with a total	Chemical	Function	OCNS or HQ	PLONOR	LC50 (product or WC component)	% of product

Planned Discharge	Discharge quantities	Known or proxy chemical details					
tubing to surface, checking well contents are ≤30ppm oil in water.	volume of 500 m^3 per well. Lost circulation material (LCM) of 6m^3 per well.	Sodium Chloride	Carrier fluid / weighting agent	E	Yes	-	-
		Bentonite (proxy)	Viscosifier	E	Yes	-	-
		Cellulose (proxy)	LCM	E	Yes	-	-
Fluid pit/tank washing.	Surface Operational Discharges.	Brines, WBM, wash water (seawater). Approximately 1000 m^3 at the end of the campaign. See above (surface returns for chemical details) which will be further diluted during tank washing. Fluids confirmed ≤30ppm oil in water prior to discharge.					

- **Environmental fate and effects**

Discharges occur in batches ranging from volume approx. 1 – 100m^3 over minutes or hours. To characterise the fate and effects of these discharges, a discharge scenario has been constructed which considers the discharge 100m^3 over 1 hour containing chemicals (above) with higher toxicity components. For conservatism, mixing / dilution has been restricted to the first 30m of the water column accounting for possible reduced mixing across thermoclines/haloclines which can be present (infrequently at this location). A current speed of 0.18 m/s has been applied, which is also conservative noting current speeds can exceed 0.9m/s in the upper water column. The scenario does not account for dilution (and reduced efficacy) of chemicals through the water treatment process prior to discharge which also provides conservatism. Selected for quantitative assessment are chemicals with highest toxicity components and/or higher treatment rates:

- Hydrosure 0-3670 @ applied at 650ppm (incumbent in flowlines and some well spaces)
- OS1 applied @ 1,095 mg/l (incumbent in WBM within the wells)
- Proxy 1 @ treated to ≤30ppm before dischsrge (proxy solvent for flowline flush and well clean-up)
- Proxy 2 @ 1% with returned clean-up brine (proxy scale remover well clean-up chemical)
- Glydrill MC @ 2% (incumbent in WBM within the wells)
- Glute 25 @ 1,040 mg/l (incumbent in WBM within the wells)

Results: chemical PNECs are not exceeded for any chemicals beyond a 500m radius of the discharge. The chemical with the quickest time to exceed PNEC in the water column is Hydrosure 0-3670. Sensitivity analysis (*Figure 6-7*) indicates:

- For the base conservative scenario the PNEC of this chemical could be exceeded within 480m of the discharge.
- For less conservative, but likely more realistic scenarios which adjust for current and mixing depth the distances are reduced. If a moderate current speed of 0.4m/s is applied, this distance reduces to within 220m; if the discharge is also assumed to mix through the upper 70m of the water column (not just the first 30m) then the PNEC is not exceeded beyond 90m (*Figure 6-8*).

The majority of chemicals within well abandonment discharges are of low toxicity though some treatment chemicals (e.g. H_2S scavenger, scale inhibitor, corrosion inhibitor) contain components that are of higher toxicity; the risk associated with their discharge is moderated by rapid dilution, inherent biodegradation rates and/or limited potential to bioaccumulate. The quantitative discharge assessments, and supporting literature shows chemicals are diluted to below PNEC levels within a short distance and time of discharge. Acute toxicity thresholds (LC50) are not exceeded beyond a few meters under any scenario.

The BMG facilities are within the area identified as the upwelling east of Eden, a key ecological feature related to eddies which originate from the East Australia Current (*Figure 6-14*, *Figure 6-15*). These eddies can move into the Gippsland region and drive episodic mixing, nutrient enrichment and blooms of phytoplankton, increased zooplankton and fish. Pelagic marine life including plankton and fish, birds, reptiles and mammals have the potential to be in the vicinity of discharge operations. However the majority are transient and any exposure to potential irritation from these short-term discharges would be brief. Planktonic organisms could be exposed for longer periods if they become entrained within the discharge, though exposure above PNEC levels would be local to the discharge and short-lived given the rapid dispersion offshore at BMG. Plankton distribution is often patchy and there are high natural rates of loss and regeneration (DEWHA, 2008). No discernible changes are expected to overall levels of plankton in the operational area, noting potential for only very localised and brief exceedance of acute toxicity thresholds.

Discharges during well abandonment occur on a batch basis during the campaign; they are short-term and quickly dispersed. The discharges are similar in nature to offshore well construction projects which all involve the discharge of drilling fluids and brines. Water based fluids have been shown to have little or no toxicity to marine organisms (Jones et al., 1996). Similarly, Neff (2005) describes that due the rapid dilution of water-based drilling fluid plumes in the water column, *"harm to communities of water column plants and animals is unlikely and has never been demonstrated"* (Neff, 2005). Suspended solids within WBM such as barite (weighting agent) have the potential to have physical impacts including clogging of gills or feeding apparatus, however elevated suspended solids would be temporary and highly localised. Barite contains metals which are present primarily as insoluble mineralised salts; the metals are not released in significant amounts to the pore water of marine sediments and have low bioavailability to benthic fauna (Crecelius et al., 2007; Neff, 2008). Surveys at BMG over the past decade show soft shifting sediments around the facilities; solids that settle on the seabed would be dispersed over time and are not expected to impact demersal fauna beyond the usual shifting and dispersion of sediments.

The consequence level assigned to well abandonment discharges is **L1** i.e. Minor local impacts or disturbances to flora/fauna, nil to negligible remedial / recovery works on land/ water systems.

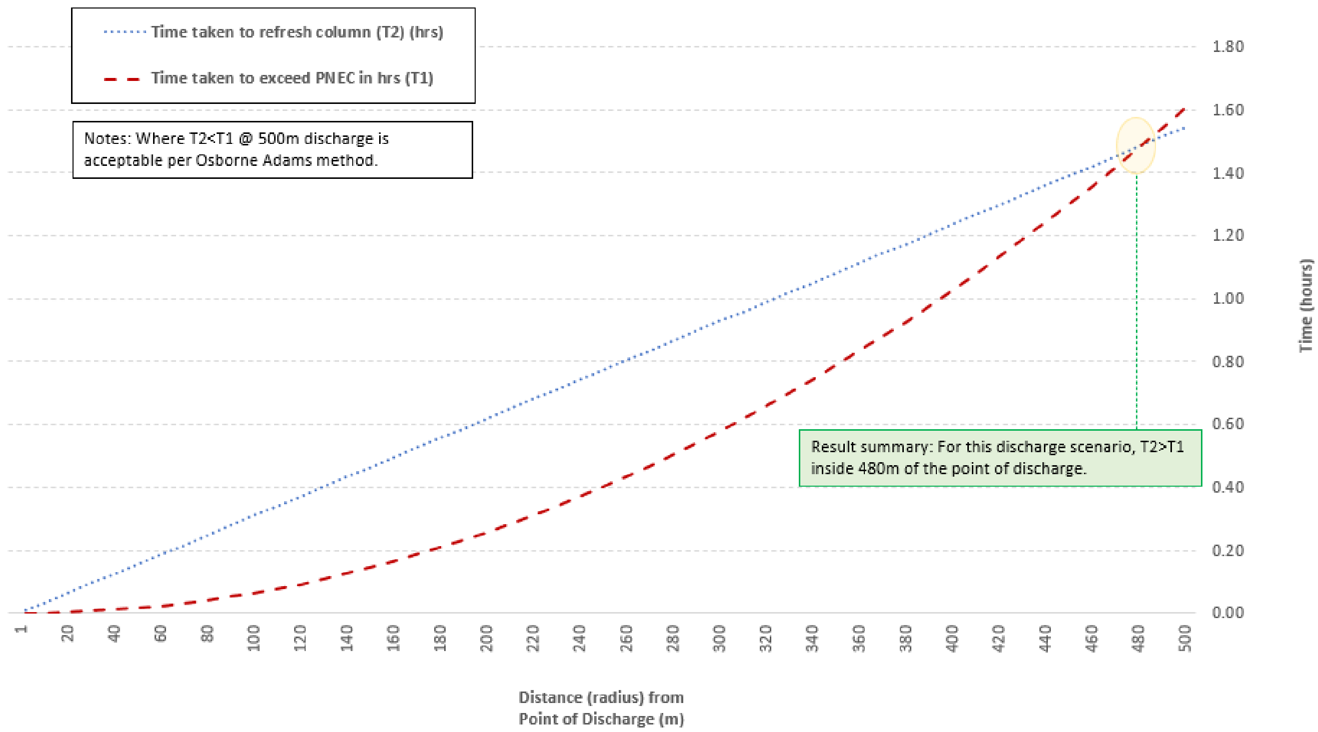


Figure 6-7 Discharge analysis – corrosion inhibitor in B6 flowline flush returns (scenario limited mixing, low current)

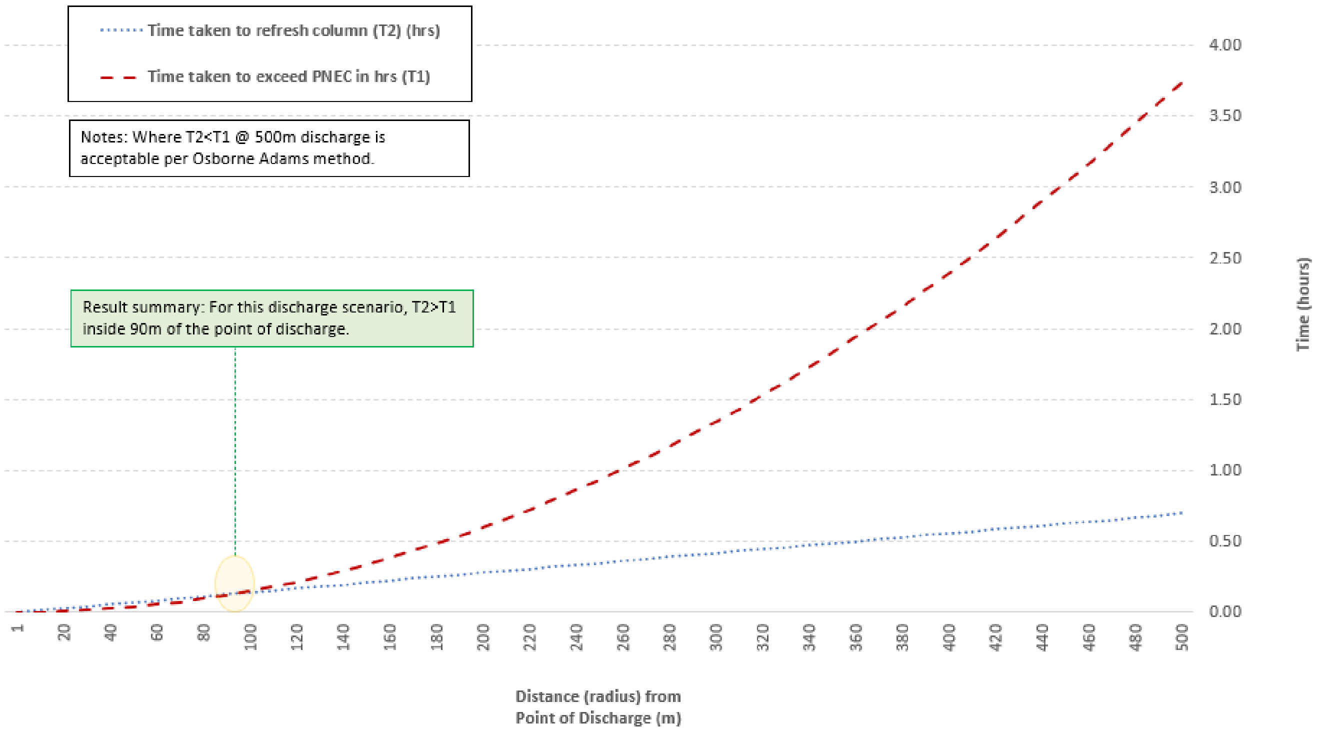


Figure 6-8 Discharge analysis – corrosion inhibitor in B6 flowline flush returns (scenario increased mixing, moderate current)

6.4.2.3 Flowline and Umbilical Disconnect

- **Nature and scale of the discharges**

Planned Discharge	Discharge quantities	Known or proxy chemical details
An ROV will cut or disconnect the flowline jumpers, flowlines, umbilicals and associated electrical and hydraulic leads from the SST and lay them on the seabed. Once lines are disconnected, small quantities of line contents will begin to disperse into the sea. Umbilicals and associated jumpers will be cut if attempts to disconnect are unsuccessful. If disconnection of umbilicals and jumpers is successful, then contents will not be entirely displaced as the line ends are self-sealing. Contents may include residual quantities of chemicals and hydrocarbons including liquids and/or gas.	Flowline volumes are between 5.67m^3 and 101.7m^3. Assume 10% volume discharge when cut (considered conservative as flowlines not at pressure)	Discharge of water with ≤30ppm oil in water, water treated with inhibitor chemical @650ppm and gas. **incumbent flowline contents will be displaced downhole or to MOU for treatment via flowline flushing in Phase 1. Depending on corrosion studies a corrosion inhibitor may be added to the seawater introduced to the flowlines in Phase 1 to provide for flowline integrity until full removal. The incumbent corrosion inhibitor @ 650ppm is used as a proxy for discharge assessment purposes. The Cooper Energy Offshore Chemical Assessment Procedure will be implemented for the selection of chemicals for use and discharge during the Phase 1 campaign, ensuring discharges remain within acceptable levels described within this EP.*
	Umbilical volumes are between 1.6m^3 and 11.8m^3 (total combined volume of cores) Assume 10% volume discharge from each core if cut (considered conservative as umbilical cores not at pressure)	Discharge is of control fluid Castrol Transaqua HT2 and uninhibited freshwater. B6 umbilical also contains PPD (Proxy 1). *Chemical details provided previously under well abandonment section.*

- **Environmental fate and effects**

Discharges during the disconnection of the flowlines and umbilicals will be minimal, limited to minor exchange between the flowline ends and the surrounding seawater. Conservatively, it is assumed 10% loss from the lines at the time of disconnection over period of 2 hours. Mixing is assumed to be limited to 30m water column above the seabed; this is considered conservative as waters in the area are generally well mixed. A current speed of 0.1m/s has been applied to seabed discharge scenarios.

Flowline discharge:

Quantitative discharge assessments for corrosion inhibitor @ 650ppm and pour point depressant @ 1000ppm[5] indicate chemical PNECs are not exceeded for any chemicals beyond a 500m radius of the discharge. The chemical with the quickest time to exceed PNEC in the water column is the corrosion inhibitor owing to the high toxicity of a minor component. A sensitivity analysis (*Figure 6-9*) indicates the PNEC of the corrosion inhibitor could be exceeded within 390m during the discharge; acute toxicity would be limited to within the immediate vicinity of the discharge point.

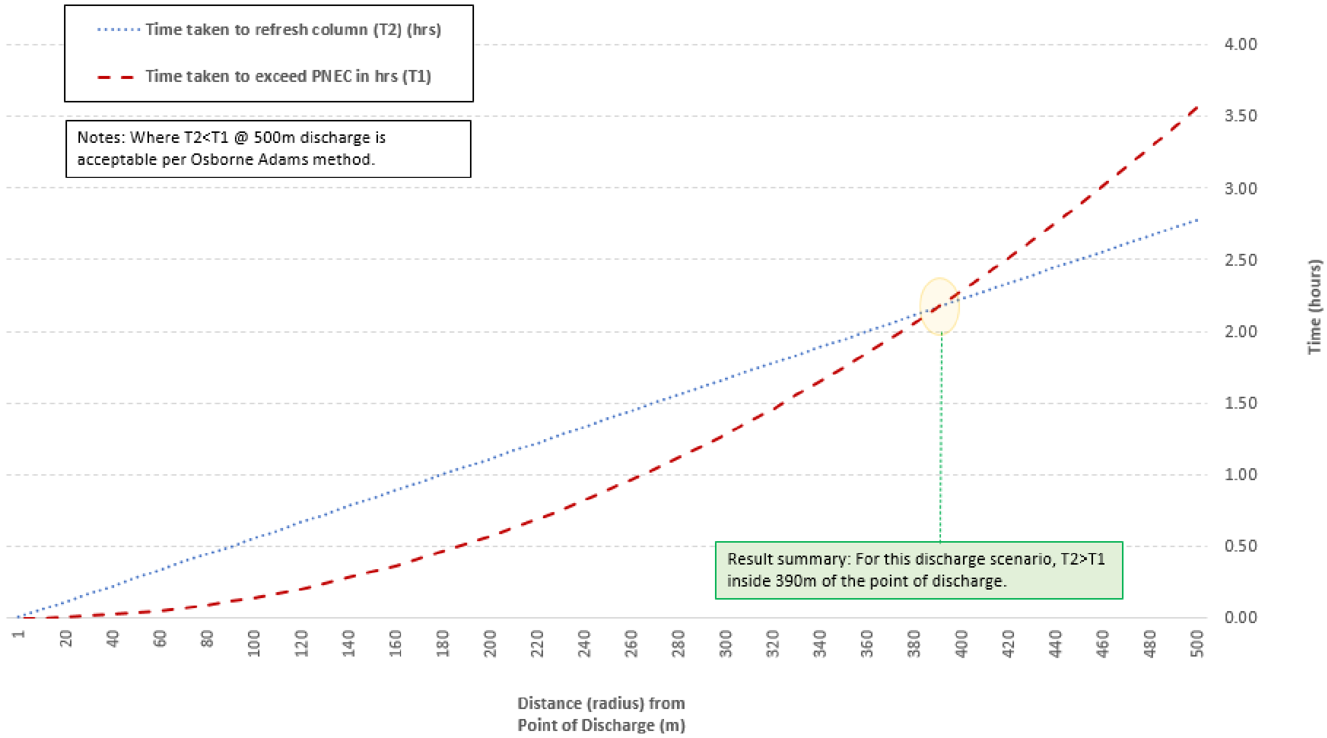


Figure 6-9 Discharge analysis – corrosion inhibitor; flowline disconnect (assume limited mixing, low current)

Umbilical discharge:

Quantitative discharge assessments for control fluid and pour point depressant indicate chemical PNECs are not exceeded for any chemicals beyond a 500m radius of the discharge. The chemical with the quickest time to exceed PNEC in the water column is the PPD owing to the higher overall toxicity of the PPD compared to the control fluid. A sensitivity analysis (*Figure 6-10*) indicates the PNEC of the PPD chemical could be exceeded within 60m during the discharge; acute toxicity would be limited to within the immediate vicinity of the discharge point.

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[5] 1000ppm is a nominal treatment rate for assessment purposes. This is conservative noting only traces of PPD may remain from the production phase following displacement of the flowline to inhibited water in 2009. If a hydrocarbon based PPD or solvent is used during Phase-1 then residuals would be reduced to ≤30ppm after successful flushing. It follows that the displacement of ≤30ppm PPD is well inside the PNEC radius determined for 1000ppm.

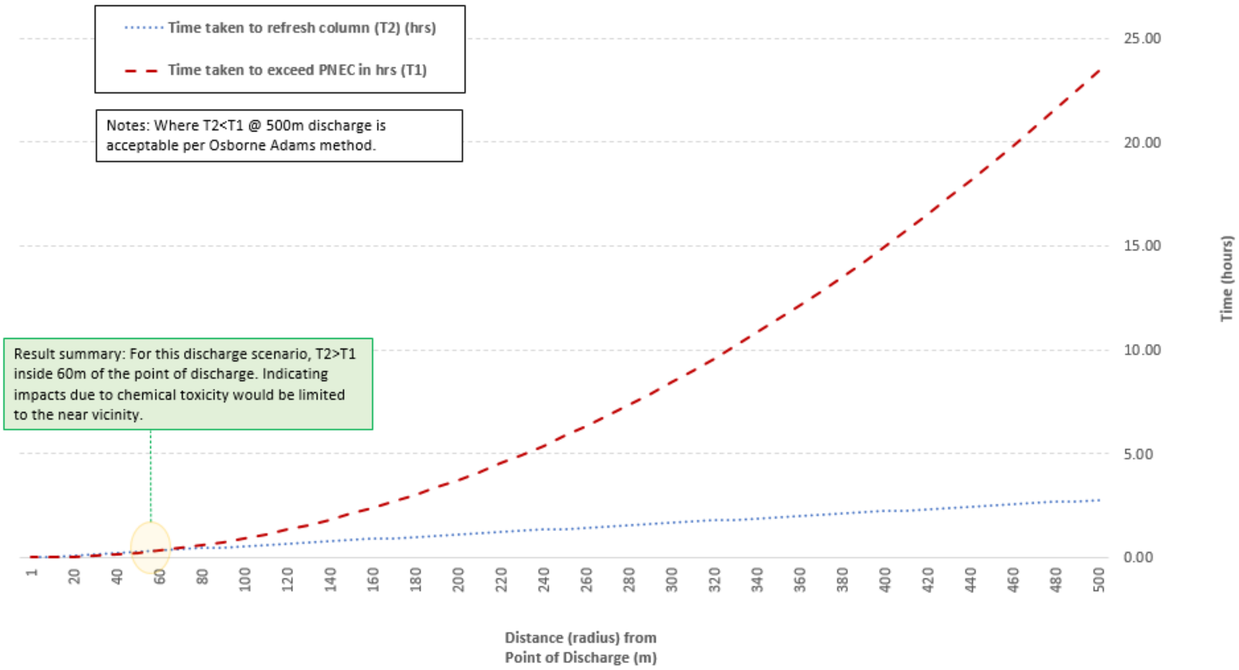


Figure 6-10 Discharge analysis – PPD umbilical disconnect (assume limited mixing, low current)

Discharges at removal (Phase 2)

When the flowlines and umbilicals are removed, contents will be displaced to sea through the process of lifting through the water column. Whilst this activity is not part of the Phase 1 activities provided for under this EP, the discharges have been contemplated and assessed to inform the broader decommissioning approach. A study undertaken by Xodus in 2021 assessed the potential impacts of displacing the full volume of the B6 umbilical subsea during removal via reverse reel, which would result in a discharge of contents over a number of hours. Other removal methods such as cut and lift would result in smaller discharges which would be similar in nature to the disconnect scenario's above. The reverse reel assessment, which uses the B6 umbilical as a worst case, indicates that PNEC levels of chemical are not exceeded beyond 500m of the discharge location, indicating no significant impacts (Xodus, 2021). Further quantitative sensitivity analysis indicates PNEC exceedance is limited to the near vicinity of the discharge for all chemicals including PPD, and Castrol Transaqua HT2 within umbilicals, and Corrosion inhibitor (@650ppm) mixed with seawater and residual PPD (B6 only) from the flowlines.

The chemical with the quickest time to exceed PNEC in the water column is the corrosion inhibitor owing to the high toxicity of a minor component. A sensitivity analysis (*Figure 6-11*) indicates the PNEC of the corrosion inhibitor could be exceeded within 490m during the discharge at low current speed (0.1m/s) and limited mixing (30m column); acute toxicity would be limited to within the immediate vicinity of the discharge point. Further analysis has been conducted assuming mixing through the full water column (taken as 130m) and increased current speed (to 0.15 m/s); this remains conservative noting maximum current speeds at depth can reach 0.65 m/s. The analysis shows the PNEC of the corrosion inhibitor is not exceeded beyond 80m during the discharge (*Figure 6-12*).

The consequence level assigned to flowline and umbilical discharges is **L1** i.e. Minor local impacts or disturbances to flora/fauna, nil to negligible remedial / recovery works on land/ water systems.

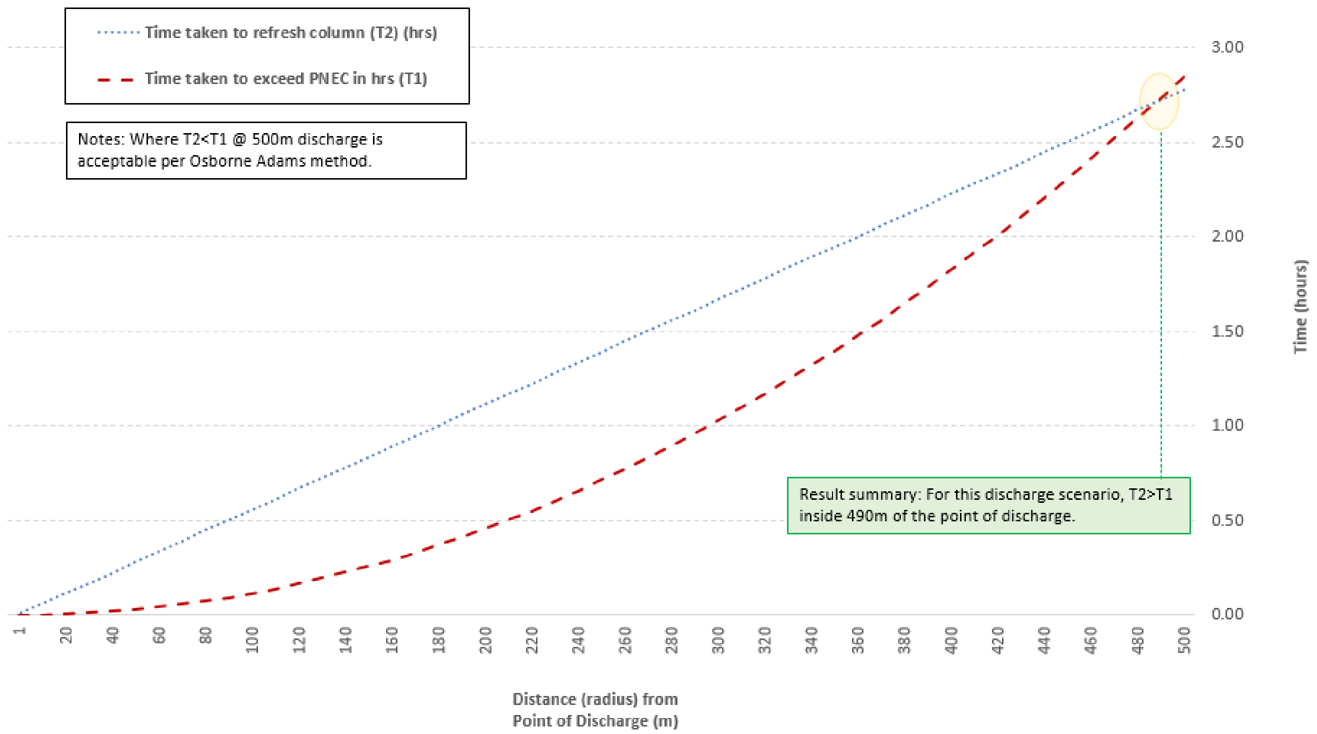


Figure 6-11 Discharge analysis – corrosion inhibitor flowline reverse-reel (assume limited mixing, low current)

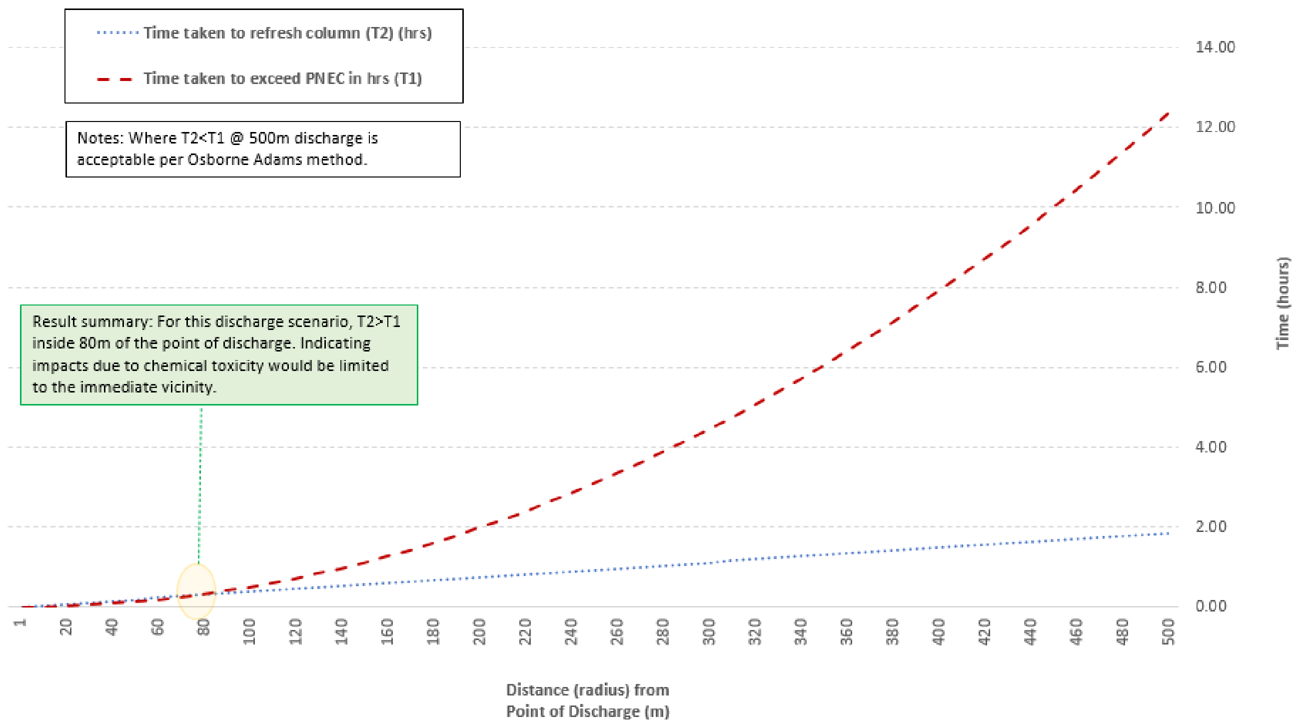


Figure 6-12 Discharge analysis – corrosion inhibitor flowline reverse-reel (assume full mixing, average current)

6.4.2.4 Cementing and flocculant

- **Nature and scale of the discharges**

<table>
<tr><th>Planned Discharge</th><th>Discharge quantities</th><th colspan="6">Known or Proxy chemical details</th></tr>
<tr><td rowspan="3">Cement spacer fluid and/or cement with incumbent well fluids (e.g. mud / brine) will be discharged at the surface.</td><td rowspan="3">Mix of cement, wellbore preparation fluids / spacer and freshwater / seawater, approximately 3 m^3 per cement job</td><td>Chemical</td><td>Function</td><td>OCNS or HQ</td><td>Treatment rate</td><td>LC50 (product or WC component)</td><td>% of product</td></tr>
<tr><td>Cement class G</td><td>Bulk cement</td><td>E (PLONOR)</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Silica blend</td><td>Cement additive</td><td>E (PLONOR)</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Cement tank washing</td><td>3 m^3 cement and seawater or freshwater washings per cement job</td><td>Proxy 1</td><td>Expanding cement additive</td><td>E (PLONOR)</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td rowspan="2">Cement slurry returns from well (contingency)</td><td rowspan="2">11m^3 cement slurry and brine displaced from well in case of instability in the plug placement phase</td><td>Proxy 2</td><td>Cement Spacer</td><td>Gold (SUB)</td><td>-</td><td>431 mg/l</td><td><20%</td></tr>
<tr><td>Proxy 3</td><td>Fluid Loss Additive</td><td>E (PLONOR)</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Excess dry cement</td><td>10 MT per well of dry cement bulk</td><td colspan="6" rowspan="2">See Cement Class G above.</td></tr>
<tr><td>Dry bulk transfer losses</td><td>12 m^3 of cement per well</td></tr>
</table>

- **Environmental fate and effects**

Cementing fluids are not routinely discharged to the marine environment, however, volumes of a cement/water mix will be released to surface waters (e.g. during equipment washing). Discharges are discrete events involving small batches. The bulk of cementing products are PLONOR products, though treatment chemicals are also required in some cases to prepare the wellbore for cementing, or to provide the cement with certain properties. The cementing program will be finalised during planning and will be subject to selection and assessment; the chemicals are described here are proxies commonly used during cementing.

The cement particles will disperse under action of waves and currents, and eventually settle out of the water column; the initial discharge will generate a downwards plume, increasing the initial mixing of receiving waters. Modelling of the release of 18 m^3 of cement wash water by de Campos et al. (2017) indicate 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 of time, or over a wide area. Particulates have the potential for physical impacts including clogging of gills or feeding apparatus, however elevated suspended solids would be temporary and highly localised. Surveys at BMG over the past decade show soft shifting sediments around the facilities; solids that settle on the seabed would be dispersed over time and are not expected to impact demersal fauna beyond the usual shifting and dispersion of sediments.

The discharge of cement from the surface is expected to result in a very short exposure of increased turbidity such that potential impacts would be expected to be localised and short-term, therefore the consequence of impact to water quality and marine life be **L1**.

6.4.2.5 Wellhead and Manifold Pile Removal

- **Nature and scale of the discharges**

<table>
<tr><th>Planned Discharge</th><th>Discharge quantities</th><th>Proxy chemical details</th></tr>
<tr>
<td>Cutting tools required to remove wellhead and manifold pile will generate metal swarf and some cement cuttings at the seabed and inside the steel pipe.

Cutting may also involve subsea discharges of grit and flocculent</td>
<td>Grit: 1.7 Mt per hour (3 – 7 hours to complete per operation)

Flocculent: 150 L per operation

Metal swarf and cement cuttings: 0.5 Mt per operation</td>
<td>
<table>
<tr><th>Chemical</th><th>Function</th><th>OCNS or HQ</th><th>Treatment rate</th><th>LC50 (product or WC component)</th><th>% of product</th></tr>
<tr><td>Proxy 1</td><td>Flocculant</td><td>N/a</td><td>-</td><td>>1000 mg/l</td><td>100</td></tr>
</table>
</td>
</tr>
</table>

- **Environmental fate and effects**

Analysis of flocculent discharge into the water column during use at low current (0.1m/s) and limited mixing (30m column), indicates PNEC would not be exceeded beyond 1m of the cutting activity. Particulates have the potential for physical impacts including clogging of gills or feeding apparatus, however elevated suspended solids would be temporary and highly localised during cutting activities, with most materials expected to remain below the mudline. Small quantities may be suspended above the seabed; surveys at BMG over the past decade show soft shifting sediments around the facilities; solids that settle on the seabed would be dispersed over time and are not expected to impact demersal fauna beyond the usual shifting and dispersion of sediments.

The discharge of cutting materials including flocculant is expected to result in a very short exposure of increased turbidity such that potential impacts would be expected to be localised and short-term, therefore the consequence of impacts to water quality and marine life will be **L1**.

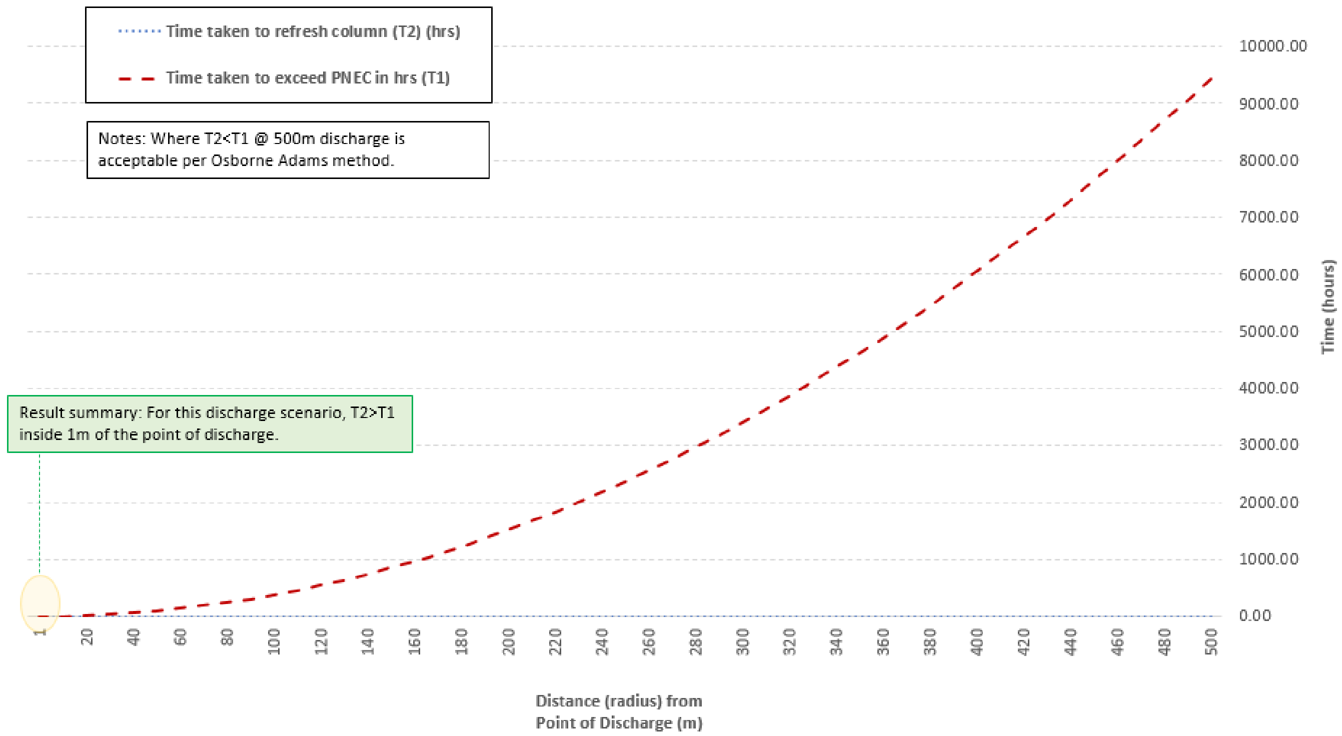


Figure 6-13 Discharge analysis – flocculant (assume limited mixing, low current)

6.4.3 Control Measures, ALARP and Acceptability Assessment

Table 6-5 provides a summary of the control measures and ALARP and acceptability assessment relevant to project discharges during Phase 1 activities; future discharges during Phase-2 (flowline decommissioning) are also considered. The ALARP assessment and control selection also provides for the integrity of the flowlines to ensure removal is not precluded in the window 2024-2026 (Phase-2), to ensure compliance with General Direction 824.

Table 6-5 Project Planned Discharges, ALARP and Acceptability Assessment

Project Planned Discharges						
ALARP Decision Context and Justification	**ALARP Decision Context: A** Project discharges are a common, well-practiced activity within the offshore industry both nationally and internationally; for this project the chemical discharges have been characterised and assessed as Level 1 consequence. Cooper Energy is experienced in industry requirements and their operational implementation through their existing ongoing operations. No objections or concerns were raised during stakeholder consultation regarding this activity or its potential impacts and risks. Based on a Level 1 consequence, Cooper Energy believes ALARP Decision Context A should apply. Good practice control measures are outlined below. These control measures consider the discharges during decommissioning, and integrity maintenance of flowlines so as full removal is not precluded during the window 2024-2026.					
Control Measures Considered	**Related Risk Event**	**Benefit**	**Recognised Good Practice?**	**Sacrifice**	**Introduced Risks**	**Conclusion**
Flowline Flushing						
Do not flush/test flowline contents	L3 (Moderate) Discharge of flowline fluids including oil @ unknown ppm and diesel introduced prior to 2009 isolation (B6 only). L1 (Negligible) Discharge of flowines fluids comprising inhibited water with oil @ ≤30ppm assuming no change since shut-in between 2009-2011	Avoids pressuring up the system which has the potential to cause a limited leak. Note, the leak would be of flowline contents that would be displaced to the environment during cut and recovery operations.	Not if flowline content is not ≤30ppm oil. Risk hydrocarbon ppm in Basker and Manta flowlines may have increased since 2011, small volumes will be discharged when flowlines are cut from the trees. B6 there is a known issue (diesel (2.3m^3) and hydrocarbon ppm unknown).	Deferral of costs and risks to subsequent campaign. Costs and risks may increase over time.	Flowlines contents could now be different to as left in 2009-2011, hence re-flushing would provide certainty of cleanliness. B6 flowline was not high velocity flushed. it was displaced to inhibited water prior to its isolation in 2009. B6 flowline may contain residual wax, diesel (2.3m^3) pour point depressant and inhibited water.	Reject. Rationale: cannot rule out that conditions have not changed since facility shut-in 2009-11. Unlikely to be able to contain all contents within flowlines during Phase 2 decommissioning. Re-flush to ensure flowlines at acceptable level of oil ppm. No benefit associated with this option.
Re-flush with untreated water	As above	Ensure flowlines flushed to defined level of cleanliness	Yes. Standard practice to flush flowlines to ensure acceptable level of oil ppm.	Off project critical path (i.e. can be done without adding to MOU duration offshore). Cost to engineer and implement offshore.	Introducing untreated water to the system could result in internal corrosion.	Implement. Rationale: provides benefit and increased confidence of contents off critical path for the project. Costs are not grossly disproportionate to the benefit. Note: flush water treatment depending on feedback from corrosion/integrity SME. Integrated via C19 Phase 1 Flowline Flushing.
Re-flush / displace to inhibited water	As above	Ensure flowlines flushed to defined level of cleanliness	Yes. Standard practice to flush flowlines to ensure acceptable level of oil ppm. Flowlines have previously been displaced to chemically	Off project critical path. Cost to engineer and operate offshore. Relatively small cost to introduce corrosion inhibitor.	Re-introducing inhibitor chemicals (typically toxic to deal with biological growth and associated corrosion). Discharge assessments	Implement. Rationale: provides benefit and increased confidence of contents off critical path for the project. Costs are not

Project Planned Discharges						
			inhibited water so as not to preclude return to service. Advice from integrity SME will be sought to determine if re-treatment is necessary post Phase-1 flushing so as not to preclude full removal.		indicate impacts are L1 (Negligible) upon release.	grossly disproportionate to the benefit. Note: Treatment of flush water depending on feedback from corrosion/integrity SME Integrated via C19: Phase 1 Flowline Flushing and C23: Phase 1 Flowline Integrity Provisions.
Select pumps to exceed lowest rates from historical flushing	As above	Sweeping residual contents from flowlines. MOU pumps expected to be capable of >0.5m^3/min. Improved sweeping as fewer high points due to absence of mid-water buoys.	Yes noting historical flushing reports raise low flushing rate for B6 as an issue; rates of only 4L/min were achieved due to use of a small chemical injection pumping spread.	Off project critical path. Utilising existing rig pumps so no extra cost to install. Limited extra cost to operate offshore.	Potential to cause leak in flowline system (e.g. at connection points) when pressuring up however considered lower risk compared to leaving lines as is.	Implement Rationale: provides benefit and increased confidence of contents off critical path for the project. Costs are not grossly disproportionate to the benefit. Integrated via C19: Phase 1 Flowline Flushing.
Pressure retaining cap fabricated in case of leak when flushing the flowline system.	As above	Allows scope to continue in case of a leak. Cap would be installed on seabed at end of flowline / at leak point.	Considered good practice contingency for this activity by project team.	Nominal $30K for cap to design, fabricate and install.	None	Implement Rationale: provides benefit and increased confidence of contents off critical path for the project. Costs are not grossly disproportionate to the benefit. Integrated via C19: Phase 1 Flowline Flushing.
Flushing sequence drawings and procedures	As above	Clear project plans and contingencies.	Yes	Completed as part of planning.	None	Implement Rationale: provides benefit and increased confidence of contents off critical path for the project. Costs are not grossly disproportionate to the benefit. Integrated via: Integrated via C19: Phase 1 Flowline Flushing
Test at surface after flush to confirm flowline fluids meet ppm criteria	As above	Confirms flowlines are sufficiently clean.	Yes	Time to line up valves and test	None	Implement: Take returns or lubricate and test where practicable. Rationale: provides benefit and increased confidence of contents off critical path for the project. Costs are not grossly disproportionate to the benefit. Integrated via C19: Phase 1 Flowline Flushing

Project Planned Discharges						
Environmental caps (post flushing and disconnect) to prevent seawater ingress	As above	Prevents ingress of seawater, corrosion and marine growth. Note, does not prevent egress during removal.	Yes. SME has provided advice capping good practice to minimise the exchange of fresh seawater within the flowlines where high chlorides could increase corrosion rates.	Nominal $5K per cap to purchase and install. 5 flowlines - cap both ends = $50K	None	Implement. Rationale: provides additional integrity maintained through to final decommissioning end state. Costs are not grossly disproportionate to the benefit. Integrated via C23 Flowline Integrity Provisions.
Oily water						
Do not discharge fluids - all fluids returned to MOU for treatment onshore	Negligible Impact Assuming Discharge of oily water at 30ppm i.e. 3L dispersed oil per 100m^3.	No offshore impact. Clean-up onshore (typically to 30ppm oil in water)	Not good / not recommended practice. Typically flowlines and well fluids cleaned up to <30ppm prior to discharge (either operational or upon removal).	Circa $320/m^3 to treat onshore x 1.5 for transport costs from wells to shore. Larger volumes: Flowlines: 180m^3*1.5 Incumbent well fluids brine, mud inhibited water (150m^3 x 7). Well Kill & clean-up - 1000m^3 x 7. Pit washings - 1000m^3 Total volume: 9320m^3 Total cost to treat onshore: $2.98M Total cost to transport: $1.5M Total cost: $4.5M (rounded). Note volumes provided include contingency, hence costs could be 20-50% less.	Onshore spills and leaks during transport. Personnel / Transport HS risks. Lifting risk, frequent lifts required to and from vessel. Restrictions onshore in terms of process capacity. Additional emissions associated with multiple vessel transfers back/forth to shore noting 1 day of vessel transit burns approx. 15m^3-20m^3 fuel.	Reject Rationale: Once treated/tested fluids will have negligible impact upon discharge. Cost, impacts/risk associated with storage, transport and treatment onshore are significant and grossly disproportionate to any benefit.
Install oily water clean-up package on MOU to achieve 30ppm oil in water. Recovered oil flared or returned to shore	As above	Environmental benefit of reducing oil concentration to known levels and Neglible impacts. Discharge analysis for 30ppm OIW indicates T2>T1 inside 10m of the point of discharge i.e. PNEC levels could be exceeded within 10m, but no discernible exceedance of acute toxicity thresholds.	Yes. ≤30ppm is industry standard and is applied consistently across multiple recently accepted EPs. Flaring (see emissions section) and ship to shore are both accepted methods for recovered oil.	$900K to install and operate water treatment unit including time/effort to circulate to clean-up to ≤30ppm.	Deck space requirements and offshore beds currently accounted for. Downtime issues with package have the potential to impact critical activities.	Implement Rationale: provides benefit and increased confidence of contents are acceptable, off critical path for the project. Costs are not grossly disproportionate to the benefit. Integrated via C9: Well Returns Management Philosophy
Re-process water to achieve ≤15ppm oil in water.	As above	Negligible impact @ 30ppm, remains Negligible impact @ 15ppm (i.e. 3L dispersed oil vs 1.5L dispersed oil per 100m^3).	<15ppm exceeds recognised good industry practice (≤30ppm) through is standard for other industries	$900K to install and operate water treatment unit. Add $400K for additional storage and filtering compared to ≤30ppm. Additional time to	Deck space requirements and offshore beds currently accounted for. Downtime issues with package have the potential to impact	Reject Minimal overall benefit when compared to ≤30ppm i.e. reduction of 1.5L dispersed oil in a given 100m^3 volume.

Project Planned Discharges						
		Discharge analysis for 15ppm OIW indicates T2>T1 inside 5m of the point of discharge i.e. PNEC levels could be exceeded within 5m, but no discernible exceedance of acute toxicity thresholds.	(i.e. shipping) under MARPOL.	circulate to clean-up to ≤15ppm is uncertain and could result in bottleneck which extends duration on each well, and overall P&A program.	critical activities. Higher risk of impacting (extending) operations where fluids are backed up awaiting reprocessing.	High additional cost and significant risk of filtration bottleneck, becoming critical path activity are considered grossly disproportionate to any benefit gained.
Chemical Use & Discharge (Phase 1)						
Re Flush flowlines back to MOU	Negligible Impact B6: Residual Chemical (hydrocarbon-based) pour point depressant. Proxy PPD LC50 51mg/l discharged during cutting and later removal. Disperses before PNEC levels exceeded within 500m; short term discharge. Minor Impact B6: residual diesel (2.3m^3) potential discharge if not flushed during Phase 1. Release of diesel is not expected but could occur (during flowline removal) depending on flushing success. This could result in impacts within the vicinity of the release lasting in the order of 24 hours. Negligible Impact Other flowlines: Seawater treated with Corrosion inhibitor at 650ppm (LC50 75mg/l) discharged during cutting and later removal. Disperses before PNEC levels exceeded within 500m; short term discharge.	Risk remains negligible if fluids brought back to MOU where fluids treated to remove hydrocarbons and discharged.	B6: Yes flowlines are typically flushed and filled with inhibited water – this was not completed successfully by previous operator. Other flowlines: Yes - already flushed and filled with inhibited water by previous operator so flowlines may be re-lifed. Since flushing in 2010/11 hydrocarbons may have been reintroduced to the flowline system which were left connected to the wells, hence plan to re-flush.	Off project critical path. $500K to engineer, re-flush / re-flood with water and test.	No introduced risk from a chemical discharge perspective.	Implement. Flushing program is planned. Rationale: provides benefit and increased confidence of contents off critical path for the project. Costs are not grossly disproportionate to the benefit. Integrated via C19 Phase 1 Flowline Flushing.
Deal with blockages in flowlines with solvent to attempt to clear flow path for flushing	As above Additional – surface/onshore HSE handling risks associated with existing flowline contents.	Cannot pump a solvent to / past solid blockage within flowline hence of no benefit.	No	Offline work scope	Unlikely to clear blockage but will increase the volume of hydrocarbons in the line increasing subsequent risks.	Reject Rationale: where there is no flow path, pumping solvent may increase overall hydrocarbon/chemical inventory and therefore increase risks. No benefit.
Clean residual wax from flowlines with solvent to enhance flow path for flushing	As above Additional – surface/onshore HSE handling risks associated with existing flowline contents.	Highest chance of success of clearing flowline of residual wax, reducing HSEC risks at surface during processing / dismantling of lines.	Solvents have been applied by previous operators successfully (e.g. Basker 6 in 2009). Note - very low flow rates achieved during subsequent flushing of B6 led to residual solvent (diesel) remaining in the B6	Offline work scope	No introduced risk from a chemical discharge perspective.	Implement where practicable and where there is a clear flow path. Rationale: provides benefit and increased confidence of contents off critical path for the project. Reduces operational risks and

Project Planned Discharges						
			line. The low flow rates were as a result of the small production chemical injection pumping spread used for flushing which achieved a maximum 4L/min.			hazards during Phase 2 decommissioning if wax content can be reduced in Phase 1. Costs are not grossly disproportionate to the benefit. Integrated via C19 Phase 1 Flowline Flushing.
Pig flowlines during phase 1	As above Additional – surface/onshore HSE handling risks associated with existing flowline contents.	Flexible lines cannot be pigged.	No	N/a	Attempting to pig will likely lead to blockages.	Reject Rationale: not feasible
Flush umbilicals back to MOU and discharge or send to shore.	Negligible Impact B6 umbilical: Chemical pour point depressant; proxy PPD (LC50 51mg/l) and control fluid (worst component LC50 4.1mg/l) discharged during cutting and later removal. Disperses before PNEC levels exceeded within 500m; short term discharge. Negligible Impact Other umbilicals: control fluid (worst component LC50 4.1mg/l) discharged during cutting and later removal. Both disperse before PNEC levels exceeded within 500m; short term discharge.	Impacts remain negligible if fluids brought back to MOU and discharged (though dilution will likely increase). Offshore impacts eliminated if fluids returned to shore	Umbilicals may be flushed at cessation of production from the production facility.	Additional planning, engineering, equipment and personnel offshore to conduct flushing. Likely exceeds $1M. Not practicable given current state of infrastructure and absence of the FPSO.	Significant additional scope introducing SIMOPs risk. Reject.	Reject Rationale: Discharges are assessed as negligible. Significant additional cost and SIMOPS risk associated with flushing umbilicals. Limited benefit (reduce or eliminate negligible impacts) gained is considered grossly disproportionate to the risks/costs.
Bullhead returns to MOU into subsurface oil reservoir	Negligible Impact Discharge of well clean-up fluids, primarily brines or seawater and associated chemicals. Water treated to reduce hydrocarbons to acceptable level prior to discharge.	Base case is to bullhead which eliminates impacts to the marine environment.	Yes, where available, bullheading is considered common and good practice option for managing fluid returns.	Part of abandonment program, MOU set up to manage returns and bullheading.	None	Implement where practicable to bullhead and obtain sea dumping permit if required. Rationale: pumping fluids into the oil reservoirs eliminates the need to treat/discharge, or ship to shore for treatment which carries cost and operational HSE risks. Costs are not grossly disproportionate to the benefit. Integrated via C9 Well Returns Management Philosophy, and C40 Sea Dumping Permits.
Take all returns that will or may contain chemicals back to MOU and	Negligible Impact Discharge of clean-up and inhibitor chemicals.	Risk eliminated if brought back to MODU and either shipped to shore or bullheaded downhole.	No. Similar to drilling and well completion, fluids including clean-up and inhibitor chemicals typically	Circa $320/m^3 to treat onshore x 1.5 for transport costs from wells to shore.	Onshore spills and leaks during transport. Personnel / Transport HS risks.	Reject Rationale: Once treated/tested fluids will have negligible impact upon

Project Planned Discharges						
ship to shore for treatment			discharged overboard. Accepted in multiple recent drilling & P&A EPs.	Larger volumes: Flowlines: 180m^3*1.5 Incumbent well fluids brine, mud inhibited water (150m^3 x 7). Well Kill & clean-up - 1000m^3 x 7. Pit washings - 1000m^3. Total volume: 9320m^3 Total cost to treat onshore: $2.98M. Total cost to transport: $1.5M. Total cost: $4.5M (rounded). Note volumes provided include contingency, hence costs could be 20-50% less.	Lifting - significant / frequent lifting.	discharge. Cost, impacts/risk associated with storage, transport and treatment onshore are significant and grossly disproportionate to any benefit.
Install pressure retaining caps on subsea lines during Phase 1 (prior to removal)	Negligible Impact Discharges from: Flowlines and jumpers - contents displaced to seawater (or treated seawater) and ≤30ppm oil in water confirmed. Umbilicals and flying leads - contents include freshwater and control fluids which was designed for and accepted for discharge during production phase. B6 umbilical also contains PPD which would disperse to PNEC levels in near vicinity of release.	Prevents discharge from lines during recovery. Eliminates negligible impacts from subsea discharges from the lines.	Not considered typical for commonplace discharges with negligible impact.	To ensure seal during recovery to surface, pressure retaining caps would need to be fabricated (various sizes) and installed on any lines which are cut or disconnected (and which do not have self-sealing connections) Costs flowlines: Approx. $60K to design/fabricate/install per flowline ($300K or more if capping jumpers also) Cost to design, fabricate and install multiple small retaining caps for umbilicals and flying leads. Estimated $10K per cap. All ends of all leads would require >30 caps at approx. cost $300K Significant additional cost to hire dedicated reel vessel with sufficient capacity for full lines (estimated >$8M additional on base removal costs).	Surface HSEC risks such as potential for pressure in flowlines (e.g. any residual pockets of gas expanding on return to surface) and increased lifting risk with flowlines due to increased weight of full lines with caps.	Reject Rationale: flowline contents will be treated and tested to confirm contents are acceptable for discharge. Resultant discharges are assessed as negligible impact. Significant additional cost and operational HSE risk associated with recovering full flowlines in Phase 2.
Attempt to disconnect umbilicals prior to cutting during removal from structures.	Negligible Impact Discharges from: Umbilicals and flying leads - contents include freshwater and control fluids which was designed for and accepted for discharge during production phase. B6 umbilical also contains PPD which would disperse to PNEC levels in near vicinity of release.	Avoids discharging fluids where practicable. Minimises negligible impacts.	Yes. Considered good practice.	Minor costs, not expected to be a critical path activity for the project.	Minor surface HSEC risks. Umbilical contents are chemicals and water only; no risk of trapped gas.	Implement Rationale: negligible environmental benefit coupled with operational benefit of limiting HSE operational risks at surface. Costs are not grossly disproportionate to the benefit.

Project Planned Discharges						
						Integrated via C24: Equipment deployment and recovery procedures.
Apply Cooper Energy chemical Assessment Process	Negligible Impact Discharge of clean-up and inhibitor chemicals.	Drives preferential selection of chemicals with lower Ecotox profile.	Yes. Method accepted, leverages international best practice OCNS. Applied for all prior campaigns.	Integrated into project planning.	Chemicals with higher efficacy or lower cost rejected where they do not have an acceptable EcoTox profile or sufficient information for assessment.	Implement Rationale: provides benefit and increased confidence of contents off critical path for the project. Costs are not grossly disproportionate to the benefit. Integrated via C18: Cooper Energy Offshore Chemical Assessment Procedure.
Record all Phase 1 Project chemical discharges	Negligible Impact Discharge of clean-up and inhibitor chemicals.	Verification of information used during the planning cycle for the characterisation, assessment and management of impacts.	Yes. Applied during previous campaigns	Already considered as part of the implementation phase.	None	Implement Rationale: provides assurance as to quantities of fluids discharged which feeds into project review, lessons learned and assessment considerations for future projects. Costs are not grossly disproportionate to the benefit. Integrated via C18: COOPER ENERGY Offshore Chemical Assessment Procedure
Chemical Discharge additional considerations for Phase 2						
Leave flowlines flushed with seawater only at end of Phase 1.	<u>Negligible Impact</u> Discharge of treated water from flowlines assume corrosion inhibitor at 650ppm (LC50 0.016mg/l for worst case component) during Phase 2. Disperses before PNEC levels exceeded within 500m; short term discharge.	Flushing with untreated seawater eliminates negligible impacts associated with dischsrge of treated seawater during Phase 2.	Seawater is commonly used, and may be supplemented with inhibitor chemicals depending on metallurgy of the flowline, length of time being left in place and subsequent use.	Offline work scope	Flowlines & Umbilicals - possible increased corrosion which may limit options (would not rule out all) for full removal. Associated regulatory/legal risk.	Implement pending advice from integrity / corrosion SME to address whether leaving flowlines filled with seawater only could preclude full removal. Rationale: provides benefit and increased confidence of contents off critical path for the project. Costs are not grossly disproportionate to the benefit. Integrated via C23 Flowline Flushing Integrity Provisions.
Cap flowlines with pressure retaining caps to retain all fluids during removal (reverse reel option for removal)	As above	No chemical discharge during removal (no impact)	No. Similar projects using only environmental plugs	Nominal $30K per cap to design, fabricate and install. Provision for 2 x caps per flowline - total $300K.	Adding pressure retaining caps creates a HSE risk at surface during recovery associated with trapped pressure. May limit the options for removal. Significant increase	Reject Rationale: flowline contents will be treated and tested to confirm contents are acceptable for discharge. Resultant discharges are assessed as negligible impact. Significant additional

Project Planned Discharges						
					in weight (because retaining all line contents) requiring larger vessel / crane if reeling up. If cutting lines into sections subsea then pressure retaining caps are obsolete.	cost and operational HSE risk associated with recovering full flowlines in Phase 2. Costs / risks are considered to be grossly disproportionate to the benefit.

Consequence	**Level 1:** Minor local impacts or disturbances to flora/fauna, nil to negligible remedial / recovery works on land/ water systems
Demonstration of Acceptability	
Principles of ESD	Planned discharges are assessed as **Level 1** 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.
Legislative and conventions	The proposed activities align with the requirements of the: • OPGGS Act 2006 (Cth) [S13(5) Risk assessment to ALARP]
Internal context	The environmental controls proposed reflects the Cooper Energy HSEC Policy goals of utilising best practice and standards to eliminate or minimise impacts and risks to the environment and community to a level which is ALARP. Relevant management system processes adopted to implement and manage hazards to ALARP include: • MS03 – Risk Management • MS09 - Health, Safety and Environment Management • MS11 – Supply Chain and Procurement Management
External context	No stakeholder objections or claims have been received regarding planned discharges. Consultation with DAWE Sea Dumping Section indicates a Sea Dumping Permit may be required to dispose of chemicals into the reservoir. This has been captured within Section 8 as performance standard C40 Sea Dumping Permits.
Acceptability Outcome	**Acceptable**

6.5 Underwater Sound Emissions

6.5.1 Cause of Aspect

Underwater sound emissions will be generated by:

- Seabed survey
- Positioning equipment (i.e. transponders)
- Cutting tools
- MOU operations
- Vessel operations
- Helicopters operations

Underwater sound emissions can be impulsive (i.e. pulsed) or continuous (i.e. non-pulsed). The Sound Pressure Level (SPL) associated with underwater sound is typically reported as dB with a reference level of 1 micro-Pascal (dB re 1 µPa). However, the dB number can represent multiple types of measurements, including zero-to-peak pressure (0-pk, or PK), peak-to-peak pressure (pk-pk), root-mean-square (RMS). For environmental impact thresholds, Sound Exposure Level (SEL) can also be used, which can be the exposure over 1 second (SEL) or cumulative (SELcum), which is typically over 24 hours. Sound source level and frequency of sound generated varies considerably between different sources.

The sound source levels for sound sources during the activity are summarised in Table 6-6.

Table 6-6 Sound source levels for Petroleum Activity

Source	Frequency	Sound Source Level dB re 1 µPa	Reference
Continuous			
MOU	2 Hz – 500 kHz	188.9 dB re 1 µPa	Connell et al., 2021
Vessels	20 to 300 Hz	185.2 dB re 1 µPa	Connell et al., 2021
ROV cutter tool	2.5 and 20 kHz	161.4 dB re 1 µPa	Connell et al., 2021
Helicopter	below 500 Hz	Refer below.	-
Impulsive			
Acoustic Transponder	18-36 kHz	204 dB re 1 µPa	Ranger USBL – Austin et al. (2012)
Single and multibeam echo sounders	200-400kHz	221 dB re 1 µPa	Austin et al. (2013)
Sidescan Sonar	100 – 400 kHz	210 dB re 1 µPa @1m	Austin et al. (2013)

Helicopter operation produces strong underwater sounds for brief periods when the helicopter is directly overhead (Richardson et al., 1995). The received sound level underwater depends on the helicopter source altitude and lateral distance, the receiver depth and water depth. Sound emitted from helicopter operations is typically below 500 Hz and sound pressure is greatest at surface in the water directly below a helicopter, but this diminishes quickly with depth. Richardson et al (1995) reports figures for a Bell 214 helicopter (stated to be one of the noisiest) being audible in the air for four minutes before it passed over underwater hydrophones, but detectable underwater for only 38 seconds at 3 m depth and 11 seconds at 18 m depth. Noise from helicopter activities would therefore be localised and will also be infrequent.

6.5.2 Predicted Environmental Impacts and Risk Events

Underwater sound generated by the BMG Closure Project (Phase 1) activities will be continuous and impulsive. Potential impacts of underwater sound emissions are:

- Change in ambient noise.

This impact results in the following risk events:

- behavioural changes; and
- auditory impairment (injury), permanent threshold shift (PTS) and temporary threshold shift (TTS).

The noise EMBA is the area where noise levels are predicted to be above the noise behaviour criteria for the most sensitive receptors (considered to be low frequency whales). The largest distances occur as a result of continuous sound sources. Modelling undertaken to determine the EMBA for continuous sound sources is described below (Section 6.5.3.1); in summary the spatial extent of potential noise effects is predicted to be:

- Behavioural effect: within 30 km of the MOU

Closer to the MOU, there is potential for injury to whales:

- TTS: if inside 5 km radius of the MOU for 24 hr or more.
- PTS: if inside 110 m radius of the MOU for 24 hr or more.

The EPBC Protected Matters Report for the noise EMBAs are in Appendix 2. These have been generated as a buffer of 30 km / 5 km around the Operational Area, so extend beyond the modelled noise EMBAs to ensure it is sufficiently inclusive.

Underwater sound emissions may impact biological receptors within the noise EMBAs such as:

- fish (with and without swim bladders) including commercial species;
- marine mammals; and
- marine reptiles.

6.5.3 Consequence Evaluation – Continuous Sound Sources

Continuous sound will be generated by MOU and vessel operations for the duration of the activity (130 days, single or split campaign). Whilst operational, the cutting tool will also generate continuous sound. This will be used intermittently and for a short duration (hours, not days).

All animals have a hearing threshold, which is described as the softest sound an animal can hear at any given frequency. Sound levels above this threshold can be detected without impairment until a certain combination of intensity and duration is reached. Above this limit, the animal's hearing threshold may be temporarily or permanently worsened, meaning that received sound must be louder for it to be detected. During this period of threshold shift, natural sounds important for animals' behaviour may be below the hearing threshold, leading to behavioural changes / disturbance to the animal. The threshold shift can be either temporary (TTS), or permanent (PTS) (DOSITS 2018).

To determine the consequence of received sound on a receptor, impact (exposure) criteria from published literature can be used. These criteria describe the level of sound a receptor must be exposed to for an impact to occur. These studies are used with caution, ensuring that consideration is given to the study methodology, applicability to the proposed Petroleum Activities, and the parameters used for reporting such as units and definition of impact / effect.

Impact (or exposure) criteria relevant to each receptor are described in the sections below.

6.5.3.1 Underwater Sound Modelling

JASCO Applied Sciences (JASCO) were contracted to undertake modelling studies of underwater sound levels associated with BMG Closure Project activities from continuous sound sources including support vessels, MOU, ROV and underwater cutting. The JASCO modelling studies considered specific components of the program at the Basker-A, Basker-6ST1, and Manta-2A well locations. The approach provides coverage across the entire depth range of the Operational Area. The JASCO modelling report (Connell et al., 2021) is available in Appendix 6.

Table 6-7 summarised the modelling scenarios applicable to BMG Closure Project (Phase 1) activities.

Table 6-7 Modelled underwater noise scenarios

#	Activity	Modelled Scenario
1	MOU operations	DP operations of a MOU. Thruster noise levels based on median noise measurements from similarly sized but higher powered semi-submersible vessel previously measured by JASCO whilst under DP (Connell et al., 2021).
2	MOU resupply	PSV under DP alongside the MOU undertaking resupply. PSV sound level and spectrum based on representative levels from representative vessels.
3	ROV vessel (cutting)	ROV vessel with ROV operating on the seabed using a cutting tool. ROV vessel sound level and spectrum based on representative levels from representative support vessels. A diamond wire saw operated via an ROV; sound level and spectrum based on published measurements (Pangerc et al., 2016).
4	Combined operations	Combination of scenarios 2 – 3, to simulate situation where resupply and ROV cutting are undertaken simultaneously at two separate locations.

The modelling study assessed distances from activities where underwater sound levels reached exposure criteria corresponding to various levels of potential impact to marine fauna. The marine fauna considered was based on a review of receptors that may be impacted by continuous noise, these were marine mammals, turtles, and fish (including fish eggs and larvae). The exposure criteria selected for the modelling and the impact assessment were selected as they have been accepted by regulatory agencies and because they represent current best available science (Connell et al., 2021).

Where several modelled scenarios are representative of vessel activities, such as where location or season has been varied in the modelling parameters, the worst-case (i.e. furthest impact distance) has been selected for evaluation of potential impacts.

6.5.3.2 Impact: Change in ambient noise

Ambient noise is the level of noise which exists in the environment without the presence of the activity.

Since 2009 (paused 2017-2018 due to unconfirmed funding), the Integrated Marine Observing System (IMOS) has been recording underwater sound south of Portland, Victoria (38° 32.5' S, 115° 0.1' E). Sound sources identified in recordings include blue and fin whales at frequencies below 100 Hz, ship noise at 20 to 200 Hz and fish at 1 to 2 kHz (Erbe et al. 2016). In the Gippsland Basin, primary contributors to background sound levels were wind, rain and current- and wave-associated sound at low frequencies under 2 kHz (Przeslawski et al. 2016). Biological sound sources including dolphin vocalisations were also recorded (Przeslawski et al. 2016). Ambient noise level in the Gippsland Basin at 100-500 Hz varied depending on recording location between 89.2 to 109.9 dB re 1 µPa2/Hz, likely due to a varied increase in distance from shipping activity, and water depth.

Underwater modelling for the activity (Connell et al., 2021) shows that noise from the activity will be above 100 dB re 1 µPa within 80 km of the activity location. The consequence of a change in ambient noise is **Level 1**, as ambient noise will return to existing levels following completion of the activity with no remedial or recovery work required.

6.5.3.3 Risk Event: Marine mammals PTS and TTS

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

The US National Marine Fisheries Service (NMFS 2018) reviewed available literature to determine exposure criterion for the onset of temporary hearing TTS and PTS for marine mammals based on their frequency hearing range. NMFS (2018) details that after sound exposure ceases or between successive sound exposures, the potential for recovery from hearing loss exists, with PTS resulting in incomplete recovery and TTS resulting in complete recovery.

The NFMS (2018) exposure criteria are based on a cumulative SELs over a period of 24 h. Table 6-8 details the criteria and modelled distances to them.

The PTS and TTS 24 h criteria are only relevant to those receptors that are likely to be present PTS EMBA or TTS 24-hr EMBA for a period of 24 h. For this assessment the PTS and TTS 24 h criteria was applied to marine mammals that may be undertaking biologically important behaviours, such as calving, foraging, resting or migration (as defined by Commonwealth of Australia, 2015c), which may mean they remain within the PTS EMBA or TTS 24-hr EMBA for an extended duration, instead of transiting through the area i.e. during migration.

Where several modelled scenarios are representative of vessel activities, such as where location or season has been varied in the modelling parameters, the worst-case (i.e. furthest impact distance) has been selected for evaluation of potential impacts. A dash indicates the threshold was not reached within the limits of the modelling resolution (20 m).

Table 6-8 Cetacean PTS and TTS noise criteria and predicted distances and areas

Hearing group	Frequency-weighted SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)	Scenario 1: MOU Operations		Scenario 2: MOU re-supply		Scenario 3: ROV vessel & cutter tool		Scenario 4: Combined Operations	
		R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)
PTS									
LF cetaceans	199	0.10	0.04	0.11	0.04	0.05	0.009	0.11	0.05
MF cetaceans	198	–	–	–	–	–	–	–	–
HF cetaceans	173	0.05	0.009	0.07	0.02	0.06	0.01	0.08	0.03
Otariid seals	219	–	–	–	–	–	–	–	–
TTS									
LF cetaceans	179	3.49	28.0	3.82	35.6	1.04	2.38	5.07	43.4
MF cetaceans	178	0.05	0.009	0.06	0.02	0.05	0.009	0.07	0.02
HF cetaceans	153	0.69	1.43	1.11	3.67	1.57	2.51	2.39	8.50
Otariid seals	199	0.03	0.004	0.03	0.004	–	–	0.03	0.004

6.5.3.3.1 Otariid seals

The otariid seal PTS criteria is not reached. TTS criteria is reached within very close proximity to the activity (0.03 km).

Otariid seals, often referred to as 'eared seals', include sea lions and fur seals. The PMST Report (Appendix 2) does not identify the presence of sea lions or fur seals. There are no BIAs or habitats critical for the survival of otariid seals within the TTS 24-hour exposure EMBA. Given this, impacts are not expected and have not been evaluated further.

6.5.3.3.2 High-frequency cetaceans

The furthest distance to the high-frequency cetacean PTS criteria is 0.08 km, and the TTS criteria is 2.39 km.

High-frequency cetaceans include sperm whales, beaked whales and large delphinid species such as killer whales and pilot whales. Porpoises and some species of dolphins form the group of very high-frequency cetaceans (Southall et al., 2019). The PMST Report (Appendix 2) identified that high-frequency cetaceans such as pygmy sperm whale may occur within the TTS 24-hour EMBA (5 km), however no biologically important areas or behaviours were identified within the TTS 24-hour EMBA and therefore they are not assessed further. Any impacts to high frequency cetaceans will be managed through the adoption of marine mammal adaptive management (C27).

6.5.3.3.3 Mid-frequency cetaceans

The mid-frequency cetacean PTS criteria was not reached and the furthest distance to the TTS criteria is 0.08 km.

The PMST Report (Appendix 2) identified several mid-frequency dolphin species, beaked and toothed whales within the TTS 24-hour EMBA (5 km), however, no biologically important areas or behaviours were identified within the TTS 24-hour EMBA and therefore they are not assessed further. Any impacts to mid-frequency cetaceans will be managed through the adoption of marine mammal adaptive management (C27).

6.5.3.3.4 Low-frequency cetaceans

The furthest distance to the low-frequency cetacean PTS criteria is 0.11 km and the TTS criteria is 5.07 km. This is a conservative estimate, based on:

- Where results differed between location, the maximum distance has been selected
- The area of impact is based on combined operations; when activities are undertaken independently the area of potential impact will be less
- The June sound speed profile is expected to be most favourable to longer-range sound propagation across the entire year. As such, June was selected for sound propagation modelling to ensure precautionary estimates of distances to received sound level thresholds.

Low-frequency cetaceans include baleen whales such as humpback whale, southern right whale and blue whale. Potential presence within the TTS 24-hour EMBA and biologically important behaviours for listed threatened low-frequency cetaceans are summarised in Table 6-9.

Table 6-9 Low frequency cetacean presence and biologically important behaviours

Species	Presence (TTS 24-hour EMBA PMST Report)	Biologically Important Behaviours
Blue whale	Species or species habitat likely to occur within area	Yes – Possible Foraging BIA
Southern Right Whale	Species or species habitat known to occur within area	Yes – Known core range BIA
Humpback Whale	Species or species habitat known to occur within area.	-
Sei whale	Foraging, feeding or related behaviour likely to occur within area	-
Fin Whale	Foraging, feeding or related behaviour likely to occur within area	-

Blue whales are identified as possibly exhibiting foraging behaviours within the area where the PTS and TTS criteria is reached. The blue whale possible foraging BIA has been identified where 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 (Commonwealth of Australia, 2015c). Typically, blue whale migrate between breeding grounds (low latitudes) where mating and calving take place in the winter, to feeding grounds (high latitudes) where foraging occurs in the summer. As described in Section 3.14.2 of the Cooper Energy Description of the Environment: Cape Jaffa (South Australia) to Gladstone (Queensland) (COE-EN-EMP-0001) [Addendum 1], two subspecies of blue whale occur within Australian waters: Antarctic blue whale and the pygmy blue whale.

The Bonney Upwelling is a known seasonal feeding area for blue whales; this feature is located approximately 300 km from the activity location (DoE, 2015d., Gill et al., 2011, McCauley et al., 2018). Outside of these main feeding areas, foraging areas for pygmy blue whale include the Bass Strait, and diving and presumably feeding at depth off the west coast of Tasmania (DoE, 2015d). Three groups of blue whale – Indo-Australian (IA) pygmy blue, Tasman-Pacific (TP) pygmy blue, and Antarctic blue, have been recorded acoustically in the Bass Strait (McCauley et al. 2018), with scientists now considering the Bass Strait to be the boundary between the East Indian Ocean and New Zealand sub-populations. No IA pygmy blues have been recorded on Australia's east coast (Balcazar et al. 2015) or in New Zealand, where TP (NZ subpopulation) pygmy blue whales gather to forage in the South Taranaki Bight west of Cook Strait (Barlow et al. 2018).

The unique song of pygmy blue whales feeding in New Zealand predominates in the western South Pacific (Balcazar et al., 2015; Barlow et al., 2018). NZ subpopulations of pygmy blue whale are typically found in New Zealand waters year-round, with studies indicating that individuals do not move far from feeding grounds in the South Taranaki Bight (Barlow et al., 2020).

Acoustic detections of TP pygmy blue whales and Antarctic blue whales have been recorded in the Bass Strait and offshore eastern Australia between April and June (Balcazar et al., 2015, McCauley et, al 2018). Based on current knowledge of patterns of behaviour elsewhere, it can be assumed that if blue whale are sighted, they are most likely foraging (Peter Gill pers comms July 2021), potentially whilst moving between seasonal feeding grounds to the south and breeding grounds to the north. Subsequently, it is possible that blue whales may be present within the TTS 24-hr EMBA at certain times of year, though remote chance given:

- the episodic nature of upwelling and productivity in the Gippsland region, the particularly low frequency of upwelling near to the shelf and near to BMG (*Figure 6-14*), and
- blue whales are likely foraging opportunistically whilst on migrating through the region

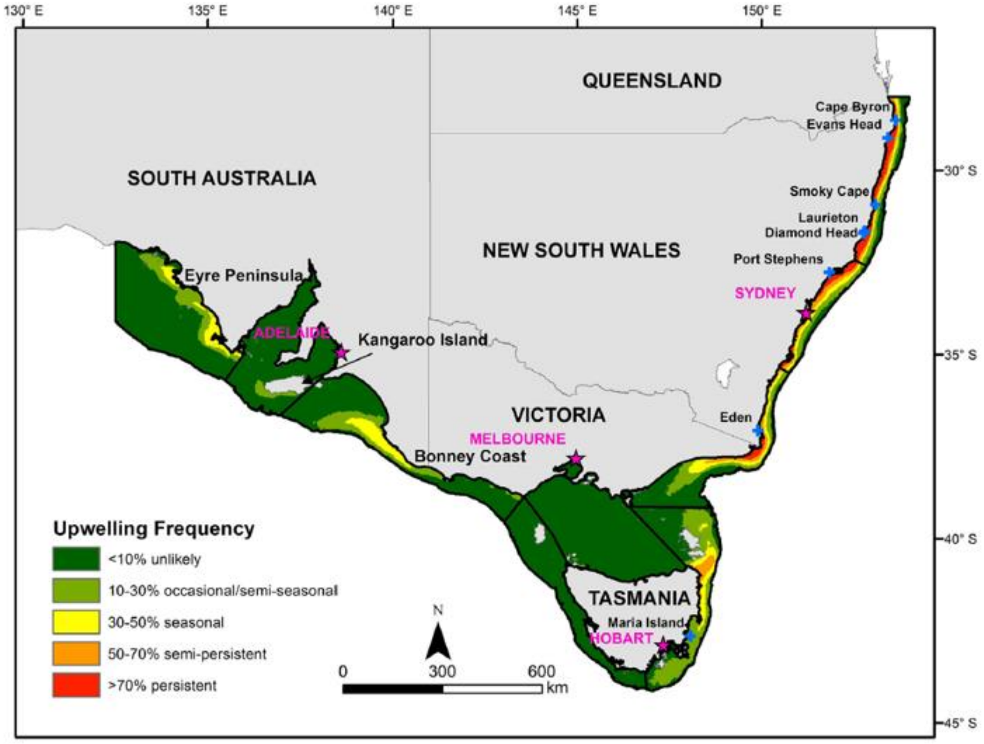


Figure 6-14 Upwelling Frequency in the Bass Strait (Huang and Wang 2019)

Sightings of blue whales in the Gippsland region have been reported in June 2020 during offshore seismic survey (CGG pers comms). The ALA holds <10 sightings records since the 1970's; the ALA data quality test notes multiple deficiencies for each sighting such as missing collection dates, hence these sightings are considered less reliable than contemporary acoustic detections. All of the above sightings were over 40km from BMG. Based on historical catch data (Cwth Australia 2015), the low sightings may in part be a function of lower levels of monitoring compared to other regions such as the Otway. Based on their migration patterns, blue whale are more likely to be moving through the Gippsland region in May, with April and June considered shoulder times given detections of both Antarctic blues and TP pygmy in central Bass Strait blues between April-June followed by detections of whales moving north, off mid NSW and Tonga from June/July (Table 6-10).

The conservation management plan (CMP) for the blue whale (Commonwealth of Australia, 2015c) Action A.2.3 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 CMP assesses the threat from shipping and industrial noise, 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 pygmy blue whales are largely unknown, a precautionary approach has been taken regarding assignation of possible consequences, hence even Minor consequences to individuals is considered a precautionary assessment in the CMP. Given no population level effects are predicted from shipping and industry noise it follows that Action A.2.3 may not be needed to achieve the CMP objective which is ultimately aimed at population recovery: *'to minimise anthropogenic threats to allow for their conservation status to improve so that they can be removed from the EPBC Act threatened species list'.* Though shipping and industry has been present offshore south east Australia (and within blue whale BIAs) for decades, estimates indicate blue whale populations are recovering (e.g. Branch et al. 2007; Balcazar et al. 2015, McCauley et al. 2018), albeit at a slower rate compared to other species such as the humpback whale (Noad et al. 2019, TSSC 2022).

The area of potential impact from decommissioning operations is small with the furthest distance of 5.07 km from combined operations (Scenario 4) for the TTS criteria. At any one time, the area of impact would be 80.75 km^2 which equates to ~0.018% of the blue whale possible foraging BIA (181,376 km^2). For the PTS criteria the furthest distance is 0.11 km with the largest area of impact of 0.038 km^2 which equates to ~0.00002 % of the blue whale possible foraging BIA.

The southern right whale known core range BIA overlaps the TTS 24-hr EMBA. Southern right whale migrate annually from their nursery grounds (lower latitudes) in winter, to their feeding grounds (higher latitudes) in summer. There is the potential for southern right whales to be transiting through the area offshore Victoria during May-June and September-November as they move to and from coastal aggregation areas (Table 6-10).

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 area of impact is small with the furthest distance of 5.07 km from combined operations (Scenario 4) for the TTS criteria. At any one time, the area of impact would be 80.75 km^2 which equates to ~0.037% of the southern right whale known core range BIA (217,825 km^2). For the PTS criteria the further distance is 0.11 km with the largest area of impact of 0.038 km^2 which equates to ~0.00002% of the southern right whale core coastal BIA.

Humpback whales could occur in the TTS 24-hr EMBA, although biological important behaviours have not been identified. Individuals have been seen foraging in the Gippsland region between September and November (i.e. Andrews-Goff et al., 2018) on their migration through the Bass Strait. The Bass Strait is not identified as a migration or foraging area for humpback whales. It is likely that presence in the area is linked to the Upwelling East of Eden (TSSC, 2015e). Peak migration offshore east Victoria is April – May (northward migration) and November – December (southward) (Table 6-10). The conservation advice for humpback whale (TSSC, 2015e) described noise interference as a threat, specifically related to impulsive sound sources. Subsequent listing advice describes noise interference as a known impact that is not threatening the species as evidenced by its continuing strong recovery (TSSC 2022).

Fin and sei whales are likely to be undertaking foraging, feeding or related behaviour within the TTS 24-hr EMBA (Appendix 2), with foraging occurring from January to April (Table 6-10). There are no BIAs or critical habitats identified in the TTS 24-hr EMBA. The fin and sei whales have conservation advice (TSSC, 2015f; TSSC, 2016g) which both identify anthropogenic noise as a threat with the conservation and management actions of:

- once the spatial and temporal distribution (including biologically important areas) of sei whales is further defined an assessment of the impacts of increasing anthropogenic noise (including from seismic surveys, port expansion, and coastal development) should be undertaken on this species.
- if required, additional management measures should be developed and implemented to ensure the ongoing recovery of sei whales.

The fin and sei whale's conservation advice (TSSC, 2015f; TSSC, 2016g) has a consequence rating for anthropogenic noise and acoustic disturbance as minor with the extent over which the threat may operate as moderate-large.

Table 6-10 Estimated timings for presence offshore east Victoria

Species	J	F	M	A	M	J	J	A	S	O	N	D
Blue whale				s		s						
Southern right whale												
Humpback whale Source: TSSC, 2015e, Andrews-Goff et al., 2018)												
Sei whale												

Species	J	F	M	A	M	J	J	A	S	O	N	D
Fin whale												

s – expected shoulder period

Risk Event Analysis – PTS & TTS in marine mammals

PTS is not considered credible due to the extended duration (24 hours) which an individual would need to be in close proximity (within 0.11 km) to the sound source (i.e. MOU).

TTS could occur within a maximum of 5.07 km of the sound source (i.e. MOU), based on the most sensitive hearing thresholds (low-frequency cetaceans). TTS is by definition, recoverable. The consequence of predicted impacts to marine mammals from TTS is assessed as localized short-term impacts to species or habitats of recognized conservation value not affecting local ecosystem function (consequence **Level 2**).

The likelihood of this level of consequence occurring is considered **Hypothetical (F)**, based on movement patterns related to foraging. DAWE 2021b notes the definition for foraging: *'to wander in search of food'*. In a region such as the Gippsland upwellings which drive feeding opportunities are episodic, temporally dynamic and infrequent near to BMG (Wang & Huang 2019). Unlike known foraging areas on the southern and west coast of Australia, the Gippsland region falls within a possible foraging area; whales travel through on a seasonal basis, possibly as part of their migration. Evidence for feeding is based on limited direct observations or through indirect evidence such as occurrence of krill in close proximity to whales (DAWE 2015).

Individuals remaining within the TTS 24-hr EMBA for an extended duration is considered **Hypothetical** given:

- If present at all, blue whales would be expected to be on migration through the Gippsland Region and not exposed to activity noise for long enough for TTS onset. Blue whales have been recorded swimming at mean speeds of 2.8km/hr +/- 2.2km/hr whilst migrating and foraging (Owen *et al.* 2016) or faster (Moller *et al*. 2020). Humpback whales have been reported as swimming at mean speeds of circa 2.5 km/h – 4km/h during migration (Noad and Cato, 2007). Accounting for these range of swimming speeds, a whale would be expected to move through any TTs zone associated with the project well before TTS onset.

- A type of foraging behaviour (observed in tagged blue whales) involving area restricted searches was reported by Owen et al. (2016) as occurring at depths around 1000m across an area of 220km^2. BMG is located in water depths <300m, with maximum project TTS contours covering an area of <50km^2 and extending in places to the 600m isobath. Therefore area restricted searches, if any, could be expected to occur outside and/or well beyond any project TTS contour, which would preclude TTS onset.

- If whales were to interrupt their foraging/migration within the TTS zone to feed on a patch of krill for >24h, the movement of plankton (and therefore krill) with the currents would move the feeding zone passively through the TTS zone before TTS onset. Minimum average currents in the surface 50m at BMG are around 0.18m/s. A discrete patch of krill moving with the plankton (and therefore the current) would move at 648m/h, moving through the TTS zone well before TTS onset.

Overall, the inherent **risk severity is Low and Acceptable**. To ensure the risks remain acceptable, ALARP, and are not inconsistent with the blue whale CMP (Table 2-6) Cooper Energy will adopt good practice control measures and adaptive management measures which involve a scalable actions to manage the risks to foraging blue whales (Table 6-16).

6.5.3.4 Risk Event: Marine mammal behaviour

The National Marine Fisheries Service (NMFS) guidance for behavioural disturbance for continuous sounds is 120 dB SPL (NFMS 2013). Richardson *et al.* (1995) and Southall *et al.* (2007) indicate that behavioural avoidance by baleen whales may onset from 140 to 160 dB SPL or possibly higher.

The NFMS (NOAA 2019) behavioural criteria and predicted distance for each scenario is detailed in Table 6-11. The furthest distance of 29.5 km has been used to define the noise behaviour EMBA (30 km) to identify potential receptors.

Table 6-11 Cetacean behavioural noise criteria and predicted distances

SPL (L_p; dB re 1 µPa)	Scenario 1: MOU Operations		Scenario 2: MOU re-supply		Scenario 3: ROV vessel & cutter tool		Scenario 4: Combined Operations	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
120	25.6	19.4	28.7	21.1	7.93	6.71	29.5	23.2

Within the noise behaviour EMBA (30 km) the following have been identified:

- up to 29 whale and cetacean species and two fur-seal species may be present based on the noise behaviour EMBA PMST Report (Appendix 2).
- foraging behaviour for the fin and sei whales as detailed in the noise behaviour EMBA PMST Report (Appendix 2); with foraging expected January to April
- humpback whale species or species habitat known to occur in the area, with presence expected April – May and September – December (Andrews-Goff et al., 2018).
- blue whale possible foraging BIA (Figure 4-4) with low level presence in the area possible April, May and June.
- Southern right whale known core range BIA, with presence expected May – June and September – November.
- no habitats critical to the survival of the species were identified for any marine mammals.

The conservation management plan (CMP) for the blue whale (Commonwealth of Australia, 2015c) Action A.2.3 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 CMP assesses the threat from shipping and industrial noise, 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 pygmy blue whales are largely unknown, a precautionary approach has been taken regarding assignation of possible consequences, hence even Minor consequences to individuals is considered a precautionary assessment in the CMP. Given no population level effects are predicted from shipping and industry noise it follows that Action A.2.3 may not be needed to achieve the long-term CMP objective which is ultimately aimed at population recovery: *'to minimise anthropogenic threats to allow for their conservation status to improve so that they can be removed from the EPBC Act threatened species list'.* Though shipping and industry has been present offshore south east Australia (and within blue whale BIA's) for decades, estimates indicate blue whale populations are recovering (e.g. Branch et al. 2007; Balcazar et al 2015, McCauley et al. 2018) albeit at a slower rate compared to other species such as the humpback whale (Noad et al. 2019).

The furthest distance to the behaviour noise criteria of 29.5 km from combined operations (Scenario 4) results in an area of impact of 2,734 km^2 which equates to 1.59% of the blue whale possible foraging BIA (181,376 km^2) (Figure 4-4). This represents a small part of a large BIA where foraging behaviours are dependent upon patches of krill, which are not uniformly distributed. Primary and secondary productivity in the region is linked to upwelling systems; the closest of which is an interconnected system of upwelling areas along the NSW coastline. The Gippsland region is outside of the area of high upwelling frequency (Huang & Wang, 2019), and primary productivity is expected to be low overall. The production and movement of krill is dynamic and unpredictable from one year to the next; it is considered unlikely that the behavioural EMBA overlaps a discrete hot spot for krill at any particular given time, and disturbance to a foraging blue whale within the possible foraging BIA is considered unlikely.

To understand the noise levels at the boundary of the southern right whale migration and resting on migration BIA (Figure 4-5), noise levels were modelled at a hypothetical receiver location at the closest point of the southern right whale known core range BIA to the activity. Received SPL is shown in Table 6-14.

Table 6-12 Received SPL levels at southern right whale migration and resting on migration BIA hypothetical receiver location

	Scenario 1: MOU Operations	Scenario 2: MOU re-supply	Scenario 3: ROV vessel & cutter tool	Scenario 4: Combined Operations
SPL (L_p; dB re 1 μPa)	109.2	102.8	103	110.6

Based on this, received sound levels are predicted to be below the behavioural criteria for southern right whale on the boundary to the migration and resting on migration BIA, and no impacts to important behaviours related to migration or resting are expected.

The noise behaviour EMBA overlaps the known core range BIA for southern right whale. The furthest distance to the behaviour noise criteria of 29.5 km from combined operations (Scenario 4) results in an area of impact of 2,734 km^2 which equates to 1.26 % of the southern right whale known core range BIA (217,825 km^2). There is space for southern right whales to pass between the noise behaviour EMBA and the coastline (approximately 15 km), and displacement from the BIA or of important behaviours is not expected.

The conservation advice for humpback whales (TSSC, 2015e) described noise interference as a threat, specifically related to impulsive sound sources. Subsequent listing advice refers to noise interference as a current impact not threatening or preventing population growth (TSSC 2022). Based on conservative impact contours established for continuous vessel noise, minor behavioural deviations (to avoid vessel noise) have to potential to occur. Based on in field observations by project vessel crew, this assessment may be overly conservative; previous projects in shallower waters in the region have recorded humpback whales approaching slow moving DP pipelay vessels and support vessel to a relatively close proximity (within hundreds of meters) before continuing on (2018 sightings records, Sole Project).

The fin and sei whales have conservation advice (TSSC, 2015f; TSSC, 2016g) which both identify anthropogenic noise as a threat with the conservation and management actions of:

- once the spatial and temporal distribution (including biologically important areas) of sei whales is further defined an assessment of the impacts of increasing anthropogenic noise (including from seismic surveys, port expansion, and coastal development) should be undertaken on this species.
- if required, additional management measures should be developed and implemented to ensure the ongoing recovery of sei whales.

The fin and sei whale's conservation advice (TSSC, 2015f; TSSC, 2016g) has a consequence rating for anthropogenic noise and acoustic disturbance as Minor with the extent over which the threat may operate as moderate-large.

Risk Event Analysis – behavioural impacts in marine mammals

Behaviour impacts are possible within the noise behaviour EMBA, which is 30 km from the Operational Area. The consequence of behavioural disturbance is that whales are deterred from undertaking important behaviours within the noise disturbance EMBA, specifically foraging blue whales.

The Gippsland area is identified as a possible foraging area; it has not been identified as a key feeding area for either blue whale groups detected in the region (the TP pygmy blue whale, and Antarctic blue whale), although it may be linked to opportunistic foraging, for example whilst whales are migrating. Foraging behaviour in the eastern Bass Strait appears different to offshore western Victoria and South Australia where East Indian Ocean pygmy blue whales are known to forage in high numbers on a seasonal basis.

Behavioural effects would be expected to be limited to individual whales which may be foraging whilst on migration. Behavioural effects may range from no or minimal observable avoidance, masking of calls which may lead to whales adapting tone when communicating (has been observed – Warren *et al.*, 2021) to movement away to avoid higher levels of noise, conservatively up to 30 km from the MOU.

The consequence of behavioural changes could include not encountering a patch of krill inside this particular area of ocean. This has the potential to temporarily impact on fitness, until food is ultimately encountered onward migration and within known key feeding grounds.

Krill productivity is dynamic and often episodic, within an area as large and dynamic as the Gippsland krill is unlikely to be limited to any single area for an extended period of time. Cooler sea surface temperature (SST) upwellings and Chlorophyll-a (Chl-a); both are environmental precursors linked to secondary production; both are episodic within the Gippsland region and can vary significantly from over short periods of time and across the region. Figure 6-15 shows a snapshot of SST and Chl-a off the south eastern coast in

April 2021. Displacement of whales from the behavioural noise EMBA whilst foraging would therefore not be expected to significantly reduce the overall number of encounters between whales and patches of krill (and therefore feeding opportunities) in any given season.

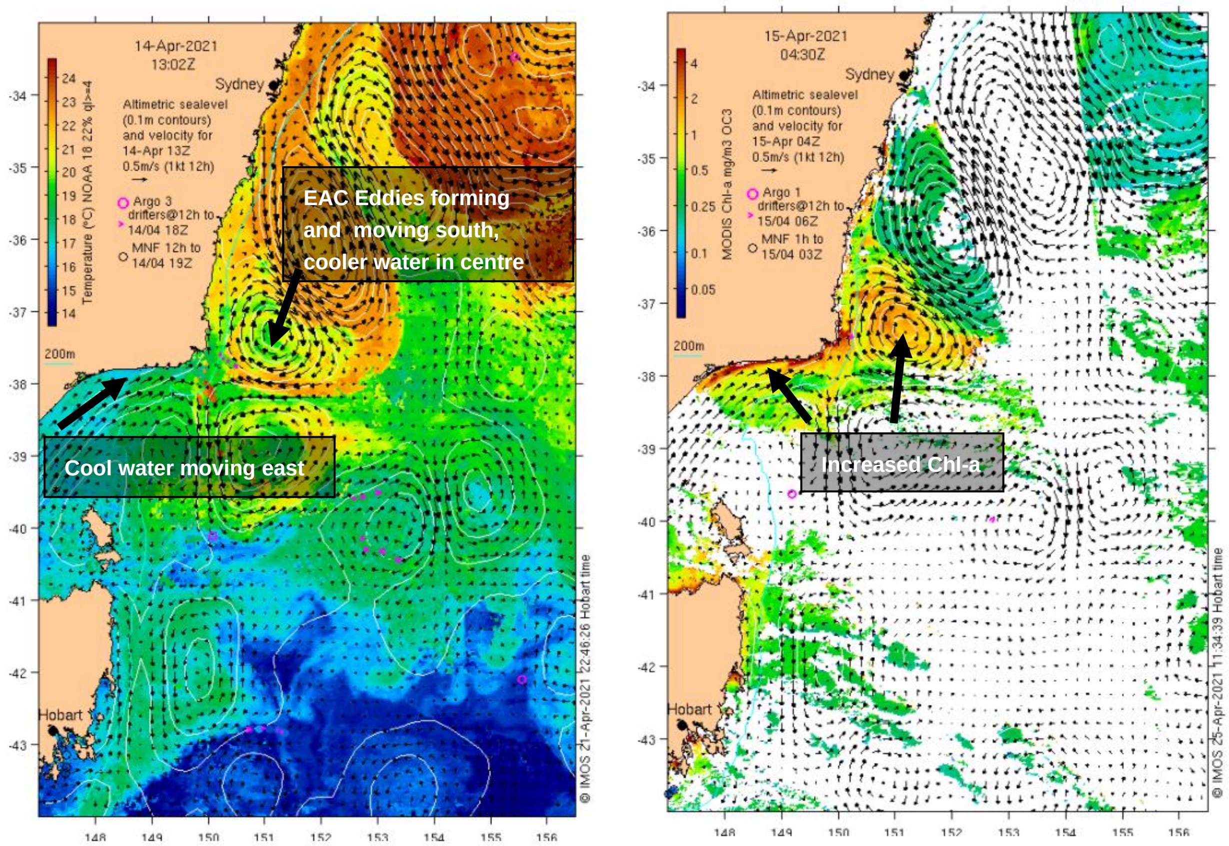


Figure 6-15 Water movements, SST and Chl-a in the south-east (IMOS 2022).

The consequence of behavioural disturbance due to the BMG Decommissioning project is therefore ranked as **Level 2** (Localized short-term impacts to species or habitats of recognized conservation value not affecting local ecosystem function). The likelihood of this consequence occurring is considered **Unlikely** 'could occur during the activity'

Overall, the **risk severity is Low and Acceptable**. To ensure the risks remain acceptable, ALARP, and are not inconsistent with the blue whale CMP (Table 2-6) Cooper Energy will adopt good practice control measures and adaptive management measures which involve a scalable actions to manage the risks to foraging blue whales (Table 6-16).

6.5.3.5 Risk Event: Fish

There are limited quantitative exposure guideline/criteria for fish for shipping and continuous sound as Popper et al. (2014) found that there was insufficient data available to establish sound level thresholds and instead suggested general distances to assess potential impacts. Popper et al. (2014) suggests that there is a low risk to fish from shipping and continuous sound noise with the exception of TTS near (10s of metres) to the sound source, and masking at near, intermediate (hundreds of metres) and far (thousands of metres) distances and behaviour at near and intermediate distances from the sound source. Popper et al. (2014) does provide a quantitative criteria for recoverable injury to fish with a swim bladder involved in hearing (170 dB RMS for 48 hrs) and TTS to fish with a swim bladder involved in hearing (158 dB RMS for 12 hrs). Ierodiaconou et al (2021) identified multiple fish species on and around the wells and flowline routes; some with swim bladders (e.g. Jackass morwong, foxfish), and some without (e.g. handfish, stingaree) however these features are at the seabed, over 100 m from the primary surface sound sources such as vessel and MOU thrusters. Resident fish are therefore not expected to be within range of TTS.

Table 6-13 details the modelled distances to these criteria.

Table 6-13 Fish behavioural noise criteria and predicted distances

SPL (L_p; dB re 1 µPa)	Scenario 1: MOU Operations		Scenario 2: MOU re-supply		Scenario 3: ROV vessel & cutter tool		Scenario 4: Combined Operations	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
170	-	-	-	-	-	-	0.02	0.02
158	0.05	0.05	0.05	0.05	0.03	0.03	0.05	0.05

Limited research has been conducted on shark responses to sound. Myberg (2001) stated that sharks differ from bony fish in that they have no accessory organs of hearing such as a swim bladder and therefore are unlikely to respond to acoustical pressure. Klimley and Myrberg (1979) established that an individual shark will suddenly turn and withdraw from a sound source of high intensity (more than 20 dB above broadband ambient SPL) when approaching within 10 m of the sound source. Thus, any potential impacts are likely to be within 10s of metres of the MOU and vessel operations.

The PMST Report (Operational Area) identifies that two threatened shark species; white shark and whale shark, may occur. The operational area is within a distribution BIA for white shark. The Recovery Plan for the White Shark (DSWEPC, 2015) does not identify noise as a threat.

The severity of the impacts to fish is assessed as **Level 2** and acceptable based on:

- The Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013a) does not identify noise impacts as a threat.
- avoidance behaviour may occur within the operational area, however, no habitats likely to support site-attached fish have been identified within the operational area.

The Operational Area overlaps with several Commonwealth and State managed fisheries, two of which (Southern and Eastern Scalefish and Shark Fishery, Southern Squid Jig Fishery) are known to actively fish within the Operational Area. Given that impacts to fish are evaluated to be minor, impacts to commercial fisheries are evaluated to cause minor localised distribution only, and are evaluated to be **Level 1**.

6.5.3.6 *Risk Event: Marine Turtles*

There is limited information on sea turtle hearing. Electro-physical studies have indicated that the best hearing range for marine turtles is in the range of 100-700 Hz.

There are currently no quantitative exposure guideline/criteria for marine turtles for shipping and continuous sound as Popper *et al.* (2014) found that there was insufficient data available to establish sound level thresholds 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 with the exception of TTS near (10s of metres) to the sound source, and masking at near, intermediate (hundreds of metres) and far (thousands of metres) distances and behaviour at near and intermediate distances from the sound source.

Finneran et al. (2017) presented revised thresholds for turtle non-impulsive PTS and TTS, considering frequency weighted SEL; PTS onset at received levels of 220 dB re:1 µPa^{2}s and TTS onset at received levels of 200 dB re:1 µPa^{2}s. These thresholds are not predicted to occur as a result on continuous sound sources generated by the activity.

Three marine turtle species may occur within the noise EMBA though no BIAs or habitat critical to the survival of the species were identified.

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.

The extent of the area of impact is predicted to be within the operational area for the duration of vessel activities. The severity is assessed as **Level 2** and acceptable based on:

- the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b) details that exposure to chronic (continuous) loud noise in the marine environment may lead to avoidance of important habitat and no marine turtle important habits are located within the area that maybe impacted.

- thresholds for turtle PTS and TTS Finneran et al. (2017) were not predicted to occur within the modelling resolution.
- avoidance behaviour may occur within the Operational Area where no marine turtle important habits are located.
- low numbers of marine turtles are predicted in the Operational Area and therefore impacts would be limited to a small number of individuals.

6.5.4 Consequence Evaluation – Impulsive Sound Sources

Impulsive sound will be generated by survey and positioning equipment throughout the activity.

Cooper Energy requested Jasco undertake a review of available literature regarding impulsive sound impacts to marine fauna and undertake an empirical estimation of underwater noise and effect from survey and positioning equipment. Ranges to thresholds were either taken from equivalent and comparable sources in literature or estimated using simple a spreading loss calculation and associated literature inputs. The results from this review are discussed in the context of the consequence evaluation below.

6.5.4.1 Fish

Potential impacts to fish depend on the presence of a swim bladder. Typically, site-attached and demersal fish have a swim bladder, whereas pelagic fish do not. As noise criteria for sharks does not currently exist, they are assessed as fish without swim bladders. Sound exposure guidelines for fish, fish eggs and larvae (including plankton) are provided by Popper et al. 2014 (Table 6-14).

Table 6-14 Criteria for seismic (impulsive) 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)	>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 (particle motion detection)	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 (primarily pressure detection)	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

Notes: Peak sound level (PK) dB re 1 µPa; SEL24h dB re 1µPa2·s. All criteria are presented as sound pressure, even for fish without swim bladders, since no data for particle motion exist. Relative risk (high, moderate, or low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F).

Based on available criteria from Popper et al (2014), potential impacts of survey and positioning equipment on fish have been assessed. Impulsive noises from survey equipment could result in physiological impacts to fish located within metres of the sound source. The likelihood of fish being close enough to the sound source for physiological impacts to occur is considered remote.

Behavioural impacts to fish from survey equipment noise will be limited to behavioural responses within metres of the noise source based on the qualitative criteria in Table 6-14. The proposed equipment operates at high frequencies and is thus unable to be heard by most fish, which further reduces the risk of impact (Ladich and Fay 2013).

The impact of masking is low at all ranges, because all sources have signals outside the hearing range of most fish in the region.

The PMST Report (Operational Area) identifies two threatened shark species; white shark and whale shark, may occur. The operational area is within a distribution BIA for white shark. The Recovery Plan for the White Shark (DSWEPC, 2015) does not identify noise as a threat.

Survey and positioning equipment will be used intermittently throughout the activity. Impacts will be limited to close proximity to the sound source and are not expected to result in impacts to species of conservation value. Subsequently, the impact consequence to fish is evaluated as **Level 1**.

The Operational Area overlaps with several Commonwealth and State managed fisheries, two of which (Southern and Eastern Scalefish and Shark Fishery, Southern Squid Jig Fishery) are known to actively fish within the Operational Area. Given that impacts to fish are evaluated to be negligible, impacts to commercial fisheries are not expected.

6.5.4.2 Marine mammals

Thresholds for PTS and TTS for marine mammals from impulsive sound are presented in NMFS, 2018, while behavioural exposure criteria are presented in NOAA 2019. These are summarised in Table 6-15.

Table 6-15 Unweighted SPL, SEL_{24h}, and PK thresholds for acoustic effects on marine mammals.

Hearing group	NOAA (2019)	NMFS (2018)			
	Behaviour	PTS onset thresholds* (received level)		TTS onset thresholds* (received level)	
	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	160	183	219	168	213
Mid-frequency cetaceans		185	230	170	224
High-frequency cetaceans		155	202	140	196
Otariid pinnipeds in water		203	232	188	226

* Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS and TTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered.
Lp–denotes sound pressure level period and has a reference value of 1 µPa.
Lpk, flat–peak sound pressure is flat weighted or unweighted and has a reference value of 1 µPa.
LE – denotes cumulative sound exposure over a 24-hour period and has a reference value of 1 µPa2s.
Subscripts indicate the designated marine mammal auditory weighting.

Impulsive sound from positioning equipment could reach the marine mammal behavioural threshold within 36 m. A nominal accumulation scenario for 1000 impulses results in an unweighted accumulated SEL significantly below thresholds for PTS and TTS in marine mammals. The measured PK at 30 m was 170 dB re 1 µPa is significantly below thresholds for PTS and TTS in marine mammals. Therefore, PTS and TTS thresholds (Table 6-15) are not predicted to be reached from positioning equipment.

The sound levels from MBES are shown in Table 6-6. The measurement study from Martin et al. (2012) indicates that the behavioural threshold (Table 6-15) could be exceeded within less than 10 m. PTS and TTS thresholds due to SEL are not predicted to be reached, considering that a measurement of along a trackline with a closest point of approach of 4 m did not result in accumulated unweighted levels higher than 121.5 dB re 1 µPa2s. PTS and TTS thresholds due to PK are not predicted to be reached, considering measurement of 170 dB re 1 µPa PK at 40 m. Therefore, considering both SEL and PK metrics, PTS and TTS thresholds (Table 6-15) are not predicted to be reached from MBES and subsequently SBES.

The sound levels from SSS are shown in Table 6-6. The measurement study Austin *et al.* (2013) indicates that the behavioural threshold (Table 6-15) could be exceeded within less than 130 m for marine mammals within the highly directional source output beam pattern. The reported per-pulse sound levels at 40 m are like those from the MBES, and as it isn't predicted to exceed either the PTS or TTS thresholds considering both SEL and PK metrics (Table 6-15), neither is the SSS. Additionally, the per-pulse peak pressure source level of the SSS is below the PK criteria threshold, therefore the criteria cannot be exceeded.

Survey and positioning equipment could cause masking of vocalisations of cetaceans due to the overlap in frequency range between signals and vocalisations. However, due to the limited propagation range of the relevant frequencies (higher frequencies attenuate rapidly), the range at which the impact could occur will be small, within hundreds of meters. The masking will apply to MF cetaceans for the positioning equipment, MBES, and SSS, with all signals above 2 kHz.

Based on this, PTS and TTS are not expected, and behaviour impacts will be limited to 130 m from the sound source (impact area of 0.05 km^2). All impacts from impulsive sound sources will be limited to the Operational Area (i.e. 2 km around subsea infrastructure). The PMST Report (Operational Area) identified:

- Four threatened whale species, including sei whale, blue whale, fin whale and southern right whale.
- The Operational Area overlaps a possible foraging BIA for pygmy blue whale and a known core range BIA for southern right whale.
- No threatened dolphin species presence, BIAs or habitats critical to the survival of species.
- No pinniped species presence, BIAs or habitats critical to the survival of a species.

As described in Section 6.5.3, a pygmy blue whale possible foraging area overlaps the Operational Area. The conservation management plan for the blue whale (Commonwealth of Australia, 2015c) details that anthropogenic noise in BIAs will be managed such that any blue whale continues to utilise the area without injury and is not displaced from a foraging area. The conservation plan identifies shipping and industrial noise as a threat that is classed as a minor consequence, which is defined as individuals are affected but not 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 Operational Area intersects the southern right whale known core range BIA, although activities at Basker-A and Basker-6 locations are outside of the BIA. 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 not 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.

Known presence of humpback whale, sei whale and fin whale is identified within the Operational Area. The conservation advice for humpback whale (TSSC, 2015e) described noise interference as a threat, specifically related to impulsive sound sources. Subsequent listing advice refers to noise interference as a current impact not threatening or preventing population growth (TSSC 2022). The fin and sei whales have conservation advice (TSSC, 2015f; TSSC, 2016g) which both identify anthropogenic noise as a threat with the conservation and management actions of:

- once the spatial and temporal distribution (including biologically important areas) of sei whales is further defined an assessment of the impacts of increasing anthropogenic noise (including from seismic surveys, port expansion, and coastal development) should be undertaken on this species.
- if required, additional management measures should be developed and implemented to ensure the ongoing recovery of sei whales.

The fin and sei whale's conservation advice (TSSC, 2015f; TSSC, 2016g) has a consequence rating for anthropogenic noise and acoustic disturbance as minor with the extent over which the threat may operate as moderate-large.

The severity of impacts to marine mammals from impulsive sound sources is assessed as **Level 2** and acceptable based on:

- Impulsive sound sources will be used intermittently for the duration of the activity (130 days).
- PTS and TTS impacts are not predicted.
- Behavioural impacts are predicted to be limited to within 130 m of the sound source, resulting in an impact area of 0.05 km^2. This is within the caution zone which will be implemented by vessels to avoid physical interaction (Table 6-3), hence behavioural disturbance is not predicted.
- The conservation management plan for the blue whale (Commonwealth of Australia, 2015c) details that:

- shipping and industrial noise are classed as a minor consequence for which the definition is: individuals are affected but no affect at a population level.
- "It is the high intensity signals with high peak pressures received at very short range that can cause acute impacts such as injury and death." As sound sources related to the activity are predicted to be below PTS and TTS criteria, no injury or death is predicted.

- Although low numbers of blue whales are predicted within the ensonification area, an adaptive management program, as detailed in Section 6.5.6, will be implemented to take into account seasonal fluctuations in presence in the Gippsland area.
- The conservation management plan for the southern right whale (DSEWPaC, 2012a) details that shipping and industrial noise, are classed as a minor consequence for which the definition is: individuals are affected but no affect at a population level.
- The conservation advice for humpback whale (TSSC, 2015e) described noise interference as a threat, specifically related to impulsive sound sources. Subsequent listing advice refers to noise interference as a current impact not threatening or preventing population growth (TSSC 2022). Impacts from continuous sound sources are expected to be limited.
- the fin and sei whale's conservation advice (TSSC, 2015f; TSSC, 2016g) has a consequence rating for anthropogenic noise and acoustic disturbance as minor with the extent over which the threat may operate as moderate-large.

6.5.4.3 Marine turtle

Popper et al. (2014) provided exposure guidelines for marine turtles exposed to seismic airgun noise, with an impact threshold criterion >207 dB PK (~ 191 dB RMS) or >210 dB SELcum for mortality and potential mortal injury to turtles.

The sound levels of the survey equipment and positioning equipment are below those associated with the PK criteria for injury beyond a few metres, and are low enough that SEL criteria will not be reached. Recoverable injury and TTS could occur within tens of metres applying the relative risk criteria from Popper et al, (2014). Behavioural changes, e.g. avoidance and diving, are only predicted for individuals near the source (high risk of behavioural impacts within tens of metres of source and moderate risk of behavioural impacts within hundreds of metres of the source).

Turtles are unlikely to experience masking even at close range to the source from all sources. This is in part because the sounds from most survey and positioning equipment are all outside of the hearing frequency range for turtles, which for green and loggerhead turtles is approximately 50–2000 Hz, with highest sensitivity to sounds between 200 and 400 Hz (Ridgway et al. 1969, Ketten and Bartol 2005, Bartol and Ketten 2006, Bartol 2008, Yudhana et al. 2010, Piniak et al. 2011, Lavender et al. 2012, 2014).

Three marine turtle species may occur within the Operational Area although no BIAs or habitat critical to the survival of the species were identified.

The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b) identifies noise interference as a threat to turtles. It details that acute noise (such as seismic) may result in avoidance of important habitats and in some situations physical damage to turtles

The extent of the area of impact is predicted to be within the operational area for the duration of vessel activities. The severity is assessed as **Level 2** and acceptable based on:

- the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b) details that acute noise (such as seismic) may result in avoidance of important habitats and in some situations physical damage to turtles.
- thresholds for turtle PTS and TTS Finneran et al. (2017) were not predicted to occur within the modelling resolution.
- avoidance behaviour may occur within the Operational Area where no marine turtle important habits are located.
- low numbers of marine turtles are predicted in the Operational Area and therefore impacts would be limited to a small number of individuals.

6.5.5 Cumulative Impacts

The activity is located in an area of busy petroleum activity, including the ATBA (to the west) and other Cooper Energy Gippsland assets such as those associated with the Sole and Patricia Baleen fields. It is also a busy shipping area, with a port located at Lakes Entrance that supports commercial and recreational fishing industries. It is expected that activities will be undertaken by ExxonMobil within the ATBA which overlap in timing with the BMG Closure Project (Phase 1) activities. The closest well location (Basker-A Manifold) is located approximately 10 km from the ATBA, and 23 km from the closest facility (Flounder) (Figure 4-10).

Noise sources typically active within the ATBA and across shipping routes will be continuous in nature, and similar in source level to a PSV. Underwater noise modelling undertaken by JASCO for a PSV under DP results in a noise behaviour EMBA of 8.62 km (Connell et al., 2021). It is therefore possible that the noise behaviour EMBA for vessels operating at the next closest oil and gas facility, or in transit across shipping routes could overlap with the BMG noise behaviour EMBA, however the overlap would be small and intermittent; cumulative impacts are not expected.

The BMG Closure Project (Phase 1) is temporary, with activities expected to take 130 days (single or split campaign). Cooper Energy will implement additional control measures, including monitoring, adaptive management where triggered, to lower the risk of cumulative impacts to acceptable levels.

6.5.6 Control Measures, ALARP and Acceptability Assessment

Table 6-16 provides a summary of the control measures and ALARP and Acceptability Assessment relevant to underwater sound emissions. A detailed assessment has been undertaken and as part of Cooper Energy's stakeholder engagement for the project Cooper Energy sought advice from AAD on measures implemented or considered by the AAD for voyages into sensitive areas. Suggestions from the AAD are noted in Table 6-16.

Table 6-16 Underwater sound emissions ALARP, Control Measures and Acceptability Assessment

Underwater sound emissions	
ALARP Decision Context and Justification	**ALARP Decision Context: Type A** Impacts from noise emissions are relatively well understood, however there is the potential for uncertainty in relation to the level of impact. Activities are well practised, and there are no conflicts with company values, no partner interests and no significant media interests. Because the potential impacts to marine mammals evaluated as **Level 2**, Cooper Energy believes ALARP Decision Context A should apply. **ALARP Decision Context: Type B** ALARP decision context B has been applied in relation to blue whales because there is a residual (low) risk in relation to TTS and behavioural disturbance to this species within a BIA. The particular action which triggers this decision context is Action A.2.3 from the blue whale CMP (Table 2-6). Further controls to manage these residual risks have been considered and several additional controls have been adopted. The adopted controls ensure the project environmental outcomes can be met and are not inconsistent with the objectives and relevant actions of the species recovery plan.
Control Measures	**Sources of good practice control measures**
C26: EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans	EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans describes strategies to ensure whales and dolphins are not harmed during offshore interactions with vessels and helicopters. 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 caution zone of 300 m, which will be increased to 500 m for the duration of the activity (refer to CM26) to enhance the buffer between whales and project vessels. Helicopters will adhere to EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans in relation to distances to cetaceans. *Impact addressed: TTS & Behavioural*

<table>
<tr><th colspan="2">Underwater sound emissions</th></tr>
<tr><td>C12: Planned Maintenance System</td><td>Power generation and propulsion systems on the MOU and vessels will be operated in accordance with manufacturer's instructions and ongoing maintenance to ensure efficient operation.
Impact addressed: TTS & Behavioural</td></tr>
<tr><th colspan="2">Additional controls adopted</th></tr>
<tr><td rowspan="3">C27: Marine Mammal Adaptive Management Measures</td><td>The impact assessment has shown the potential for interaction between whales and the activity, with some uncertainty around the likelihood if impacts. This uncertainty is addressed through the implementation adaptive management measures. The measures provide assurance of protecting all species, with particular focus on blue whales and the requirements set by the blue whale CMP Action A.2.3. These adopted measures (as detailed in Section 9.9) are applicable during the defined blue whale period::
- Exclude the use of DP MOU
- For DP vessels (IMR scopes):
▪ Dedicated marine mammal observer (MMO)
▪ DP prestart observation and shutdown triggers
▪ Conditions for operating DP at night
▪ Defined risk review triggers
Impact addressed: TTS & Behavioural</td></tr>
<tr><td>MOU, vessel bridge watch crew and helicopter crew will be provided with project inductions which will include whale ID and reporting guidelines.
Impact addressed: TTS & Behavioural</td></tr>
<tr><td>MOU, vessel bridge watch crew and helicopter crew will report observations daily (when in field).
This monitoring will be in place for the duration of the project, for all times of year. Based on prior campaigns, this approach will provide an indicator of any nearby or notable whale activity. This is considered the base level of monitoring and will be supplemented as detailed under adaptive management.</td></tr>
<tr><td>Impact Consequence</td><td>TTS & Behavioural impacts: Level 2 - Localized short-term impacts to species or habitats of recognized conservation value not affecting local ecosystem function; remedial, recovery work to land, or water systems over days/weeks.</td></tr>
<tr><td>Risk event Likelihood</td><td>TTS: Hypothetical (F) - Generally considered hypothetical or non-credible. Black Swan.
Behavioural: Unlikely (D) - Could occur during the activity.</td></tr>
<tr><td>Residual Risk Severity</td><td>Low</td></tr>
<tr><th colspan="2">Demonstration of Acceptability</th></tr>
<tr><td>Principles of ESD</td><td>Underwater sound emissions are evaluated as having Level 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.</td></tr>
<tr><td>Legislative and conventions</td><td>Noise emissions will be managed in accordance with legislative requirements.
Noise emissions will:
• not impact on the recovery of marine turtles as per the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017b).
• be managed such that any blue whale continues to utilise the area without injury and is not displaced from a foraging area (Commonwealth of Australia, 2015b).
• not impact the recovery of the blue whale as per the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b).
• not impact southern right whale established or emerging aggregation BIAs or the migration and resting on migration BIA (Commonwealth of Australia 2015b).
• not impact the recovery of the southern right whale as per the Conservation Management Plan for the Southern Right Whale (DSEWPaC, 2012a).
• not impact the recovery of the white shark as per the Recovery Plan for the White Shark (DSEWPaC, 2013a).</td></tr>
</table>

Underwater sound emissions	
	Actions from the Conservation Management Plan for the Blue Whale (Commonwealth of Australia 2015b) applicable to the activity in relation to assessing and addressing anthropogenic noise have been addressed as per: • assessing the effect of anthropogenic noise on blue whale behaviour. Section 6.5 assesses the effects of anthropogenic noise from the activity on blue whale behaviour. • anthropogenic noise in biologically important areas will be managed such that any blue whale continues to utilise the area without injury, and is not displaced from a foraging area. Section 6.5 demonstrates that the activity can be conducted in a manner that is consistent with the conservation management plan and will not result in injury or displacement of blue whales from a foraging BIA.
Internal context	Relevant management system processes adopted to implement and manage hazards to ALARP include: • Risk Management (MS03) • Health Safety and Environment Management (MS09) • Supply Chain and Procurement Management (MS11) Activities will be undertaken in accordance with the Implementation Strategy (Section 9).
External context	No stakeholder objections or claims have been received regarding underwater sound emissions. Cooper Energy sought advice from the AAD in relation to the management of impacts from noise. The AAD provided some suggestions which have been evaluated within the ALARP assessment process.
Acceptability Outcome	**Acceptable**

Additional Control Measures Considered	Related Risk Event	Benefit	Recognised Good Practice?	Sacrifice	Introduced Risks	Conclusion
Eliminate activity	TTS and Displacement of blue whales from vessel / industry noise. Rated as Minor consequence by DAWE (2015) and rated as L2 consequence and Low risk in relation to these project activities.	By not undertaking the activity, sound sources would be eliminated.	No	N/a	Decommissioning activities at BMG are required to go ahead; Cooper Energy has a commitment as titleholder to complete decommissioning activities (Section 2).	Reject. Rationale: The BMG wells were originally shut-in between 2009 and 2011. The wells require P&A to eliminate legacy risks. This project is necessary to eliminate those legacy risks. The legacy risks of not undertaking the activity are considered to be grossly disproportionate to the risk reduction achieved in relation to temporary operational subsea noise.
Eliminate use of DP MOU during defined periods when blue whales are more likely to occur.	As above	By avoiding periods when blue whales are more likely to occur, impacts to species of conservation significance during important behaviours can be eliminated (for the species of concern).	Not typical in this region or other regions where industry and shipping overlap possible blue whale foraging BIA to avoid certain times of year. This could become typical if Action A.2.3 is applied consistently across offshore industries. Stakeholder feedback: AAD advised they consider operational mitigations during Antarctic voyages such as avoidance of areas where large aggregations of cetaceans are well known or predictable. Though there are no known or predicted large aggregations of blue whales within the Gippsland region, blue whales are considered more likely to be in the region from April to June.	There is no window where all seasonal environmental sensitivities for all species can be completely avoided. The period for blue whale migration/possible foraging (Q2) through the Gippsland region does not overlap the current scheduled MOU activity at BMG (Q3 2023). The defined blue whale period can therefore be avoided without significant sacrifice.	Reduced schedule flexibility. Removes the option to bring the P&A activity forward in 2023 due to risk of overlap with blue whale timing in the region. Recent strict interpretation of Action A.2.3 and associated DAWE guidelines precludes other options.	Implement. Rationale: Risk elimination is preferred where practicable. This option is currently aligned to project schedule hence no significant schedule or cost impact. Costs are not grossly disproportionate to the risk reduction achieved in relation to temporary operational subsea noise. Integrated via C27 Marine Mammal Adaptive Management Measures
Eliminate use of DP IMR vessels defined periods when blue whales are more likely to occur.	As above	By avoiding sensitive periods, impacts to species of conservation significance during important behaviours can be eliminated (for the species of concern).	As above	There is no window where all seasonal environmental sensitivities for all species can be completely avoided. The period for blue whale migration/possible foraging (Q2) through the Gippsland region does overlap with the planed IMR scope. The IMR scope is a critical precursor to the P&A campaign. Delaying the campaign	Reduced schedule flexibility with knock-on effect on the P&A scope. Risk of delay past deadlines set under General Direction 824.	Reject. Rationale: Risk elimination is preferred where practicable; however IMR activities must be undertaken (with DP vessel) in the months prior to (to prepare for) the P&A activity and will therefore overlap period for possible blue whale foraging. Deferring the IMR activity could have knock on schedule impacts and encroach on deadlines set

Additional Control Measures Considered	Related Risk Event	Benefit	Recognised Good Practice?	Sacrifice	Introduced Risks	Conclusion
				would have a knock-on effect on the P&A scope.		under General Direction 824. The residual risks are low and can be managed via lower-level controls. The costs associated with this option are therefore considered to be grossly disproportionate to the risk reduction achieved in relation to temporary operational subsea noise.
Substitute DP MOU for Moored MOU on the basis of subsea noise profiles.	As above	By using a moored rig, sound emissions related to MOU DP would be reduced. The risks remain low.	Not typical for subsea noise profiles to drive MODU or vessel selection within shipping and industry sectors in this region or other regions where industry and shipping overlap possible foraging BIA.	Estimated additional costs >$40M (exclusive mob costs, additional time on location estimated as 40 days) and a potential delay to the BMG Closure Project program of >1 year accounting for project recycle, engineering and contracting. A moored MOU would require extra support from Anchor handing and supply vessels with DP and high bollard pull to set and retrieve anchors. Running and re-running moorings would be a frequent activity during this campaign given the number/location of wells to be plugged, and equipment picked up, during the campaign. Each move of a moored MOU adds 2-3 days to the campaign, increasing the overall duration of the campaign.	The use of a DP MOU eliminates risks such as impact to facilities from unplanned loss or drag of anchors. A DP MOU provides flexibility within the campaign to pick-up structures around the BMG field, which would otherwise require a separate DP construction vessel, increasing the overall vessel activity (and associated risks) in the area. A DP MOU provides a means to expedite source control response (survey, intervention, debris clearance, capping) in the event of an emergency.	Reject. Rationale: Risk from DP MOU eliminated at higher level.
Anchoring of vessels to hold position rather than use DP.	As above	By anchoring vessels, sound emissions related to vessel DP would be reduced. The risks remain low.	This is not feasible as the vessel on standby for the MOU must be able to react to an errant vessel, person overboard or other safety issue. The vessels cannot anchor when unloading or loading the MOU as the vessel needs to be able to hold station relative to the MOU.	Not feasible	Not feasible.	Reject. Rationale: Option not feasible.

Additional Control Measures Considered	Related Risk Event	Benefit	Recognised Good Practice?	Sacrifice	Introduced Risks	Conclusion
Limit power to thrusters of DP MOU / vessels to reduce noise contours.	As above	Limiting thruster power may reduce the noise contours though would not eliminate them. Risks expected to remain Low.	Thruster power is determined by safety limits and operational requirements. Thruster levels are optimised to operating modes and conditions. It is not safe to adjust thruster power outside of operationally defined ranges, and therefore the control is not selected.	N/a	N/a	Reject. Rationale: Risk from DP MOU addressed at higher level.
DP MOU / Vessel noise reduction in design (DNV Silent notation).	As above	MOU and Vessel design can reduce noise.	Stakeholder feedback: AAD advised their new state of the art survey/ice breaker vessel Nuyina which will operate in the Antarctic has been designed to reduce noise and vibration. The vessel has been assigned DNV Silent R notation equivalence at 8 knots electric propulsion for science acoustic work. Currently not typical for industry. A review of industry vessels (MOU's, PSVs, CSV's) operating inside and outside of Australian waters has not identified any vessels assigned the DNV Silent notation.	Given the current absence of industry vessels with Silent notation, this measure is not considered to be feasible for the project.	N/a	Reject. Rationale: Risk from DP MOU eliminated at higher level. Not considered feasible for the IMR component of the project.
DP Shutdown Zones for DP MOU.	As above	Shutting down MOU DP could reduce impacts from subsea noise. Risks would remain Low.	Not typical for subsea noise profiles to influence MOU DP use. Not safe practice to switch off DP whilst on well.	Cost associated with shutting down DP, requiring suspension of program. Potential cost >$10M	Shutting down the MOU may take a number of days; it would introduce additional safety and environmental hazards, including and not limited to: • impairment of safety and environmental critical equipment on the MOU. • dropped or swinging objects from crane or derrick resulting in potential MOU stability impairment. • inability to maintain well integrity with possible loss of containment from a well. Potential also exists for escalation to other more serious outcome events and medical emergency	Reject. Rationale: risk from DP MOU addressed at higher level.

Additional Control Measures Considered	Related Risk Event	Benefit	Recognised Good Practice?	Sacrifice	Introduced Risks	Conclusion
					involving the need to treat and evacuate injured parties from the installation and implement oil spill response. As a result, the use of shutdown zones for the MOU is not considered feasible or practicable.	
DP MOU disconnect and move away process.	As above	Disconnecting and moving away DP MOU if a blue whale is sighted could reduce impacts from subsea noise. Risks would remain Low.	Not typical for subsea noise profiles to influence MOU DP use. Good practice to avoid disconnecting from the well unnecessarily.	Cost to the project from downtime if whales are nearby. Depending on time away from the well, the potential cost could easily exceed $10M.	Potential to jeopardise the primary objectives of the campaign. Low reliability at project operational level.	Reject. Rationale: risk from DP MOU addressed at higher level.
DP Shutdown Zones for DP vessels.	As above	Shutting down Vessel DP could reduce impacts from subsea noise. Shutting down DP Vessel can be done well within the exposure time for TTS onset and also serves to reduce the risk of displacement if whales are foraging in the vicinity. Risks would remain Low.	Not typically applied to DP vessels. Typically applied to activities that generate impulsive noise such as piling and seismic survey. During consultation, AAD noted use of shutdown zones for explosive use (during wharf construction) in Antarctica.	Cost associated with shutting down DP, requiring suspension of program. Potential cost >$10K.	Retrieval of subsea equipment (e.g. ROV) required prior to DP shutdown. Increased frequency of handling through the splash zone and on deck increases personnel H/S risk exposure. This is considered manageable through existing systems for control of work. Good reliability at project operational level.	Implement Rationale: eliminates risk of TTS and reduces risk of displacement. Costs are not grossly disproportionate to the risk reduction achieved in relation to temporary operational subsea noise. Integrated via C27 Marine Mammal Adaptive Management Measures
Deploy bubble curtains around DP MOU and / or vessels.	As above	Bubble curtains are sometimes utilised within offshore construction projects which involve piling or detonation of explosives. The bubble curtain (perforated hose) is deployed to the seabed and encompasses the noise source; this obscures noise transmission, resulting in a reduction of received sound levels to receptors outside of the bubble curtain. Circa 15 dB noise attenuation has been reported for impulsive noise from piling; efficacy is dependent on various factors. Risks would remain Low.	Bubble curtains were raised as an idea during project ALARP workshops and also by the AAD during stakeholder consultation. No known examples of bubble curtains being used as mitigation for DP vessels.	Not considered feasible.	Discussions with technology providers indicates the deployment of bubble curtains at BMG presents a number of technical challenges that are currently insurmountable. The challenges include: • Water depth. The maximum working depth of bubble curtains is typically <100m. Providing oil-free air to the seabed at BMG would require a large quantity of large diesel-run air compressors. At least one additional dedicated DP support vessel would likely be required for these compressors.	Reject Rationale: Not considered feasible for the project. Note - risk from MOU subsea noise addressed at higher level.

Additional Control Measures Considered	Related Risk Event	Benefit	Recognised Good Practice?	Sacrifice	Introduced Risks	Conclusion
					• Currents. Bubble curtains are drastically impacted by currents. Current speeds and directional shifts with wind and tide at the BMG would result in bubble curtains being distorted and ineffective by the time bubbles rise from the seabed to surface. • Alternate options such as the deployment of hoses on MOU pontoons at thruster locations, or offset on buoys present SIMOPS and safety risks including congestion of the MOU safety zone and potential interference with/from thrusters. As a result, the use of bubble curtains is not considered effective, feasible or practicable.	
DP Vessel Pre-activity Survey (initial arrival).	As above	Increased confidence no foraging blue whales in the vicinity which could be displaced upon DP start. Survey undertaken with means appropriate to assure across the TTS and behavioural displacement area. Risks would remain Low.	Not typically applied to DP vessels. Typically applied to activities that generate impulsive noise such as piling and seismic survey. During consultation, AAD noted use of survey prior to explosive use (during wharf construction) in Antarctica.	Costs associated with pre-activity survey in the order of $50K accounting for vessel time, personnel and / or aerial survey costs.	HSE risks associated with aerial survey (can be managed via existing control of work processes). Weather or visibility downtime risk (can be mitigated via different survey options). Good reliability at the project operational level with multiple options for survey.	Implement Rationale: reduces risk of displacement. Costs are not grossly disproportionate to the risk reduction achieved in relation to temporary operational subsea noise. Integrated via C27 Marine Mammal Adaptive Management Measures
Dedicated daily aerial surveys during IMR campaign	As above	Increased confidence no foraging blue whales in the vicinity which could be injured or displaced. Risks would remain Low	Not typically applied to DP vessels. Aerial survey typically applied to activities that generate impulsive noise such as seismic survey.	Daily aerial surveys could double the cost of the IMR campaign.	HSE risks associated with aerial survey (can be managed via existing control of work processes). Moderate reliability at the project operational level.	Reject Rationale: The measure is not typical practice for this type of activity and does not result in a discernible reduction in risk, whilst adding significant cost and additional operational HSEC risks. The costs/risks are grossly disproportionate to the

Additional Control Measures Considered	Related Risk Event	Benefit	Recognised Good Practice?	Sacrifice	Introduced Risks	Conclusion
						benefit and therefore the control is not selected.
Opportunistic monitoring from project vessels and helicopters.	As above	Increased confidence no foraging blue whales in the vicinity which could be injured or displaced. Risks would remain Low.	Yes. Opportunistic monitoring is typically integrated into offshore industry operations including from vessels and helicopters (where used for crew changes).	Costs associated with inducting crew accounted for in planning.	No introduced risks. Good reliability at the project operational level.	Implement Rationale: supports elimination of TTS risk and reduces risk of displacement. Costs are not grossly disproportionate to the risk reduction achieved in relation to temporary operational subsea noise. Integrated via C26: EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans, and C27 Marine Mammal Adaptive Management Measures.
Dedicated MMO on IMR vessel	As above	Increased confidence no foraging blue whales in the vicinity which could be injured or displaced. Higher confidence in identifying whales and whale behaviour compared to opportunistic monitoring alone. Risks would remain Low.	Yes. Though not typically applied in industry in this region for vessel activities there are examples of this control being applied to vessel activities elsewhere in known foraging areas / where important behaviours are known to occur. AAD advised in relation to rock blasting activities (wharf construction) in the Antarctic, dedicated MMO's were used.	Additional cost of MMO mob/demob and time offshore accounted for in planning.	No introduced risks. Good reliability at the project operational level.	Implement. Rationale: supports elimination of TTS risk and reduces risk of displacement. Costs are not grossly disproportionate to the risk reduction achieved in relation to temporary operational subsea noise. Integrated via C27 Marine Mammal Adaptive Management Measures.
Drone surveillance from vessel	As above	May provide slight increase in visibility beyond nominal MMO viewing platform height for the duration of drone flight. This could provide slight increased confidence no foraging blue whales in the vicinity which could be injured or displaced. Risks would remain Low.	Not for this activity type. Some examples of drone use nearshore and offshore particularly for scientific study, though weather sensitive, and not for sustained periods.	Additional cost of drone hire/purchase and pilot for the duration of the campaign estimated circa $60K.	Dropped object risks. Risks of loss of equipment. Not considered reliable at the operational level for this activity.	Reject Rationale: The measure is not typical practice for this type of activity and does not result in a discernible reduction in risk, whilst adding cost and additional operational HSEC risks. The costs/risks are grossly disproportionate to the risk reduction achieved in relation to temporary operational subsea noise.
Monitor oceanographic precursors (early warning system)	As above	There are oceanographic and biological precursors such as SST, eddies and primary production which may provide an indication of increased secondary production	Not typically applied in offshore industries. Primary productivity measurements are not an accurate pre-cursor to feeding activity. There can be a significant lag between peaks in	Administrative costs of monitoring and interpreting environmental precursors estimated circa $50K.	Reliability is likely to be low, which could lead to many false positives with significant cost and schedule impact to the project.	Reject Rationale: The measure is not typical practice for this type of activity and does not result in a discernible reduction in risk. The option adds cost and there

Additional Control Measures Considered	Related Risk Event	Benefit	Recognised Good Practice?	Sacrifice	Introduced Risks	Conclusion
		(including krill), which may then be conducive to successful foraging (e.g. Murphy *et al.* 2017). The of benefit of this early warning system is dependent on reliability of these precursors as indicators of blue whale foraging; currently, reliability is likely to be low, which could lead to many false positives. Risks would remain Low.	Chl-A levels and peaks in krill presence. Other factors determine presence of foraging marine mammals aside from prey levels.			is limited confidence in operational reliability for this application. The costs are grossly disproportionate to the risk reduction achieved in relation to temporary operational subsea noise.
Satellite imagery	As above	Satellite imagery can be used to gather oceanographic and biological information to support the understanding of presence of marine mammals in the area. Risks would remain Low.	Not typically applied in offshore industries. Sourcing and interrogating satellite imagery is possible, however at the operational level is not considered reliable.	Administrative costs of monitoring and interpreting satellite images.	Reliability is likely to be low with limited additional benefit relative to accepted controls.	Reject Rationale: The measure is not typical practice for this type of activity and does not result in a discernible reduction in risk. The option adds cost and there is limited confidence in operational reliability for this application. The costs are grossly disproportionate to the risk reduction achieved in relation to temporary operational subsea noise.
Infra-red systems	As above	Infra-red (IR) systems could enhance the ability of MMOs to visually detect the presence of foraging whales. Risks would remain Low.	Infra-red systems are not available as a real-time monitoring tool for operations and have the following limitations: • Poor performance of the system in sea states greater than Beaufort Sea State 4 (due to the inability to adequately stabilise the camera) (Verfuss *et al*. 2018; Smith et al. 2020). • Conditions such as fog, drizzle, rain limit detections to be made using IR (Verfuss *et al.* 2018). Detection range for large baleen whales is 1 to 3 km.	Additional cost of IR tech hire/purchase and operators for the duration of the campaign estimated circa $100K.	Reliability is likely to be low with limited additional benefit relative to accepted controls.	Reject Rationale: The measure is not typical practice for this type of activity and does not result in a discernible reduction in risk. The option adds cost and there is limited confidence in operational reliability for this application. The costs are grossly disproportionate to the risk reduction achieved in relation to temporary operational subsea noise.
Passive Acoustic monitoring	As above	PAM can be used to detect marine mammal calls, and	Not typical for offshore vessel activities. Likely to be some	Additional cost of PAM tech hire/purchase and operators	Reliability considered lower than direct observations, with limited	Reject

Additional Control Measures Considered	Related Risk Event	Benefit	Recognised Good Practice?	Sacrifice	Introduced Risks	Conclusion
		support sightings made by MMO. Feedback from AAD indicated PAM was utilised during rock blasting activities in the Antarctic to verify subsea noise levels; if noise levels were higher than anticipated then explosive charges could be reduced.	interference from vessel noise at close range. Not safe to adjust vessel DP thrust on the basis of subsea noise profiles; operational safety considerations take precedence.	for the duration of the campaign estimated circa $100K.	additional benefit relative to accepted controls.	Rationale: The measure is not typical practice for this type of activity and does not result in a discernible reduction in risk. The option adds cost and there is limited confidence in operational reliability for this application. The costs are grossly disproportionate to the risk reduction achieved in relation to temporary operational subsea noise.

Table 6-17 Underwater sound emissions extended ALARP Assessment for possible blue whale foraging period

6.6 Introduction, Establishment and Spread of IMS

6.6.1 Cause of Aspect

Invasive marine species (IMS) are marine plants or animals that have been introduced into a region beyond their natural range and can survive, reproduce and establish founder populations. Species of concern are those that are not native and are likely to survive and establish in the region; and are able to spread by human mediated or natural means. Factors that dictate their survival and invasive capabilities depends on environmental factors such as water temperature, depth, salinity, nutrient levels and habitat type.

IMS have historically been translocated and introduced around Australia by a variety of natural and anthropogenic means. In relation to the BMG Closure activities, the introduction, establishment and spread of IMS could occur as/within a number of different pathways and risk events (Table 6-18).

Table 6-18. IMS risk events: pathways for potential introduction, establishment and spread of IMS.

Risk event	Pathway to introduction	Means of establishment	Mechanisms of spreading	Campaign context
IMS is transferred into the field, becomes established and spreads	IMS within biofouling on MOU or vessels dislodged to the seabed IMS within biofouling on equipment that is routinely submerged in water, and which is dislodged to the seabed	Suitable habitat and conditions available for IMS in field.	Once established may spread by itself if conditions are suitable. In field equipment may provide connectivity allowing spread across infrastructure. Other anthropogenic influence (e.g. trawling) could spread established IMS within and outside of the field.	Section 6.6.1.1
IMS is transferred between vessels, establishes on vessels and is spread to other areas (e.g. ports)	Discharge of ballast water containing IMS. Cross contamination of IMS between vessels and the MOU	Suitable habitat and conditions available for IMS on vessels and within ballast and seawater systems.	IMS spreads between ports and other facilities via vessels acting as a vector.	Section 6.6.1.2
IMS is transferred out of the field, becomes established at locations inside or outside the region and spreads.	Already established populations of IMS within the offshore field via natural or anthropogenic influences are recovered with equipment and dislodged whilst being transferred to shore.	Suitable habitat and conditions available for IMS at shoreside facilities.	Once established may spread by itself if conditions are suitable. May become established on structures at ports, and from there spread to vessels which then become a vector for the spread of IMS.	Section 6.6.1.2

6.6.1.1 IMS associated with MOU, vessels and project equipment

Since the DAWR (now DAWE) introduction of mandatory ballast water regulations, where ballast water must be exchanged outside territorial sea (12 nautical miles off the Australian coast, including islands), risk of invasive marine species (IMS) from international shipping has been greatly reduced. Therefore, the risk of IMS introduction into territorial waters from international shipping should be negligible to low. Domestic ships that discharge or exchange water at any Australian port has variable risk ratings depending on where the ballast water was last acquired.

DAWR (2017) suggest that biofouling has been responsible for more foreign marine introductions than ballast water, and provides guidelines as to the management of IMS from biofouling (Marine Pest Sectoral committee 2009). For the BMG closure activities, the MOU, vessels and equipment may be sourced internationally and domestically. During the activity, vessels will transit between the MOU and domestic ports. Each vessel has the potential to host IMS. There will be periods where the MOU and vessels work in close proximity, where there may be potential for IMS to translocate from one vessel to another, for example, through ballast exchange, or dislodged biofouling, if vessels are not managed appropriately.

6.6.1.2 IMS already established in the region

A variety of IMS has established within ports around Australia; even within the same region, different ports typically host a different mix of established IMS (https://www.marinepests.gov.au/pests/map, Cooper Energy IMS Risk Management Protocol, Australian Government 2019; Parks Victoria 2019). Ports are often suitable for establishment of IMS because they are regularly exposed to IMS from many different vessels that may lay-up for long periods of time. Ports also typically have shallow areas and hard structures which provide suitable substrate for establishment. IMS can be translocated from a port in either vessel ballast or as biofouling (refer above).

Outside of port areas and coastal areas, documented IMS within the Bass Strait include the New Zealand screw shell (*Maoricolpus roseus*). The NZ screw shell was thought to have been introduced from NZ and spread via fishing activity. Some oil and gas infrastructure in the region overlaps NZ screw shell beds (Cooper Energy IMS Risk Management Protocol). No screw shell, or any other IMS have ever been identified at the BMG facilities. The most recent survey utilising high-definition imagery was analysed extensively; no IMS were identified (Ierodiaconou et al 2021). Consequently, the BMG field and infrastructure is not currently considered a potential source of IMS.

Prior to and during operations the Cooper Energy IMS Risk Management Protocol will be implemented for all vessels, MOU and submersible equipment, and will consider all regions visited by the facilities (international and domestic). Further information on the risk management process is provided within Section 9.8.

6.6.2 Predicted Environmental Impact (consequence)

The known and potential impacts of IMS introduction (assuming their survival, colonisation and spread) include:

- Reduction in native marine species diversity and abundance;
- Displacement of native marine species;
- Socio-economic impacts on commercial fisheries; and
- Changes to conservation values of protected areas.

The introduction of an IMS can have a range of impacts on the receiving environment and can potentially alter the ecosystem dynamics of an area. Due to the complexity of ecosystems and level of interactions between and amongst biotic and abiotic receptors; there is no sure way to predict how an individual species may interact with a foreign environment.

Once an IMS is established, its level of invasiveness and ecosystem damage is determined by a range of factors detailed above. IMS have the potential to change ecosystem dynamics by competing for natural resources, reducing the availability of natural resources, predation, change natural cycling processes, segregation of habitat, spread of viruses, change in water quality, producing toxic chemicals, disturb, injure or kill vital ecosystem organisms (ecosystem engineers and keystone species), change surrounding ecosystems, change conservation values of protected areas and create new habitats.

IMS have proven economically damaging to areas where they have been introduced and established, particularly as IMS are difficult to eradicate from areas once established (Hewitt et al. 2002). If the introduction is captured early, eradication may be effective but is likely to be expensive, disruptive and, depending on the method of eradication, harmful to other local marine life. It has been found that highly disturbed nearshore environments (such as marinas) are more susceptible to colonisation than open-water environments, where the number of dilutions and the degree of dispersal are high (Paulay et al. 2002).

IMS can have a primary and/or secondary impact on socio economic receptors. Primary impacts include direct damage to vessels, equipment and infrastructure which may then cause flow on affects and lead to a reduction in efficiency, productivity and profit. The presence of fouling organisms within a marine environment is likely to have the same or similar impacts to socio-economic receptors.

Secondarily, ecological impacts associated with IMS introduction may have an impact to socio economic receptors through reduction in ecological values. Marine pest species can deplete fishing grounds and aquaculture stock, with between 10% and 40% of Australia's fishing industry being potentially vulnerable to marine pest incursion. For example, the introduction of the Northern Pacific Sea star (*Asterias amurensis*) in Victorian and Tasmanian waters was linked to a decline in scallop fisheries (DSE 2004).

Predicted impacts from IMS if introduced to the operational area could affect marine fauna, benthic habitats, and commercial fisheries that may utilise BMG operational area and protected marine areas present in the wider region). No protected marine areas, habitats or communities were identified in or near the operational area.

If IMS were transferred between the MOU and support vessels, or vice-versa whilst working within the operational area, IMS could be translocated and introduced to other local areas beyond the operational area; ports and other offshore industry could potentially be exposed through both ballast and biofouling. If an IMS is spread, there is the potential for local impacts to receptors where IMS has become established, including benthic communities, listed marine fish species, coastal and offshore industry. These potential impacts beyond the operational area drive a consequence **Level 4**.

6.6.3 Likelihood Evaluation

Any IMS introduced to the Operational area would be expected to remain fragmented and isolated, and only within the vicinity of the wells (i.e. it would not be able to propagate to nearshore environments. The chances of successful colonisation inside the operational area are considered small given:

- The nature of the benthic habitats near the operational area where seabed contact is made (i.e. predominantly bare silt and sands with patchy occurrences of hard substrate, and outside of coastal waters where the risk of IMS establishment is considered greatest (BRS, 2007).
- The Operational Area is in waters 135 - 270 m deep and therefore very low light levels are expected at the seabed; the depth and associated lack of light rules out establishment of a lot of the more common IMS.
- The well locations are geographically isolated from other subsea or surface infrastructure which might be suitable for colonisation.

The likelihood of IMS becoming established within the operational area as a result of BMG activities is considered **Remote**.

The transfer of IMS between vessels within the operational, and which may then become established elsewhere is also considered here. A number of factors reduce the chance of IMS translocating between vessel:

- Vessels will come alongside the MOU for materials transfers; time alongside is relatively short, and managed via DP; there is typically no or minimal contact between vessels and MOU, risking damage.
- The offshore environment within the Gippsland region is highly dispersive, and vessels will be frequently moving; these conditions are not typically conducive to the establishment of marine organisms onto a new surface.
- There are a number of international and national management measures which already manage

The likelihood of the transfer of IMS between vessels within the operational, and which may then become established elsewhere, as a result of the BMG activities is considered **Remote**.

6.6.4 Control Measures, ALARP and Acceptability Assessment

Table 6-19 provides a summary of the control measures and ALARP and Acceptability Assessment relevant to introduction, establishment and spread of IMS.

Table 6-19 Introduction, establishment and spread of IMS Control Measures, ALARP and Acceptability Assessment

Introduction, establishment and spread of IMS	
ALARP Decision Context and Justification	**ALARP Decision Context: B** The introduction, establishment and spread of IMS has been assigned a Level 4 consequence; the likelihood of this consequence occurring is considered Remote.

Introduction, establishment and spread of IMS	
	The causes resulting in an introduction of IMS from a planned release of ballast water or vessel or equipment biofouling are well understood and effectively managed by international, national and State requirements and industry guidance. Cooper Energy is experienced in industry requirements and their operational implementation through their existing ongoing operations. No objections or concerns were raised during stakeholder consultation regarding this activity or its potential impacts and risks. Based on a **Moderate risk severity**, Cooper Energy believes **ALARP Decision Context B** should apply.
Control Measure	**Source of good practice control measures**
C20: Cooper Energy IMS Risk Management Protocol (CMS-EN-PRO-0002)	The National biofouling management guidelines for the petroleum production and exploration industry (DAFF 2009) recommend a biofouling risk assessment is undertaken for vessels and MODUs and, where necessary, conducting in water inspection, cleaning and antifouling renewal. These guidelines should also be read in conjunction with the Anti-fouling and In-water Cleaning Guidelines (DoA 2015). In line with these recommendations Cooper Energy uses an IMS Risk Assessment to evaluate IMS risks. Prior to and during operations the Cooper Energy IMS Risk Management Protocol will be implemented for all vessels, MOU and submersible equipment, and will consider all regions visited by the facilities (international and domestic). The Cooper Energy IMS Risk Management Protocol has been prepared to align with: • Advice from the Victorian Government Marine Biosecurity Section. • National biofouling management guidelines for the petroleum production and exploration industry (DAFF 2009) • Guidelines for the control and management of a ships' biofouling to minimise the transfer of invasive aquatic species (IMO Biofouling Guidelines; IMO 2011). • Reducing marine pest biosecurity risks through good practice management Information paper (NOPSEMA 2020) Further information on the Cooper Energy IMS Risk Assessment is provided within Section 9.8.
Consequence	**Level 4:** Extensive medium to long-term impact on highly valued ecosystems, species populations or habitats.
Likelihood	**Remote:** A freak combination of factors would be required for an occurrence. Not expected to occur during the activity. Occur in exceptional circumstances.
Residual Risk Severity	Moderate
Demonstration of Acceptability	
Principles of ESD	Introduction, establishment and spread of IMS is evaluated as having **Level 4** consequence which has the potential to result in serious or irreversible environmental damage. Due to the lack of hard substrate and depths present at the Operational Area it is very unlikely that an IMS would be able to establish. There is currently no documented evidence of an IMS establishing in deeper offshore waters. BRS (2007) estimated the probability of an IMS incursion as 2% chance at 24 nm, which was also based on a 50 m deep contour. The Operational Area is 50 km from shore, and in 135 m – 270 m water depth, further decreasing the probability of incursion.
Legislative and conventions	The control measures proposed to manage this risk are meet the following requirements: • *Biosecurity Act 2015* (Cth) - Chapter 5, Part 3 (Management of discharge of ballast water) & Chapter 4 (Managing biosecurity risks) • International Convention for the Control and Management of Ships' Ballast Water and Sediments 2004 (the Ballast Water Management Convention) • Protection of the Sea (Harmful Anti-fouling Systems) Act 2006 • AMSA Marine Order 98: Marine Pollution Prevention - Anti-fouling Systems. • *Environment Protection Act 1970* (Vic) • Environment Protection (Ships Ballast Water) Regulations 2006 • Australian Ballast Water Management Requirements (DAWR 2017)

Introduction, establishment and spread of IMS	
	• Guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species (IMO 2011) • National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Commonwealth of Australia 2009)
Internal context	The environmental controls proposed reflects the Cooper Energy HSEC Policy goals of utilising best practice and standards to eliminate or minimise impacts and risks to the environment and community to a level which is ALARP. Relevant management system processes adopted to implement and manage hazards to ALARP include: • MS03 – Risk Management • MS09 - Health, Safety and Environment Management • MS11 – Supply Chain and Procurement Management
External context	No stakeholder objections or claims have been received regarding IMS.
Acceptability Outcome	**Acceptable**

6.7 Accidental Hydrocarbon Release

Accidental hydrocarbon releases to the environment could include both gas and liquid hydrocarbons.

There are infinite variations in the nature and scale of a spill from these activities. This section deals with the higher order (most severe) spill scenarios. Minor loss of containment scenarios and loss of containment from subsea infrastructure are assessed in Table 6-3.

6.7.1 Cause of Aspect

Activities associated with the BMG Closure Project (Phase 1) have the potential to result in an accidental release of hydrocarbons to the marine environment. Guidance on the identification of worst-case credible spills scenarios is given in the Australian Maritime Authority's (AMSA) Technical guidelines for preparing contingency plans for Marine and Coastal Facilities (AMSA, 2015) and SPE Technical Report (Calculation of Worst-Case Discharge (WCD), September 2016). A range of credible accidental release scenarios up to and including worst case scenario loss of well control (LOWC) are described in Table 6-20. The release scenarios do not cover all potential permutations (which are infinite) and should be considered indicative.

Table 6-20 Accidental Hydrocarbon Release Types, Causes and Estimated Volumes

Accidental Hydrocarbon Release	Cause of Aspect	Fluid Type and Volume	Release location	Source control response
Accidental release scenarios from infrastructures during Phase 1 Activities				
Subsea leak from Xmas tree	Dropped object leading to minor leak from Xmas tree before abandonment barriers in place	Gas, condensate or light crude. Approx. 100 litres/day	Basker or Manta wells.	On-site response utilising project equipment and personnel.
Subsea release from riser (auto shut-in)	MOU drift off leading to emergency disconnect. Shear of riser subsea (auto shut-in as planned) volume of well fluids released equivalent to riser.	Mix of well fluids 46.5 m^3	Basker or Manta wells.	On-site response utilising project equipment and personnel.
Release from well (manual shut-in)	MOU drift off leading to shear of riser subsea (auto shut-in failure – manual shut-in with ROV) LOWC through pressure control equipment at seabed for 24 – 48 hours.	Mix of well fluids 46.5 m^3 plus 48 hours of well release (restricted flow, nominal 4,000 m^3 condensate or light crude released)	Basker or Manta wells.	On-site response utilising project equipment and personnel. Off-site support as required e.g. debris clearance.
LOWC - Topsides	Hydrostatic barrier failure inside the well prior to or during the setting of downhole plugs (riser in place). Well fluids escaping at surface via the riser and well fluids handling package. Fluids captured and processed via well clean-up package or diverted overboard if necessary, for safety of personnel. Kick resolved via choke/kill, well controlled inside 1 hr. If release cannot be controlled, MOU moves off ensuring safety of personnel on board. Additional failures within subsea pressure control equipment could result in	Mix of well fluids 100 m^3	Basker or Manta wells	On-site response utilising project equipment and personnel.

Accidental Hydrocarbon Release	Cause of Aspect	Fluid Type and Volume	Release location	Source control response
	protracted subsea release (see LOWC subsea).			
LOWC – Subsea	MOU drift or move off leading to uncontrolled disconnect from the well (auto shut-in failure, manual shut-in with ROV fails); extended LOWC at seabed to the marine environment. To determine the potential causes and parameters for LOWC, Cooper Energy undertook a review of worst case discharges across all wells included in this EP (BMG-RE-TFN-0002). The assessment was aligned to SPE 2016 guidelines for determining worst case discharge. A series of screening exercises identified two wells with comparable worst-case discharges: Basker-2 (B2) and Basker-6ST1 (B6). Some of the key outcomes were: • Credible WCD scenario for both wells involved hydrocarbon flow from the reservoir up existing 4-1/2" completion out of the well (unconstrained). Pressure control equipment (BOP) is presumed to have failed. • Initial flow rate for B6 is predicted to be higher than B2, although overall cumulative volume is slightly less at B6. • Both wells reach a point before 100 days where continuous flow stops and an intermittent flow may continue as the wells cycle through depletion and recharge. • Some oil properties for B6 were absent, but could be derived from a combination of B2 oil assay data and B6 oil fingerprint analysis. The properties that were available for B6 crude indicated it is has a higher % wax and is potentially more persistent than B2. • B2 is located closer to the shore and in shallower water than B6, therefore provides a worst-case location. Based on this, a single composite case was derived (Figure 6-16), which combined the most conservative elements of the B2 and B6 Worst Case Discharge (BMG-EN-TFN-003). By modelling this composite release from the B2 location, the modelling scenario is considered	Subsea release of 77,339 m^3 of Basker crude over 120 days	Basker-2 Well	Initial onsite response. Extensive off-site support.

Accidental Hydrocarbon Release	Cause of Aspect	Fluid Type and Volume	Release location	Source control response
	representative of a worst-case release from either well. Modelling simulation length was 180 days, extending across multiple seasons. A release duration of 120 days was applied; this exceeds the predicted time to kill the well via relief well drilling, and therefore provides additional conservatism for response planning (Section 7.4.2).			
Vessel releases				
Hydraulic line failure	Refer Table 6-3.	1 m^3 of hydraulic fluid	Spill to containment, deck or ocean.	Onsite response.
Release of fuel during bunkering	Refer Table 6-3.	50 m^3 of MDO	Spill to containment, deck or ocean.	Onsite response.
LOC – Passing or visiting Vessel Collision with support vessel	Navigational error or loss of DP resulting in a high energy collision between a support vessel and another project or third-party vessel could result in hull damage and fuel tank rupture. For the impact assessment the vessel largest fuel tank volume was used as recommended by AMSA's guideline for indicative maximum credible spill volumes for other, non-oil tanker, vessel collision (AMSA 2015). This was assessed to be 250 m^3 of marine diesel oil (MDO) or marine gas oil (MGO).	250 m^3 of MDO	Surface release within the BMG operational area.	Vessel and off-site resources.
LOC – Passing or Vessel Collision with MOU	Navigational error or loss of DP resulting in a high energy collision between the MOU and a support or third-party vessel could result in hull damage allowing water ingress. Damage will mainly be in the outer hull, which is typically ballast or other water tanks. Fuel tanks could be at risk of impact. For the impact assessment the vessel largest fuel tank volume was used as recommended by AMSA's guideline for indicative maximum credible spill volumes for other, non-oil tanker, vessel collision (AMSA 2015). This was assessed to be 500 m^3 of marine diesel oil (MDO) or marine gas oil (MGO). The release was modelled to occur over a 5-hour period, which is considered to be a short (and therefore conservative) approach. Vessel grounding was not assessed as a credible risk as the water depth in the Operational Area is 135 m – 270 m.	500 m^3 of MDO	Surface release within the BMG operational area. Modelling location is the Manta-2A well location (closest well to shore in the BMG Field)	Vessel and off-site resources.

Accidental Hydrocarbon Release	Cause of Aspect	Fluid Type and Volume	Release location	Source control response
	There are no emergent features within the Operational Area.			
Other				
Helicopter crash / ditch in operational area	Equipment malfunction leading to helicopter ditching into ocean. Fuel tank compromised during landing resulting in a release of fuel to sea.	3 m^3 of Jet A1 (entire fuel tank volume)	BMG Field	Project and offsite resources.

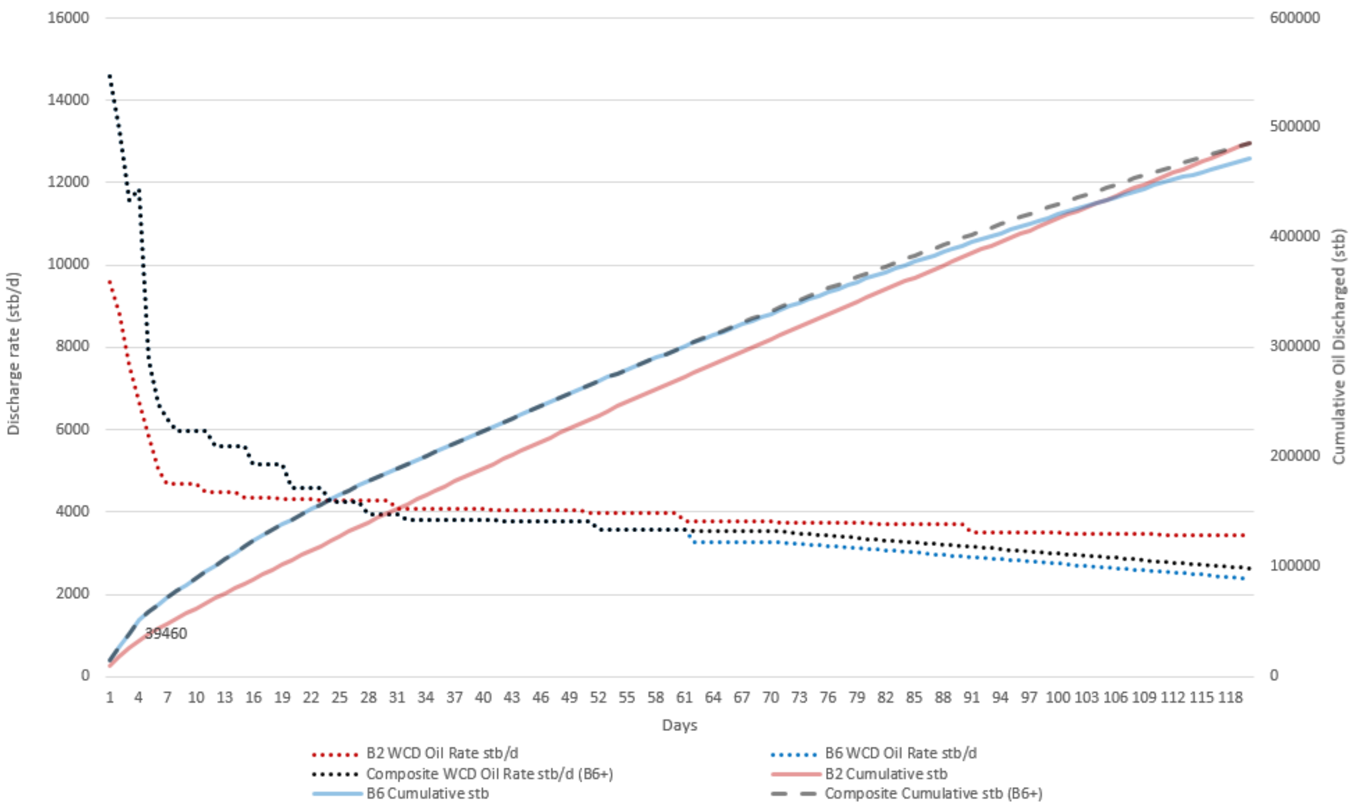


Figure 6-16 B2, B6 and Composite WCD over 120 days

6.7.1.1 Quantitative Hydrocarbon Spill Modelling

Quantitative spill modelling was undertaken for the following two credible, worst-case spill scenarios:

- Scenario 1 – Loss of well control – 77,338 m^3 subsea release of Basker 6ST1 crude over 120 days
  - This scenario examined a 77,338 m^3 subsea release of Basker 6 ST1 crude over 120 days, tracked for 180 days, representing a loss of well control at the B2 well location. A total of 100 spill trajectories were simulated across the year. Additional (seasonal) runs were considered but were considered to be of no value due to the duration (and persistence) of the spill across multiple seasons.
- Scenario 2 – LOC Vessel Collision - 500 m^3 instantaneous surface release of Marine Diesel Oil
  - This scenario examined a 500 m^3 surface release of MDO over 5 hours, tracked for 30 days, representing a fuel tank rupture after a vessel collision at the Manta-2A (M2A) well location. A total of 200 spill trajectories were simulated across two seasons; summer and winter (i.e. 100 spills per season).

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 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”.

The SIMAP model can track hydrocarbons to levels lower than biologically significant or visible to the naked eye. Therefore, reporting thresholds have been specified (based on the scientific literature) to account for “exposure” on the sea surface and “contact” to shorelines at meaningful levels.

6.7.1.2 Thresholds

Based on available information, concentration thresholds for use in the impact assessment have been defined for the different exposure types (surface, in-water, shoreline) (Table 6-21). These impact thresholds and exposure pathways are then applied at a receptor level for use in the consequence evaluations.

These thresholds align with the NOPSEMA environmental bulletin ‘Oil Spill modelling’ (A652993, April 2019).

Table 6-21: Justification for Hydrocarbon Impact Thresholds

Exposure Level	Impact Threshold	Justification
Surface Oil		
Low	1 g/m^2	The low threshold to assess the potential for surface 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). This threshold is below the level which could cause environmental harm, however at this concentration, oil on water is expected to be noticeable, and thus has the potential to impact nature-based activities (such as tourism) given the potential reduction in aesthetics. The threshold has been used to calculate the EMBA.
Moderate	10 g/m^2	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 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). A sea surface oil exposure of 10 g/m^2 represents the practical limit for surface response options; below this thickness, oil containment, recovery and chemical treatment (dispersant) become ineffective (AMSA 2015).
High	50 g/m^2	Concentrations above 50 g/m^2 are considered the lower actionable threshold, where oil may be thick enough for containment and recovery, therefore the high exposure threshold is considered for response planning.
Shoreline		
Low	10 g/m^2	The low 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

Exposure Level	Impact Threshold	Justification
		trigger attempts for shore clean-up on beaches or man-made features/amenities (breakwaters, jetties, marinas, etc.). French-McCay et al. (2005a; 2005b) also use 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 accumulation.
Moderate	100 g/m^2	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.
High	1,000 g/m^2	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). The impacts of surface hydrocarbons on wetlands are generally similar to those described for mangroves and saltmarshes. The degree of impact of oil on wetland vegetation are variable and complex, and can be both acute and chronic, ranging from short-term disruption of plant functioning to mortality (Corn & Copeland, 2010). This concentration equates to approximately 1 litre or 4 ¼ cups of fresh oil per square meter of shoreline accumulation. The appearance is described as an oil cover.
In-water - Dissolved		
Low	10 ppb	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 & 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
Moderate	50 ppb	
High	400 ppb	

Exposure Level	Impact Threshold	Justification
		xylenes), and the soluble alkanes (straight chain hydrocarbons) also contribute to toxicity, but these compounds are highly volatile, so that their contribution will be low when oil is exposed to evaporation and higher when oil is discharged at depth where volatilisation does not occur (French-McCay, 2002). French-McCay (2002) reviewed available toxicity data, where marine biota was exposed to dissolved hydrocarbons prepared from oil mixtures, finding that 95% of species and life stages exhibited 50% population mortality (LC50) between 6 and 400 ppb total PAH concentration after 96 hrs exposure, with an average of 50 ppb. Hence, concentrations lower than 6 ppb total PAH value should be protective of 97.5% of species and life stages even with exposure periods of days (at least 96 hours). Early life-history stages of fish appear to be more sensitive than older fish stages and invertebrates. Thresholds of 10, 50 or 400 ppb over a 1 hour timestep to indicate increasing potential for sub-lethal to lethal toxic effects (low to high). The dissolved hydrocarbon 10 ppb exposure value has been used to inform the EMBA.
In-water - Entrained		
Low	10 ppb	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, 2003). 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.
High	100 ppb	The 100 ppb exposure value is considered to be representative of sub-lethal impacts to most species and lethal impacts to sensitive species based on toxicity testing. This is considered conservative as toxicity to marine organisms from oil is likely to be driven by the more bioavailable dissolved aromatic fraction, which is typically not differentiated from entrained hydrocarbon in toxicity tests using water accommodated fractions. Given entrained hydrocarbon is expected to have lower toxicity than dissolved aromatics, especially over time periods where these soluble fractions have dissoluted from entrained hydrocarbon, the high exposure value is considered appropriate for risk evaluation.

6.7.1.3 Weathering and Fate

A Marine Diesel Oil (MDO) was used for the containment loss from a vessel scenario. The MDO is a light persistent fuel oil used in the maritime industry. It has a density of 829.1 kg/m^3 (API of 37.6) and a low pour point (-14°C). The low viscosity (4 cP) indicates that this oil will spread quickly when released and will form a thin to low thickness film on the sea surface, increasing the rate of evaporation. Approximately, 5% (by mass) of the oil is categorised as a group II oil (light-persistent) based on categorisation and classification derived from AMSA (2015a) guidelines. The classification is based on the specific gravity of hydrocarbons in combination with relevant boiling point ranges.

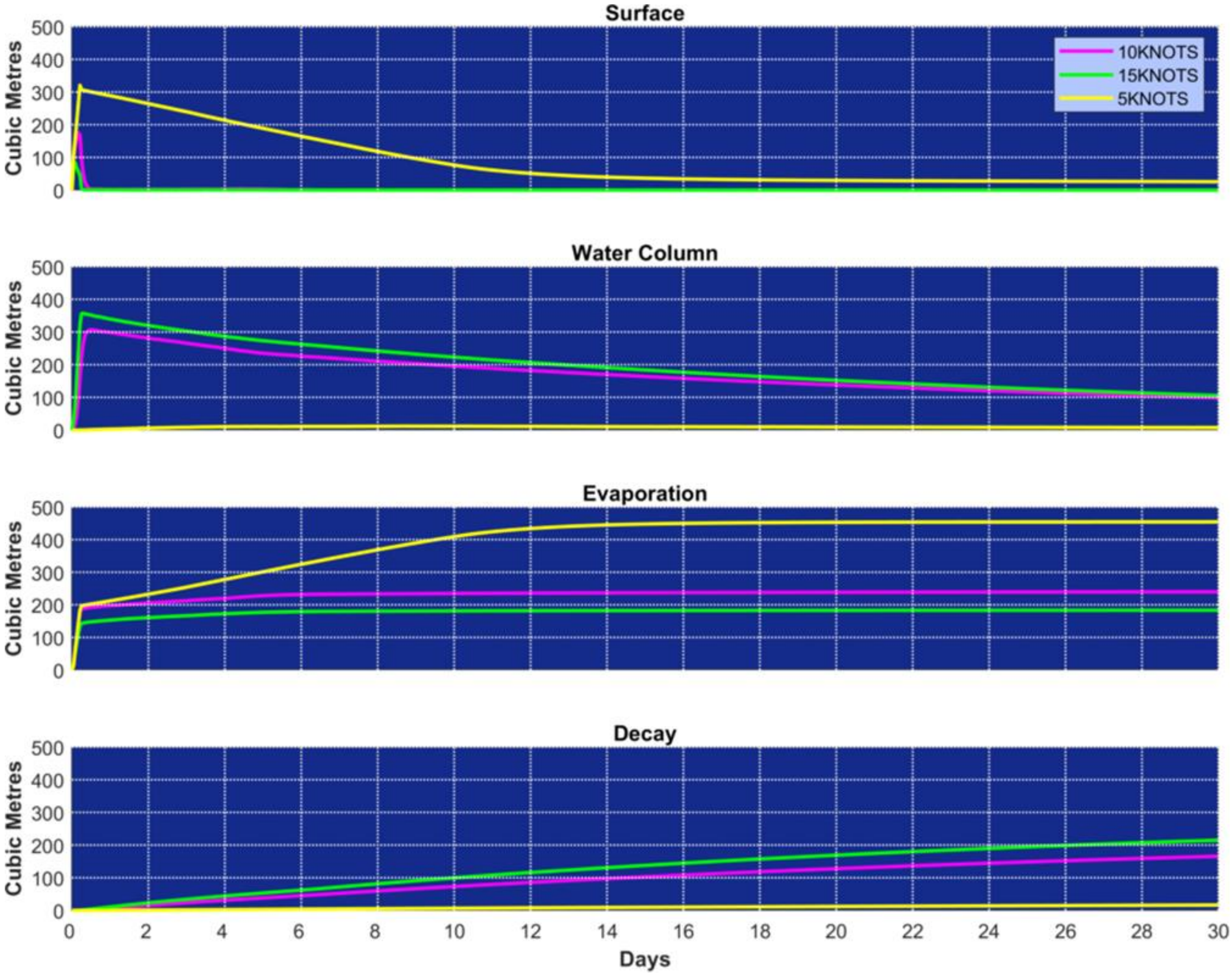


Figure 6-17 shows weathering graphs for a 500 m^3 release of MDO over 5 hours (tracked for 30 days) during three static wind conditions. The prevailing weather conditions will influence the weathering and fate of the MDO. Under lower windspeeds (5 knots), the MDO will remain on the surface longer, spread quicker, and in turn increase the evaporative process. Conversely, sustained stronger winds (>15 knots) will generate breaking waves at the surface, causing a higher amount of MDO to be entrained into the water column and reducing the amount available to evaporate.

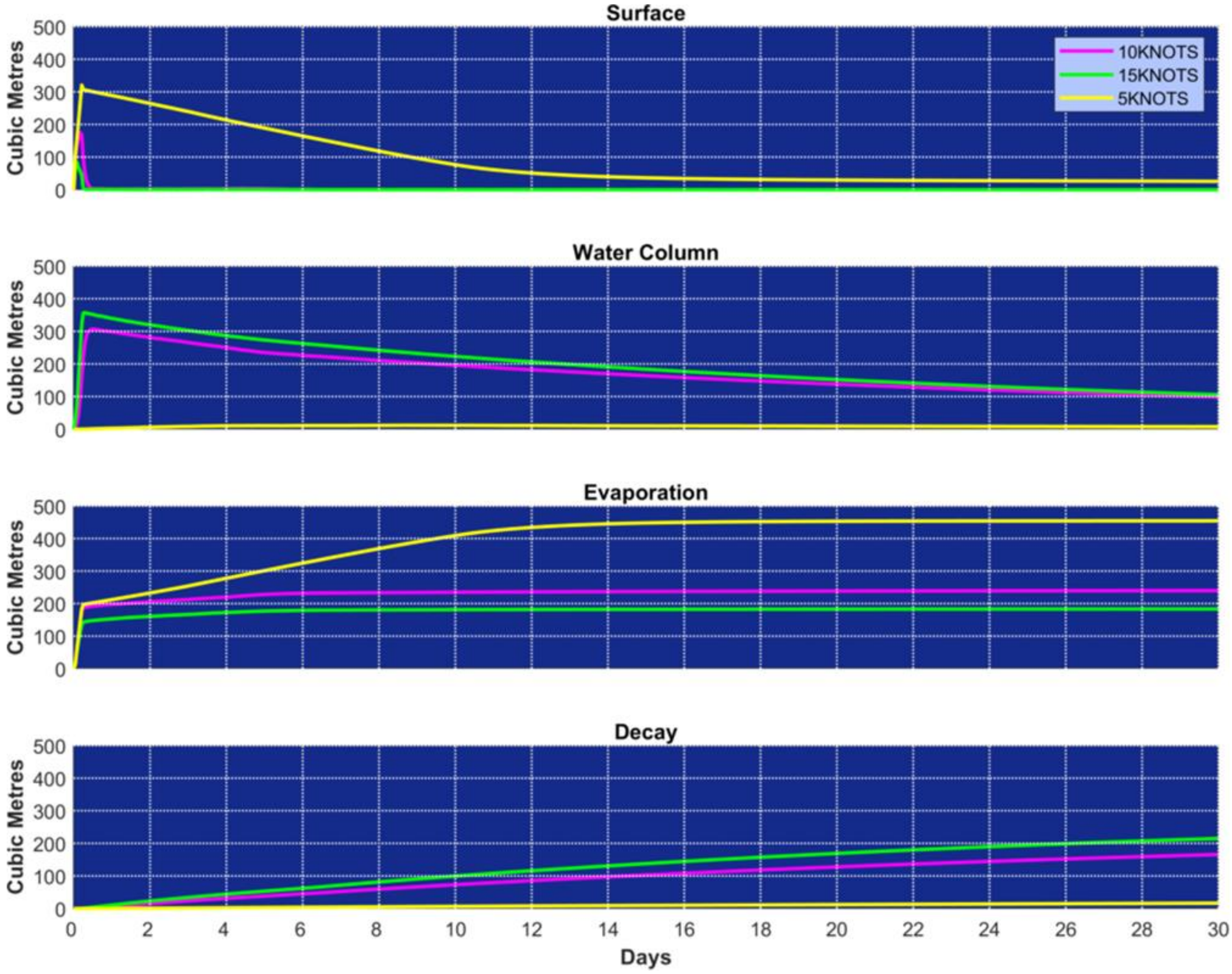


Figure 6-17 Weathering of MDO under three static wind conditions (5, 10 and 15 knots). The results are based on a 500 m³ surface release of MDO over 5 hours and tracked for 30 days.

The oil type used to represent the loss of well control was a composite crude (referred to as Basker 6ST1 crude). Basker 6ST1 was derived from a combination of worst-case physical properties that characterised the Basker 2 and Basker 6ST1 crude oils; both are light crudes and have similar properties.

Basker 6ST1 crude has a density of 829.8 kg/m³ (API of 45.2), a dynamic viscosity of 2.8 cP (at 25 °C) and a high pour point of 15 °C (when compared to ambient water temperature). This oil is categorised as a group II oil (light-persistent) based on categorisation and classification derived from AMSA (2015a) guidelines. The classification is based on the specific gravity of hydrocarbons in combination with relevant boiling point ranges.

Generally, about 19.4% of the crude mass should evaporate within the first 12 hours (BP < 180 °C); a further 19.5% should evaporate within the first 24 hours (180 °C < BP < 265 °C); and an additional 20.8% should evaporate over several days (265 °C < BP < 380 °C). Approximately 40.3% (by mass) of Basker 6ST1 crude is considered persistent compounds and characterised by a high pour point (above ambient water temperature) and a wax content of 27.7%. This portion of the crude will likely solidify over time to form small waxy flakes as it loses the light end hydrocarbons acting as solvent to the heavier compounds.

Figure 6-18 shows weathering graphs for a 2,321 m³ subsea release of Basker 6ST1 crude over 24 hours (tracked for 60 days) under three static wind conditions. This volume represents the predicted maximum daily discharge rate which occurred on day 1. The graphs demonstrate that this oil has the capacity to entrain into the water column in the presence of moderate winds (> 10 knots) and can potentially remain entrained for as long as the winds persist. It is also worth noting that regardless of the wind conditions, the maximum portion of hydrocarbons that can be lost to the atmosphere varies between 30% and 50% under moderate and calm wind conditions, respectively.

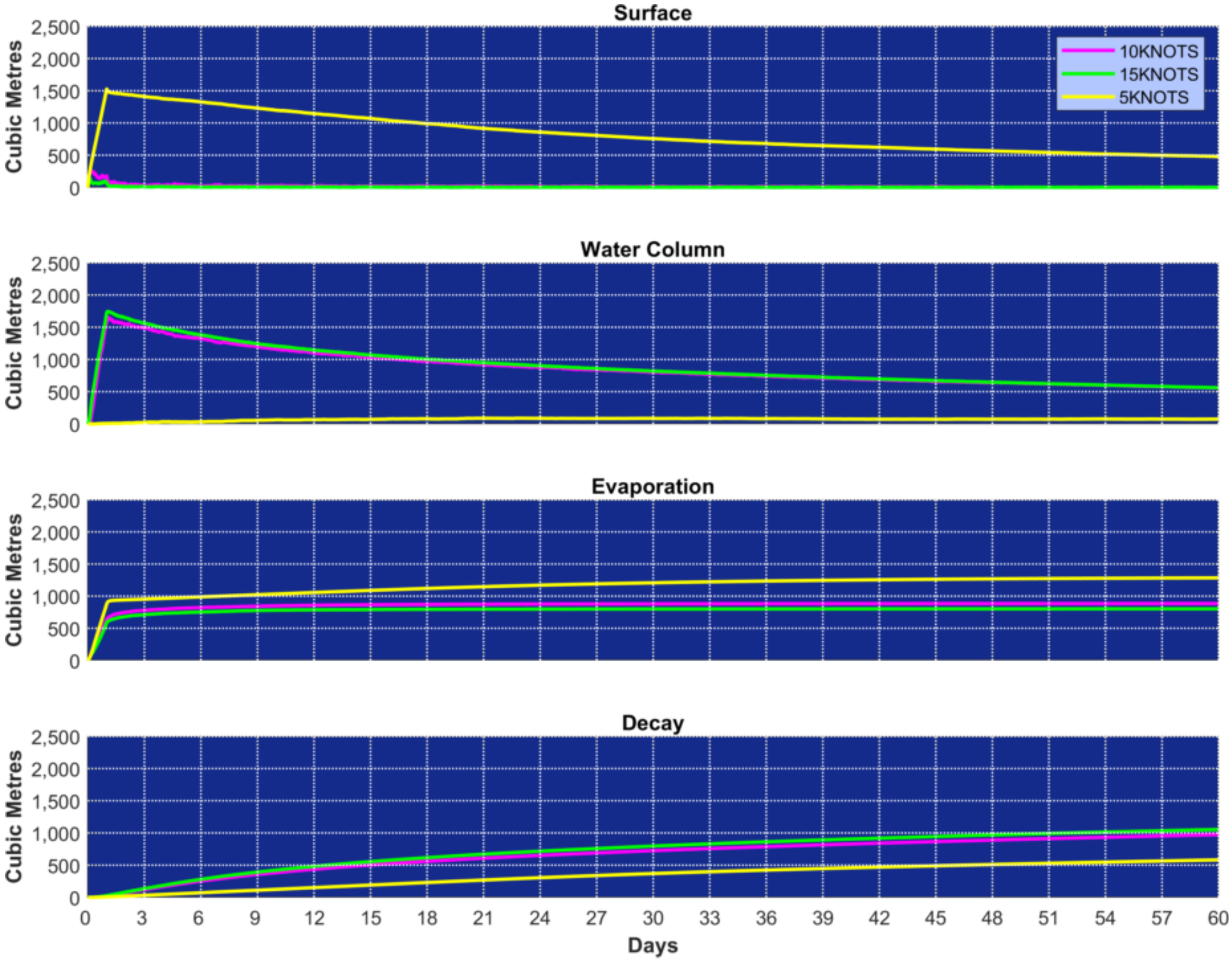


Figure 6-18 Weathering of Basker 6ST1 crude under three static wind conditions (5, 10 and 15 knots). The results are based on a 2,321 m³ subsea release of Basker 6ST1 crude over 24 hours and tracked for 60 days.

6.7.2 Potential Impact

Spills to the marine environment have the potential to expose ecological and social receptors to different hydrocarbon expressions and concentrations. Hydrocarbon expressions include:

- Surface; and
- In water (entrained only).

These exposures have the potential to result in potential impacts directly via:

- Potential toxicity effects/physical oiling
- Potential for reduction in intrinsic values/visual aesthetics.

Or indirectly as a result of the potential impacts noted above, there is the potential to result in

- Potential impact to commercial businesses.

6.7.3 EMBA

Predicted impacts and risks from accidental hydrocarbon release could occur within the spill EMBA. The boundary of the EMBA is defined using the hydrocarbon exposure (low) thresholds for the accidental release of MDO from a vessel collision and the release of light crude oil from a LOWC event.

Based on the seasonality of key sensitivities within the region (Table 4-4), there is no period of time when fauna would be more or less susceptible to the impacts related to an accidental release. Therefore the oil spill modelling and subsequent assessment is based on the meteorological conditions which result in the largest area of impact, and therefore the greatest spatial extent of potential impacts to values and sensitivities.

Based on stochastic modelling results (RPS, 2020), the EMBA covers waters from Victoria and Tasmania, through to south-eastern Queensland and out to Lord Howe Island (Figure 4-1). The EMBA overlaps four State water boundaries (Victoria, Tasmania, New South Wales and Queensland), six IMCRA Provincial Bioregions (Central Eastern Shelf Province, Central Eastern Province, Southeast Shelf Transition, Southeast Shelf Transition, Bass Strait Shelf Province, Tasmanian Shelf Province) and three international economic Exclusive Zones (EEZ) [New Caledonian, New Zealand and Norfolk Island], which are described further in Addendum 1.

6.7.4 Consequence Evaluation

6.7.4.1 LOC - Vessel Collision

Below is a summary of the results from the stochastic modelling undertaken for a loss of containment caused by vessel collision and outline the area potentially exposed to hydrocarbons. The modelling report is provided in Appendix 7. The ecological and social receptors with the potential to be exposed to surface, shoreline accumulation and in-water hydrocarbons from a loss of containment caused by vessel collision event are evaluated in Table 6-22, Table 6-23 and Table 6-24 respectively.

Surface Exposure (Figure 6-19)

- For summer conditions, the predicted maximum distance of surface exposure from the release location at moderate exposure threshold (≥ 10 g/m^2) was 32 km WSW and at high exposure threshold (≥ 50 g/m^2) was 11 km NNW.
- For winter conditions, the predicted maximum distance of surface exposure from the release location at moderate exposure threshold (≥ 10 g/m^2) was 132 km ENE and at high exposure threshold (≥ 50 g/m^2) was 7 km NE.

Shoreline Exposure

- Probability of shoreline contact ranged from 4% (summer) to 8% (winter)
- The minimum time before shoreline contact was approximately 1.9 days (~46 hours) and the maximum volume of oil ashore was 64.8 m^3, both predicted during winter conditions.
- Only two sites, East Gippsland and Cape Howe / Mallacoota recorded exposure values at or above the high threshold and only during the winter season.
- No sites were exposed at the high threshold during the summer season.
- Gabo Island recorded the highest probability of shoreline accumulation at the low threshold during summer conditions with 3%, while East Gippsland and Cape Howe / Mallacoota recorded the highest probability at the low accumulation threshold during winter conditions with 7%.
- The minimum time recorded before low shoreline accumulation was 1.92 days at Cape Howe / Mallacoota and East Gippsland under winter conditions while the maximum volume to reach the shoreline was 64.6 m3, recorded at East Gippsland and Cape Howe / Mallacoota.

In-Water Exposure – Dissolved

- In the surface (0-10 m) depth layer, a total of 12 BIAs (i.e. the BIAs which intersect the Operational Area) were predicted to be exposed to dissolved hydrocarbons at or above the low and moderate thresholds during summer and winter conditions, and the greatest probabilities of 72% and 36% and 69% and 50% respectively.
- Aside from the 12 BIAs that the release location resides within, all the other BIAs recorded probabilities of less than 10% except the White-faced Storm-petrel – Foraging BIA which recorded a 17%.
- No locations were exposed at or above the high exposure threshold for either season.
- Two AMPs (East Gippsland and Flinders) were predicted to be exposed to dissolved hydrocarbons at the low threshold during summer conditions and one AMP (East Gippsland) during winter conditions, with all recording a 1% probability of exposure.
- Dissolved hydrocarbons at, or above the low threshold were predicted to cross into both New South Wales and Victoria state waters with probabilities of 1% and 4% and 3% and 5% during summer and winter conditions, respectively.

In-Water Exposure – Entrained

- In the surface (0-10 m) depth layer, a total of 12 BIAs (i.e. the BIAs which intersect the Operational Area) were predicted to be exposed to entrained oil at or above the low and high thresholds during summer and winter conditions, and the highest probabilities were 94% and 89% and 98% and 89% respectively.
- Aside from the 12 BIAs that the release location resides within, 13 and 12 additional BIAs recorded probabilities of exposure to entrained hydrocarbons at the high threshold during summer and winters conditions, respectively. The greatest probabilities of high exposure during summer and winter conditions were predicted at the White-faced Storm-petrel – Foraging BIA with 36% and 37%, respectively.
- A total of four and three AMPs were predicted to be exposed to entrained hydrocarbons at, or above the low threshold during summer and winter conditions, respectively, with the highest probability predicted at East Gippsland (15%) during summer conditions.
- Entrained hydrocarbons at, or above the low threshold were predicted to cross into New South Wales, Tasmania and Victoria state waters during summer conditions with probabilities of 26%, 5% and 37%, respectively. During winter conditions, entrained hydrocarbons at or above the low threshold were predicted to cross into New South Wales and Victoria state waters with probabilities of 28% and 33%, respectively.

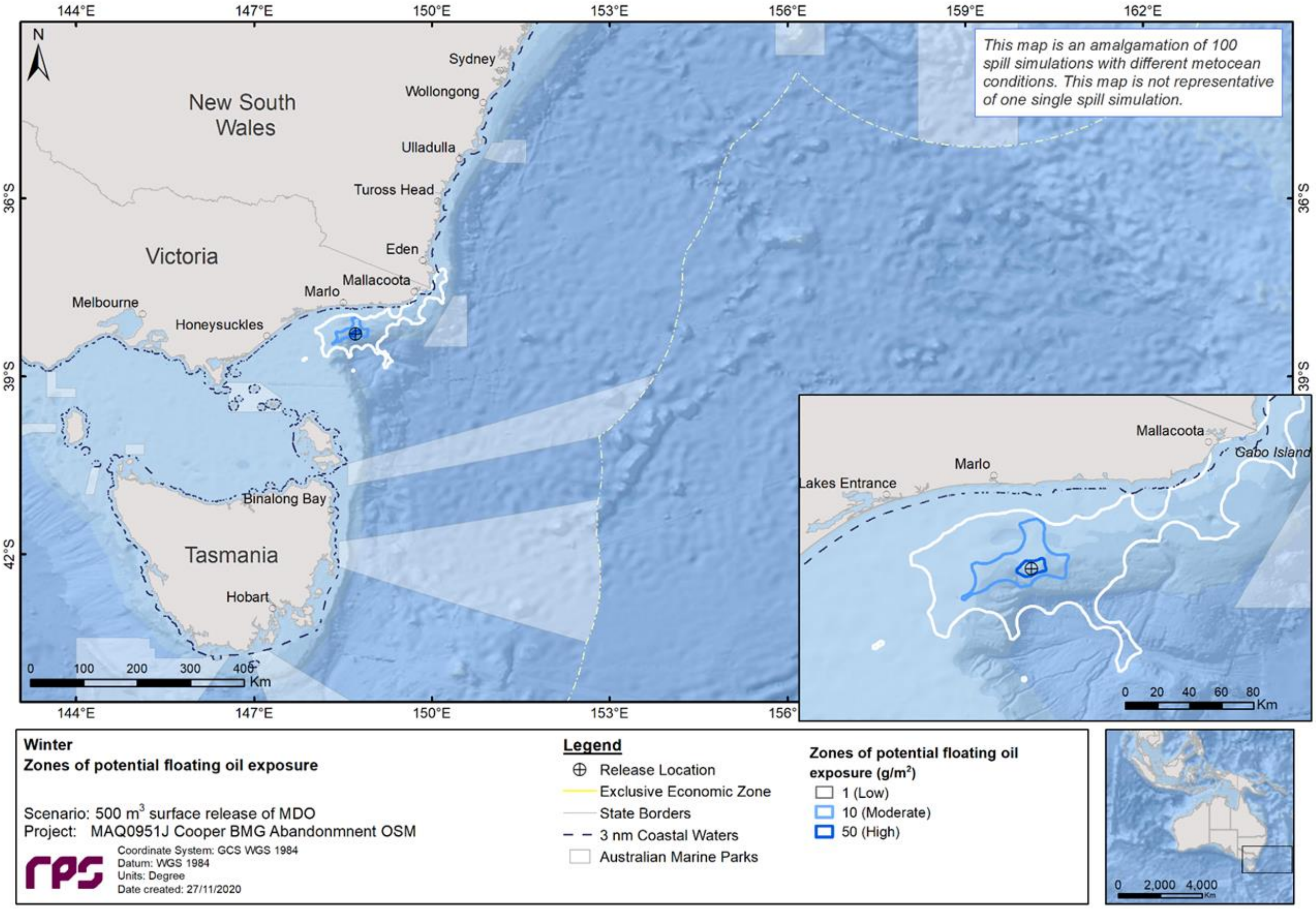


Figure 6-19: Zones of potential floating oil exposure, in the event of a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days. The results were calculated from 100 spill trajectories simulated during summer (May to September) wind and current conditions.

Table 6-22 Consequence evaluation for MDO hydrocarbon exposure – Surface

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
Ecological Receptors			
Marine Fauna	Seabirds	Several threatened, migratory and/or listed marine species have the potential to be rafting, resting, diving and feeding within the area predicted to be contacted by >10 g/m^2 surface hydrocarbons. There are several foraging BIAs that are present within the area potentially exposed to >10 g/m^2 surface hydrocarbons for albatross, petrel, and shearwater species. Foraging BIAs are typically large broad areas (e.g. Antipodean Albatross) (Section 3.10 - Addendum 1). The birds can feed via surface skimming or diving – both exposing the bird to any oil on the water surface. No breeding activity occurs in oceanic waters.	When first released, MDO has higher toxicity due to the presence of volatile components. Individual birds making contact close to the spill source at the time of the spill may be impacted, however, it is unlikely that a large number of birds will be affected as the majority (95 %) of the MDO volume will have evaporated within a few days of release. Seabirds rafting, resting, diving or feeding at sea have the potential to come into contact with areas where hydrocarbons concentrations greater than 10 µm and due to physical oiling may experience lethal surface thresholds. As such, acute or chronic toxicity impacts (death or long-term poor health) to birds are possible but unlikely for an MDO spill as the number of birds would be limited due to the small area and brief period of exposure above 10 µm (95% evaporation expected within a few days). Therefore, potential impact would be limited to individuals, with population impacts not anticipated. Marine pollution is listed as a threat for several migratory shorebirds and seabird conservation advice / recovery plans (refer to Table 2-5), however management actions mostly relate to nesting locations. The potential consequence to seabirds from a vessel collision (MDO) event is assessed as **Level 2** based on the potential for localised and short-term impacts to species of recognized conservation value but not affecting local ecosystem functioning.
	Marine Turtles	There may be marine turtles in the area predicted to be >10 g/m^2. However, there are no BIAs or habitat critical to the survival of the species within this area.	Marine turtles are vulnerable to the effects of oil at all life stages. Marine turtles can be exposed to surface oil externally (i.e. swimming through oil slicks) or internally (i.e. swallowing the oil). Ingested oil can harm internal organs and digestive function. Oil on their bodies can cause skin irritation and affect breathing. The number of marine turtles that may be exposed to MDO is expected to be low as there are no BIAs or habitat critical to the survival of the species present, hence, turtles may be transient within the EMBA. Surface oiling area is expected to reduce quickly, with the majority (95 %) of the MDO volume predicted to have evaporated within a few days of release. Therefore, potential impact would be limited to individuals, with population impacts not anticipated. Marine pollution is listed as a threat to marine turtle in the Recovery Plan for Marine Turtles in Australia, 2017- 2027, particularly in relation to shoreline oiling of nesting beaches. There are no nesting beaches within the EMBA, and the activity will be conducted in a manner which is not inconsistent with the relevant management actions.

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
			The potential consequence to turtles from a vessel collision (MDO) event is assessed as **Level 2** based on the potential for localised and short-term impacts to species of recognized conservation value but not affecting local ecosystem functioning.
	Marine Mammals (Pinnipeds)	There may be pinnipeds in the area predicted to affected by hydrocarbons 10 g/m^2. However, there are no BIAs or habitat critical to the survival of the species within this area.	Exposure to surface oil can result in skin and eye irritations and disruptions to thermal regulation. Oiling of pinnipeds can lead to hypothermia if the fur is affected, or poisoning if oil is ingested, resulting in reduced foraging and reproductive fitness or death (DSEWPAC 2013). Fur seals are particularly vulnerable to hypothermia from oiling of their fur, as well as irritation to lungs if breathing in fumes (e.g. if feeding occurs in the area). Fur seals are known to forage throughout the Gippsland, and have been sighted foraging at BMG. The number of pinnipeds that may be exposed to MDO is expected to be low as there are no BIAs or habitat critical to the survival of the species present, hence, pinnipeds may be transient within the EMBA. Surface oiling area is expected to reduce quickly, with the majority (95 %) of the MDO volume predicted to have evaporated within a few days of release. Therefore, potential impact would be limited to individuals, with population impacts not anticipated. Conservation Listing Advice for the *Neophoca cinerea* (Australian sea lion) (TSSC, 2010) identifies oil spills as a potential threat to habitat. Activities within this Environment Plan will not be inconsistent with the conservation and management priorities outlined in this advice. Given that fur seals are vulnerable to hypothermia from oiling and poisoning from ingestion, the potential consequence to pinnipeds from a vessel collision (MDO) event is assessed as **Level 3** based on the potential for medium term impacts to species of recognized conservation value but not affecting local ecosystem functioning.
	Marine Mammals (Cetaceans)	Several threatened, migratory and/or listed marine cetacean species have the potential to be migrating, resting or foraging within an area predicted to be above the surface thresholds of >10 g/m^2. The following BIAs are within the area predicted to be above the surface thresholds of >10 g/m^2: • pygmy blue whale known foraging BIA • Southern right whale known core area BIA • Southern right whale migration and resting on migration BIA	Cetaceans can be exposed to oil through direct contact with the skin, eyes, mouth, and blowhole(s), and they can also inhale volatile petroleum fractions at the water's surface, ingest oil directly, and consume oil components in food (Amstrup et al., 1989; O'Hara et al., 2001). Physical contact by individual whales with MDO is unlikely to lead to any long-term impacts, due to the insulative properties of their thick layers of blubber and skin (Geraci and St Aubin, 1990). Given the mobility of whales, only a small proportion of the migrating population might surface in the affected areas, resulting in short-term and localised consequences, with no long-term population viability effects. If whales are foraging at the time of the spill, a greater number of individuals may be present in the area where sea surface oil is >10 g/m^2 (10 µm). Surface oiling area is expected to reduce quickly, with the majority (95 %) of the MDO volume predicted to have evaporated within a few days of release.

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
			Habitat degradation caused by marine pollution is listed as a threat for several cetaceans in the relevant conservation advice / recovery plans (refer to Table 2-5). Activities within this Environment Plan will not be inconsistent with the conservation and management actions outlined in this advice. The potential consequence to cetaceans from a vessel collision (MDO) event is assessed as **Level 2** based on the potential for localised and short-term impacts to species of recognized conservation value but not affecting local ecosystem functioning.
Social Receptors			
Natural Systems	Key Ecological Features	Upwelling East of Eden is within the area predicted to be above the surface thresholds of >10 g/m^2. Values associated with this areas are high productivity and aggregations of whales, seals, sharks and seabirds.	Based on the worse case potential consequence to key receptors within the Upwelling East of Eden KEF (e.g. seabirds, pinnipeds and cetaceans), the potential consequence to this KEF is assessed to be **Level 3** as per the assessment for pinnipeds. Refer also to: • Seabirds. • Marine mammals (Pinnipeds, Cetaceans).
Natural Systems	State Marine Protected Areas	Cape Howe Marine National Park is within the area predicted to be above the surface thresholds of >10 g/m^2. Values associated with these areas include providing habitats for a diverse range of invertebrates, fish, mammals and birds.	Based on the worse case potential consequence to key receptors (e.g. seabirds, pinnipeds and cetaceans) the potential consequence to this protected area is assessed to be **Level 3** as per the assessment for pinnipeds. Refer also to: • Seabirds. • Marine mammals (Pinnipeds, Cetaceans).
Human Systems	Recreation and Tourism (including recreational fisheries)	Marine pollution can result in impacts to marine-based tourism from reduced visual aesthetic. MDO is known to rapidly spread and thin out on release and consequently, a large area may be exposed to hydrocarbon concentrations greater than 1 g/m^2. Low exposure thresholds (1 g/m^2) are predicted up to 194 km E (summer) or 177 km NE (winter) of the release location. Local government areas and sub-areas where low threshold surface oil is predicted include East Gippsland, Gabo Island and Cape Howe & Mallacoota.	Visible surface hydrocarbons have the potential to reduce the visual amenity of the area for tourism and discourage recreational activities. Given the nature of the oil, it is expected to rapidly weather offshore and once onshore is expected to continue weathering until it is flushed via natural processes from the coastline, or until it is physically cleaned-up. Regardless any exposure is expected to be limited in duration and consequently, the potential consequence to recreation and tourism from a vessel collision (MDO) event are considered to be **Level 2** as they could be expected to result in localised short-term impacts. Refer also to: • Marine Mammals (Pinnipeds, Cetaceans). • State Marine Protected Areas.

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
	Shipping	Shipping occurs within the area predicted to be above the surface thresholds of >10 g/m^2.	Vessels may be present in the area where sea surface oil is >10 g/m^2 (10 µm), however, due to the short duration of surface exposure (95% evaporated within a few days) impacts would be localised and short term, consequently, the potential consequence is considered to be **Level 1.**
	Oil and gas	Oil and gas platforms are located within the area predicted to be above the surface thresholds of >10 g/m^2.	Oil and gas infrastructure present in the area where sea surface oil is >10 g/m^2 (10 µm) could be potentially oiled. However, due to the short duration of surface exposure (95% evaporated within a few days) impacts would be localised and short term, consequently, the potential consequence is considered to be **Level 1.**

Table 6-23 Consequence evaluation for MDO hydrocarbon exposure – Shoreline

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
Ecological Receptors			
Habitat	Rocky Shoreline	Rocky shores are within the area potentially exposed to hydrocarbon ashore; however, within the stretch of coast where shoreline contact could be expected, there is no sheltered rocky coasts (i.e. those rocky coasts more sensitive to shoreline oiling). As MDO is not sticky or viscous, if it contacts rocky shorelines, it is not expected to stick with tidal washing expected to influence the longevity of exposure.	The sensitivity of a rocky shoreline to oiling is dependent on a number of factors including its topography and composition, position, exposure to oceanic waves and currents etc. Exposed rocky shorelines are less sensitive than sheltered rocky shorelines. One of the main identified values of rocky shores/scarps is as habitat for invertebrates (e.g. sea anemones, sponges, sea-squirts, molluscs). Rocky areas are also utilised by some pinniped and bird species; noting that foraging and breeding/nesting typically occurs above high tide line. The impact of oil on any organism depends on the toxicity, viscosity and amount of oil, on the sensitivity of the organism and the length of time it is in contact with the oil. Even where the immediate damage to rocky shores from oil spills has been considerable, it is unusual for this to result in long-term damage and the communities have often recovered within 2 or 3 years (IPIECA, 1995). The potential consequence to rocky sites from a vessel collision (MDO) event is assessed as **Level 3** based on the potential for localised medium-term impacts to species or habitats of recognized conservation value or to local ecosystem function. Refer also to: • Marine Invertebrates. • Seabirds and Shorebirds. • Pinnipeds.

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
	Sandy Shoreline	Sandy beaches are within the area potentially exposed to hydrocarbons ashore. Sandy beaches are the predominant habitat type within the stretch of coast where shoreline contact could be expected from a vessel collision (MDO) event. MDO would be expected to penetrate porous sediments of sandy shorelines quickly but may also be washed off shorelines just as quick via waves and tidal flushing. NOAA (2014) note that as MDO is readily and completely degraded by naturally occurring microbes, it could be expected to disappear from shorelines within one to two months. MDO has the potential to be buried due to the continual washing in the intertidal zone.	Sandy beaches are considered to have a low sensitivity to hydrocarbon exposure. Sandy beaches provide habitat for a diverse assemblage (although not always abundant) of infauna (including nematodes, copepods and polychaetes); and macroinvertebrates (e.g. crustaceans). Due to proximity to shore, a release of MDO may reach the shoreline prior to it completely weathering and consequently impacts due to toxicity and/or smothering of infauna may occur. The potential consequence to sandy shorelines from a vessel collision (MDO) event is assessed as **Level 3** based on the potential for localised medium-term impacts to species or habitats of recognized conservation value or to local ecosystem function. Refer also to: • Marine Invertebrates. • Seabirds and Shorebirds. • Pinnipeds. • Recreation.
	Mangroves	Strands of mangroves are within the area potentially exposed to hydrocarbons ashore, however, within the stretch of coast expected to be exposed from vessel collision (MDO) event, there is no coastal habitat mapped specifically as this vegetation type. Oil can enter mangrove forests when the tide is high and be deposited on the aerial roots and sediment surface as the tide recedes. This process commonly leads to a patchy distribution of the oil and its effects because different places within the forests are at different tidal heights (IPIECA 1993, NOAA 2014). The physical smothering of aerial roots by standard hydrocarbons can block the trees' breathing pores used for oxygen intake and result in the asphyxiation of sub-surface roots (International Petroleum Industry Environmental Conservation Association (IPIECA 1993).	Mangroves are considered to have a high sensitivity to hydrocarbon exposure. Mangroves can be killed by heavy or viscous oil, or emulsification, that covers the trees' breathing pores thereby asphyxiating the subsurface roots, which depend on the pores for oxygen (IPIECA 1993). Mangroves can also take up hydrocarbons from contact with leaves, roots or sediments, and it is suspected that this uptake causes defoliation through leaf damage and tree death (Wardrop et al. 1987). Acute impacts to mangroves can be observed within weeks of exposure, whereas chronic impacts may take months to years to detect. Given the non-viscous nature of MDO and impacts are expected to be limited to the volatile component of the hydrocarbon, however given their sensitivity to hydrocarbons, the potential consequence to mangroves is assessed to be **Level 3** based on the potential for localised medium-term impacts to species or habitats of recognized conservation value or to local ecosystem function.
	Saltmarsh	Communities of saltmarsh are within the area potentially exposed to hydrocarbons ashore; and is	Saltmarsh is considered to have a high sensitivity to hydrocarbon exposure. Saltmarsh vegetation offers a large surface area for oil absorption and tends to trap oil.

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
		present within some estuaries and inlet/riverine systems. Some of the saltmarsh habitat along this coast will be representative of the Subtropical and Temperate Saltmarsh TEC. Oil can enter saltmarsh systems during the tidal cycles if the estuary/inlet is open to the ocean. Similar to mangroves, this can lead to a patchy distribution of the oil and its effects, because different places within the inlets are at different tidal heights. Oil (in liquid form) will readily adhere to the marshes, coating the stems from tidal height to sediment surface. Heavy oil coating will be restricted to the outer fringe of thick vegetation, although lighter oils can penetrate deeper, to the limit of tidal influence.	Evidence from case histories and experiments shows that the damage resulting from oiling, and recovery times of oiled marsh vegetation, are very variable. In areas of light to moderate oiling where oil is mainly on perennial vegetation with little penetration of sediment, the shoots of the plants may be killed but recovery can take place from the underground systems. Good recovery commonly occurs within one to two years (IPIECA 1994). The potential consequence to saltmarsh is assessed to be **Level 3** based on the potential for localised medium-term impacts to species or habitats of recognized conservation value or to local ecosystem function.
Marine Fauna	Invertebrates	Invertebrates that live in intertidal zones include crustaceans, molluscs and infauna, and can be present in wide range of habitats including sandy beaches and rocky shores (refer also to the exposure evaluation for these habitats). Exposure to hydrocarbons for invertebrates is typically via direct contact and smothering but can also occur via ingestion.	The impact of oil on any marine organism depends on the toxicity, viscosity and amount of oil, on the sensitivity of the organism and the length of time it is in contact with the oil. Acute or chronic exposure, through surface contact, and/or ingestion can result in toxicological impacts, reproductive impacts, smothering and potentially cause death. However, the presence of an exoskeleton (e.g. crustaceans) will reduce the impact of hydrocarbon absorption through the surface membrane. Other invertebrates with no exoskeleton and larval forms may be more sensitive to impacts from hydrocarbons. If invertebrates are contaminated by hydrocarbons, tissue taint can remain for several months, but can eventually be lost. As MDO is expected to rapidly spread out, a large portion of the coast with the potential to be exposure to hydrocarbons comprises habitats that are suitable for intertidal invertebrates could be exposed, with the potential consequences assessed as **Level 3** based on the potential for localised medium-term impacts to species or habitats of recognized conservation value or to local ecosystem function.
	Seabirds and Shorebirds	Listed marine, threatened and/or migratory bird species have the potential to be resting, feeding or nesting within the area potentially exposed to hydrocarbons ashore. This fauna can be present in wide range of habitats including sandy beaches and rocky shores (refer also to the exposure evaluation for these habitats).	Direct contact with hydrocarbons can foul feathers, which may result in hypothermia due to a reduction in the ability of the bird to thermo-regulate and impair water-proofing. Oiling of birds can also suffer from damage to external tissues, including skin and eyes, as well as internal tissue irritation in their lungs and stomachs. Toxic effects may result where the oil is ingested as the bird attempts to preen its feathers, or via consumption of oil-affected prey. Marine pollution is listed as a threat for several migratory shorebirds and seabird conservation advice / recovery plans (refer to Table 2-5), however management actions mostly relate to nesting locations.

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
		There are several foraging BIAs throughout the area, however these species are oceanic foragers, not shoreline foragers. Shorebirds will still utilise intertidal and onshore zones for feeding though no BIAs or habitat critical to the survival of the species have been identified. Given hydrocarbons may wash ashore prior to weathering, there is the potential for both physical oiling and toxicity (e.g. surface contact or ingestion; particularly for shorebirds utilizing the intertidal area. Noting that these events will be temporary, so length of exposure is limited.	The potential consequence to seabirds and shorebirds from a vessel collision (MDO) event is assessed as **Level 3** based on the potential for localised medium-term impacts to species or habitats of recognized conservation value or to local ecosystem function.
	Marine Reptiles	Turtles nesting on exposed shores would be exposed by direct contact with skin/body. However, there are no BIAs or habitat critical to the survival of the species within the shorelines that could be potentially affected. Therefore, shoreline exposure to marine turtles is not expected and not evaluated further.	NA
	Marine Mammals (Pinnipeds)	Listed marine and/or threatened pinniped species have the potential to present within the area predicted to be exposed to hydrocarbons ashore. There are no BIAs or habitat critical to the survival of the species within the area that maybe exposed to hydrocarbons ashore. Pinnipeds hauling out on exposed shores could be exposed by direct contact of oil with skin/body. Direct oiling is possible but expected to have a limited window for occurring due to rapid weathering and flushing of MDO.	Pinnipeds have high site fidelity and can be less likely to exhibit avoidance behaviours, thus staying near established colonies and haul-out areas. Fur seals are particularly vulnerable to hypothermia from oiling of their fur (DSEWPAC 2013) and consequently, once onshore hydrocarbons pose a significant hazard to pinnipeds with biological impacts caused from ingestion possibly resulting in reduced reproduction levels. Conservation Listing Advice for the *Neophoca cinerea* (Australian sea lion) (TSSC, 2010) identifies oil spills as a potential threat to habitat. Activities within this Environment Plan will not be inconsistent with the conservation and management priorities outlined in this advice. Thus, the potential consequence to pinnipeds from exposure are assessed as **Level 3** based on the potential for localised medium-term impacts to species or habitats of recognized conservation value or to local ecosystem function.
Social Receptors			
Natural System	Wetlands	Wetlands are predicted to be within the area potentially exposed to hydrocarbons ashore,	The impacts of hydrocarbons on wetlands are generally similar to those described for mangroves and saltmarshes. The degree of impact of oil on wetland vegetation are variable and complex, and can be both acute and chronic, ranging from short-term disruption of plant functioning to mortality. Spills reaching

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
		however, no nationally or internationally important wetlands are present in this area.	wetlands during the growing season will have a more severe impact than if oil reaches wetlands during the times when many plant species are dormant. Wetland habitat can be of particular importance for some species of birds and invertebrates. As such, in addition to direct impacts on plants, oil that reaches wetlands also affects these fauna utilising wetlands during their life cycle, especially benthic organisms that reside in the sediments and are a foundation of the food chain. Thus, the potential consequence to wetlands from exposure are assessed as **Level 3** based on the potential for localised medium-term impacts to species or habitats of recognized conservation value or to local ecosystem function. Refer also to: • Marine Invertebrates. • Seabirds and Shorebirds.
Human System	Coastal Settlements	Coastal settlements are within the area potentially exposed to hydrocarbons ashore; however, the stretch of coast expected to be exposed is not densely populated. Noting that these events will be temporary, so duration of exposure is also limited. Most of the hydrocarbons will be concentrated along the high tide mark while the lower/upper parts are often untouched (IPIECA 1995) and expected to be visible.	Visible hydrocarbons have the potential to reduce the visual amenity of the area for coastal settlements. Given its rapid weathering and potential for tidal flushing and rapid degradation, the potential consequence to coastal settlements is assessed as **Level 2** based on the potential for localised short-term impacts. Refer also to: • Rocky Shores. • Sandy Beaches.
	Recreation and Tourism	Recreational and tourism activities occur within the area potentially exposed hydrocarbons ashore; however, the stretch of coast expected to be exposed, as such the volume of recreation/tourism is not as high as other places. Noting that these events will be temporary, so duration of exposure is also limited. Most of the oil will be concentrated along the high tide mark while the lower/upper parts are often untouched (IPIECA 1995) and expected to be visible.	Visible hydrocarbons have the potential to reduce the visual amenity of the area for tourism and discourage recreational activities. The potential consequence to recreation and tourism is assessed as **Level 2** based on the potential for localised short-term impacts. Refer also to: • Rocky Shores. • Sandy Beaches. • Coastal Settlements.

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
	Heritage	Specific locations of spiritual and ceremonial places of significance, or cultural artefacts, are often unknown, but are expected to be present along the mainland coast. Therefore, there is the potential that some of these sites may be within the area potentially exposed to hydrocarbons ashore. Noting that these events will be temporary, so duration of exposure is also limited. Most of the oil will be concentrated along the high tide mark while the lower/upper parts are often untouched (IPIECA 1995) and expected to be visible.	Visible hydrocarbons have the potential to reduce the visual amenity of heritage sites. However, it is expected that these sites would be above the high tide mark. Thus, the potential consequence to heritage is assessed as **Level 2** as they could be expected to result in localised short-term impacts. Refer to: • Rocky Shores. • Sandy Beaches. • Coastal Settlements.

Table 6-24 Consequence evaluation for MDO hydrocarbon exposure – In-water

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
Ecological Receptors			
Habitat	Coral	Soft corals may be present within reef and hard substrate areas within the area predicted to be exposed above thresholds. Note that the greater wave action and water column mixing within the nearshore environment will also result in rapid weathering of the MDO residue.	Exposure of entrained hydrocarbons to shallow subtidal corals has the potential to result in lethal or sublethal toxic effects, resulting in acute impacts or death at moderate to high exposure thresholds (Shigenaka 2001). Contact with corals may lead to reduced growth rates, tissue decomposition, and poor resistance and mortality of sections of reef (NOAA 2010). However, given the lack of hard coral reef formations, and the sporadic cover of soft corals in mixed reef communities, such impacts are considered to be limited to isolated corals. Thus, the potential consequence to corals is assessed as **Level 2** based on the potential for localised short-term impacts to species/habitats of recognised conservation value, but not affecting local ecosystem functioning.
	Macroalgae	Macroalgae may be present within reef and hard substrate areas within the area predicted to be exposed above thresholds, however, it is not a dominant habitat feature in eastern Victoria or other regions of the EMBA. Note that the greater wave action and water column mixing within the nearshore	Reported toxic responses to oils have included a variety of physiological changes to enzyme systems, photosynthesis, respiration, and nucleic acid synthesis (Lewis & Pryor 2013). A review of field studies conducted after spill events by Connell et al. (1981) indicated a high degree of variability in the level of impact, but in all instances, the algae appeared to be able to recover rapidly from even very heavy oiling.

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
		environment will also result in rapid weathering of the MDO residue.	In the event that a TEC: Giant kelp marine forests of SE Australia is present within the area potentially affected following a spill, there is the potential to expose this important habitat to in-water hydrocarbons. However as described above, given hydrocarbons are expected to have limited impacts to macroalgae and as MDO is not sticky and expected to rapidly degrade upon release, the potential consequence to macroalgae is assessed as **Level 2** based on the potential for localised short-term impacts to species/habitats of recognised conservation value, but not affecting local ecosystem functioning.
	Seagrass	Seagrasses may be present within the area predicted to be exposed above thresholds. Seagrass in this region isn't considered a significant food source for marine fauna.	There is the potential that exposure could result in sub-lethal impacts, more so than lethal impacts, possibly because much of seagrasses' biomass is underground in their rhizomes (Zieman et al. 1984). Thus, the potential consequence to seagrass is assessed as **Level 2** based on the potential for localised short-term impacts to species/habitats of recognised conservation value, but not affecting local ecosystem functioning.
Marine Fauna	Plankton	Plankton are likely to be exposed to entrained above thresholds. Exposure above thresholds is predicted in the 0-10 m water depth, which is also where plankton are generally more abundant. Entrained phase MDO may intersect the Upwelling East of Eden KEF. While a spill would not affect the upwelling itself, if the spill occurs at the time of an upwelling event, it may result in krill being exposed to low (effects) level entrained phase MDO (99% species protection). Pygmy blue whales feeding on this krill may suffer from reduced prey, however, these impacts are expected to be extremely localised and temporary.	Relatively low concentrations of hydrocarbon are toxic to both plankton [including zooplankton and ichthyoplankton (fish eggs and larvae)]. Plankton risk exposure through ingestion, inhalation and dermal contact. Plankton are numerous and widespread but do act as the basis for the marine food web, meaning that an oil spill in any one location is unlikely to have long-lasting impacts on plankton populations at a regional level. Once background water quality conditions have re-established, the plankton community may take weeks to months to recover (ITOPF 2011f), allowing for seasonal influences on the assemblage characteristics. Thus, the potential consequence to plankton is assessed as **Level 2** based on the potential for short-term and localised impacts, but not affecting local ecosystem functioning.
	Invertebrates	The modelling indicates that temporary patches of entrained MDO may be present at 0-10 m water depth. Impact by direct contact of benthic species with hydrocarbon in the deeper areas of the release area is not expected given the surface nature of the spill and the water depths throughout much of the EMBA. Species closer to shore may be affected although	Acute or chronic exposure through contact and/or ingestion can result in toxicological risks. However, the presence of an exoskeleton (e.g. crustaceans) reduces the impact of hydrocarbon absorption through the surface membrane. Invertebrates with no exoskeleton and larval forms may be more prone to impacts. Localised impacts to larval stages may occur which could impact on population recruitment that year. Thus, the potential consequence to invertebrates including commercially fished invertebrates is assessed as **Level 2** based on the potential for localised short-term impacts to species/habitats of recognised conservation value, but not affecting local ecosystem functioning.

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
		these effects will be localised, low level and temporary, noting that in-water thresholds selected for interpretation are effects levels for 95-99% species protection. Filter-feeding benthic invertebrates such as sponges, bryozoans, abalone and hydroids may be exposed to sub-lethal impacts, however, population level impacts are considered unlikely. Tissue taint may occur and remain for several months in some species (e.g. lobster, abalone) however, this will be localised and low level with recovery expected. In-water invertebrates of value have been identified to include squid, crustaceans (rock lobster, crabs) and molluscs (scallops, abalone). Several commercial fisheries for marine invertebrates are within the area predicted to be exposed above the impact threshold: • Cth Southern Squid Jig Fishery. • Victorian Abalone Fishery. • Victorian Rock Lobster Fishery. • Victorian Giant Crab Fishery.	
	Fish and Sharks	Entrained hydrocarbon droplets can physically affect fish exposed for an extended duration (weeks to months). Effects will be greatest in the upper 10 m of the water column and areas close to the spill source where hydrocarbon concentrations are likely to be highest. Several fish communities in these areas are demersal and therefore more prevalent towards the seabed, which modelling does not predict is exposed >10m water depth. Therefore, any impacts are expected to be highly localised.	Pelagic free-swimming fish and sharks are unlikely to suffer long-term damage from oil spill exposure because dissolved/entrained hydrocarbons in water are not expected to be sufficient to cause harm (ITOPF, 2010). Subsurface hydrocarbons could potentially result in acute exposure to marine biota such as juvenile fish, larvae, and planktonic organisms, although impacts are not expected cause population-level impacts. Impacts on fish eggs and larvae entrained in the upper water column are not expected to be significant given the temporary period of water quality impairment, and the limited areal extent of the spill. As egg/larvae dispersal is widely distributed in the upper layers of the water column it is expected that current induced drift will rapidly replace any oil affected populations. Thus, the potential consequence to fish and sharks including commercially fished species is assessed as **Level 2** based on the potential for localised short-term impacts to species/habitats of recognised conservation value, but not affecting local ecosystem functioning.

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
		There is a known distribution and foraging BIA for the great white shark in the area predicted to be over the impact threshold, however, it is not expected that this species spends a large amount of time close to the surface where thresholds are predicted to be exceeded.	
	Pinnipeds	Localised parts of the foraging range for New Zealand fur-seals and Australian fur-seals may be temporarily exposed to low concentrations of entrained MDO in the water column (no dissolved phase).	Exposure to low/moderate effects level hydrocarbons in the water column or consumption of prey affected by the oil may cause sub-lethal impacts to pinnipeds, however given the temporary and localised nature of the spill, their widespread nature, the low-level exposure zones and rapid loss of the volatile components of MDO in choppy and windy seas (such as that of the EMBA), the potential consequence is assessed as **Level 2** based on the potential for localised short-term impacts to species/habitats of recognised conservation value, but not affecting local ecosystem functioning.
	Cetaceans	Several threatened, migratory and/or listed marine species have the potential to be migrating, resting or foraging within an area predicted to be above the surface thresholds. Known BIAs are present for foraging for the pygmy blue whale; distribution for the southern right whale and migration for the humpback whale. Cetacean exposure to entrained hydrocarbons can result in physical coating as well as ingestion (Geraci and St Aubin 1988). Such impacts are associated with 'fresh' hydrocarbon; the risk of impact declines rapidly as the MDO weathers.	The potential for impacts to cetaceans would be limited to a relatively short period following the release and would need to coincide with migration to result in exposure to a large number of individuals. However, such exposure is not anticipated to result in long-term population viability effects. A proportion of the migrating population of whales could be affected for a single migration event, thus potential consequence is assessed as **Level 2** based on the potential for localised short-term impacts to species/habitats of recognised conservation value, but not affecting local ecosystem functioning.
Social Receptors			

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
Human System	Commercial Fisheries and Recreational Fishing	In-water exposure to entrained MDO may result in a reduction in commercially targeted marine species, resulting in impacts to commercial fishing and aquaculture. Actual or potential contamination of seafood can affect commercial and recreational fishing and can impact seafood markets long after any actual risk to seafood from a spill has subsided (NOAA 2002) which can have economic impacts to the industry. Several commercial fisheries operate in the EMBA and overlap the spatial extent of the water column hydrocarbon predictions.	Any acute impacts are expected to be limited to small numbers of juvenile fish, larvae, and planktonic organisms, which are not expected to affect population viability or recruitment. Impacts from entrained exposure are unlikely to manifest at a fish population viability level. Any exclusion zone established would be limited to the immediate vicinity of the release point, and due to the rapid weathering of MDO would only be in place 1-3 days after release, therefore physical displacement to vessels is unlikely to be a significant impact. Thus, the potential consequence to commercial and recreational fisheries is assessed as **Level 2** based on the potential for localised short-term impacts to species/habitats of recognised conservation value, but not affecting local ecosystem functioning. Refer also to: • Fish and Sharks. • Invertebrates.
Natural System	State Marine Protected Areas	Marine protected areas predicted to be exposed to entrained hydrocarbons above thresholds are Cape Howe Marine National Park and the Point Hicks Marine National Park. Conservation values for these areas include high marine fauna and flora diversity, including fish and invertebrate assemblages and benthic coverage (sponges, soft corals, macroalgae).	Based on the worse case potential consequence to key receptors the consequence to protected marine areas is assessed **Level 2.** Refer to: • Invertebrates. • Macroalgae. • Pinnipeds.
	Key Ecological Features	Big Horseshoe Canyon and Upwelling East of Eden are predicted to be exposed to entrained hydrocarbons above thresholds. Values associated with these areas are: • Big Horseshoe Canyon – hard substrate for benthic flora and fauna.	Based on the worse case potential consequence to key receptors within these KEFs, the potential consequence is assessed to be **Level 2**. Refer also to: • Coral. • Macroalgae. • Seagrass. • Plankton.

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
		• Upwelling East of Eden – high productivity and aggregations of whales, seals, sharks and seabirds.	• Invertebrates • Seabirds. • Fish and Sharks. • Marine mammals (Pinnipeds, Cetaceans).

6.7.4.2 LOWC

Below is a summary of the results from the stochastic modelling undertaken for a loss of containment caused by vessel collision and outline the area potentially exposed to hydrocarbons. The modelling report is provided in Appendix 7. The ecological and social receptors with the potential to be exposed to surface, shoreline accumulation and in-water hydrocarbons from a loss of containment caused by a LOWC are evaluated in Table 6-25, Table 6-26 and Table 6-27 respectively.

The BMG crude oil contains approximately 40.3% persistent compounds characterised by a high pour point (above ambient water temperature) and a wax content of 27.7%. This portion of the crude will likely solidify over time to form small waxy flakes as it loses the light end hydrocarbons that act as solvent to the heavier compounds (RPS, 2021).

Surface Exposure (Figure 6-20)

- The predicted maximum distance of surface exposure from the release location at moderate exposure threshold (≥ 10 g/m^2) was 386 km NE and at high exposure threshold (≥ 50 g/m^2) was 140 km ENE.
- Floating oil at, or above the low threshold was predicted to cross into New South Wales, Tasmania and Victoria state waters with probabilities of 82%, 4% and 99%, respectively.

Shoreline Exposure

- Probability of shoreline contact at low thresholds (10-100 g/m^2) was 100%
- The minimum time before shoreline accumulation was approximately 3.42 days and the maximum volume of oil ashore was 1,975 m^3.
- The maximum volume of oil to accumulate on a shoreline receptor was 1,658.1 m^3, predicted at East Gippsland.
- East Gippsland and Points Hicks recorded the highest probabilities of shoreline accumulation at the low threshold with 100% and 95%, respectively.
- East Gippsland and Cape Howe / Mallacoota recorded the highest probabilities of shoreline accumulation at the high threshold with 53% and 50%, respectively. The minimum time before high shoreline accumulation was 4.13 days, predicted at East Gippsland and Cape Howe / Mallacoota.

In-Water Exposure – Dissolved

- In the surface (0-10 m) depth layer, of 34 BIAs were predicted to be exposed to dissolved hydrocarbons at or above the high threshold. Aside from the BIAs that intersect the Operational Area, the highest probabilities of exposure to moderate and high dissolved hydrocarbons were predicted as 95% and 29% at the Southern Right Whale – Migration BIA.
- Six AMPs were predicted to be exposed to dissolved hydrocarbons at, or above the low threshold with the highest probability predicted at East Gippsland with 85%. Four AMPs were predicted to be exposed to dissolved hydrocarbons at, or above the high threshold with probabilities of 1% (Beagle, Flinders and Freycinet) and 3% (East Gippsland).
- Dissolved hydrocarbons at, or above the low threshold were predicted to cross into New South Wales, Tasmania and Victoria state waters with probabilities of 95% and 16% and 95%, respectively.

In-Water Exposure – Entrained

- In the surface (0-10 m) depth layer, a total of 54 BIAs were predicted to be exposed to entrained oil at or above the low and high thresholds. Aside from the BIAs that intersect the Operational Area, the highest probability of high entrained exposure was 95%, predicted at 8 BIAs (Humpback Whale – Foraging, Indo-Pacific/Spotted Bottlenose Dolphin – Breeding, Little Penguin – Foraging, Short-tailed Shearwater – Foraging, Southern Right Whale – Migration, Wedge-tailed Shearwater – Foraging, White Shark – Foraging, White-faced Storm-petrel – Foraging).
- A total of 18 AMPs were predicted to be exposed to entrained hydrocarbons at, or above the low threshold during the annualised conditions. East Gippsland and Flinders recorded the highest probability of low entrained exposure with 95% while East Gippsland recorded a 76% probability of exposure to entrained hydrocarbons at, or above the high threshold.
- A total of 11 reefs, shoals and banks were predicted to be exposed to entrained hydrocarbons at, or above the low threshold. The New Zealand Star Bank and Beware Reef recorded the highest

probabilities of exposure to low and high entrained hydrocarbons with 95% and 90% probabilities at the low threshold and 95% and 46% at the high threshold, respectively.

- Entrained hydrocarbons at, or above the low threshold were predicted to cross into New South Wales, Tasmania and Victoria state waters with probabilities of 95% and 51% and 95%, respectively.

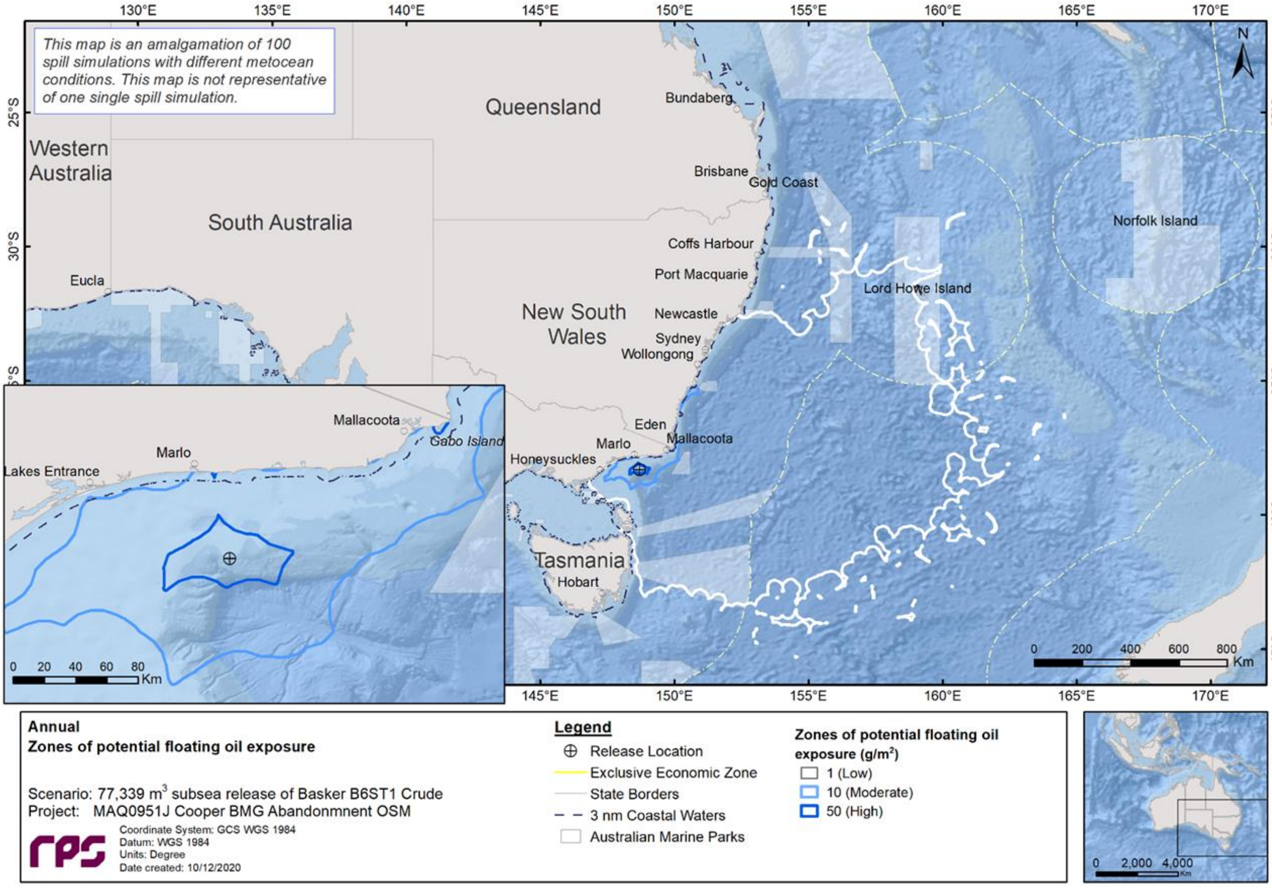


Figure 6-20: Zones of potential floating oil exposure, in the event of a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days. The results were calculated from 100 spill trajectories simulated during annual conditions

Table 6-25 Consequence evaluation for Basker Crude hydrocarbon exposure – Surface

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
Ecological Receptors			
Marine Fauna	Seabirds and Shorebirds	Listed marine, threatened and/or migratory bird species have the potential to be rafting, resting, diving and feeding within the area predicted to be exposed to >10 g/m^2 surface hydrocarbons. There are several foraging BIAs that are present within the area potentially exposed to >10 g/m^2 surface hydrocarbons for albatross, petrel, and shearwater species, and the Little Penguin. Foraging BIAs are typically large broad areas (e.g. Antipodean Albatross); but can be smaller segmented for some species (e.g. Little Penguin) (see Section 3.10 of Addendum 1). The birds can feed via surface skimming or diving – both exposing the bird to any oil on the water surface. No breeding activity occurs in oceanic waters. Based on deterministic modelling scenarios a maximum of 438 km^2 of surface oil >10 g/m^2 would be present during a single day during the spill event (day 41 of the deterministic scenario); therefore, exposure pathway would be limited to contact within this area. Over time, persistent compounds and wax content of the Basker Crude will solidify to form small waxy flakes. Due to the nature of the oil, there is not expected to be an exposure pathway to oiling of bids; however, the potential for ingestion or inhalation exposure pathways will still be present.	Birds foraging or resting at sea have the potential to directly interact with oil on the sea surface. Direct contact with hydrocarbons can foul feathers, which may result in hypothermia due to a reduction in the ability of the bird to thermo-regulate and impair water-proofing. Direct contact with surface hydrocarbons may also result in dehydration, drowning and starvation. Oiling of birds can also suffer from damage to external tissues, including skin and eyes, as well as internal tissue irritation in their lungs and stomachs. Toxic effects may result where the oil is ingested as the bird attempts to preen its feathers, or via consumption of oil-affected prey. Fresh crude has been shown to be more toxic than weathered crude to birds. Due to the waxy flake-like nature of the oil once solidification begins, minimal impact from direct oiling is expected, and therefore this is not considered a significant impact at a population level. Marine pollution is listed as a threat for several migratory shorebirds and seabird conservation advice / recovery plans (refer to Table 2-5), however management actions mostly relate to nesting locations. Consequently, the potential impacts and risks to seabirds from a LOWC event are considered to be **Level 2**, as they could be expected to result in localised short-term impacts to species/habitats of recognised conservation value but not affecting local ecosystem functioning.
	Marine Reptiles	Listed marine, threatened and/or migratory marine turtle species have the potential to be present within the area predicted to be exposed to >10 g/m^2 surface oil. There is no identified critical habitat, or spatially defined aggregations (i.e. no BIA's) for marine turtles within the area; as such exposure is expected to be minimal. Over time, persistent compounds and wax content of the Baster Crude will solidify to form small waxy flakes. Due to the nature of	Marine turtles are vulnerable to the effects of oil at all life stages. Marine turtles can be exposed to surface oil externally (i.e. swimming through oil slicks) or internally (i.e. swallowing the oil). Ingested oil can harm internal organs and digestive function. Oil on their bodies can cause skin irritation and affect breathing. Due to the waxy flake-like nature of the oil, minimal impact from direct oiling is expected, and therefore this is not considered a significant impact at a population level. Marine pollution is listed as a threat to marine turtle in the Recovery Plan for Marine Turtles in Australia, 2017- 2027, particularly in relation to shoreline oiling of nesting beaches. There are

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
		the oil, there is not expected to be an exposure pathway to oiling of marine turtles; however, the potential for ingestion or inhalation exposure pathways will still be present.	no nesting beaches within the EMBA, and the activity will be conducted in a manner which is not inconsistent with the relevant management actions. Consequently, the potential impacts and risks to marine turtles from a LOWC event are considered to be **Level 2**, as they could be expected to result in localised short-term impacts to species/habitats of recognised conservation value but not affecting local ecosystem functioning.
	Marine Mammals (Pinnipeds)	Listed marine and/or threatened pinniped species have the potential to be foraging within the area predicted to be exposed to >10 g/m^2 surface oil. Both the Australian and New Zealand Fur Seal are known to forage in both coastal and pelagic waters; however, there are no spatially defined aggregations (i.e. no BIA's) for pinnipeds within the area. Based on deterministic modelling scenarios a maximum of 438 km^2 of surface oil >10 g/m^2 would be present during a single day during the spill event; therefore, the exposure pathway would be limited to contact within this area. Over time, persistent compounds and wax content of the Baster Crude will solidify to form small waxy flakes. Due to the nature of the oil, there is not expected to be an exposure pathway to oiling of pinnipeds; however, the potential for ingestion or inhalation exposure pathways will still be present.	Pinnipeds are vulnerable to sea surface exposures given they spend much of their time on or near the surface of the water, as they need to surface regularly to breathe. Pinnipeds have high site fidelity and can be less likely to exhibit avoidance behaviours, thus staying near established colonies and haul-out areas. Exposure to surface oil can result in skin and eye irritations and disruptions to thermal regulation. Fur seals are particularly vulnerable to hypothermia from oiling of their fur. Exposure to oil may also results in physiological effects from toxic fume inhalation, biological impacts from ingestion of the oil, and may reduce reproduction levels. 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 (Engelhardt, 1982; Addison & Brodie, 1984; Addison et al., 1986). Due to the waxy flake-like nature of the oil, minimal impact from direct oiling is expected, and therefore this is not considered a significant impact at a population level. Fur seals are known to forage throughout the Gippsland, and have been sighted foraging at BMG. Conservation Listing Advice for the *Neophoca cinerea* (Australian sea lion) (TSSC, 2010) identifies oil spills as a potential threat to habitat. Activities within this Environment Plan will not be inconsistent with the conservation and management priorities outlined in this advice. Consequently, the potential impacts and risks to pinnipeds from a LOWC event are considered to be **Level 2,** as they could be expected to result in localised short-term impacts to species/habitats of recognised conservation value but not affecting local ecosystem functioning.
	Marine Mammals (Cetaceans)	Listed threatened and/or migratory cetacean species have the potential to be migrating, resting or foraging within the area predicted to exposed to >10 g/m^2 surface oil.	Cetaceans can be exposed to the chemicals in oil through internal exposure by consuming oil or contaminated prey; inhaling volatile oil compounds when surfacing to breathe; external exposure by swimming through oil and having oil directly on the skin and body; and maternal

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
		A foraging BIA for the Pygmy Blue Whale occurs in the area with the greatest probability of being exposed; this BIA is a broad area extending through Victorian and Tasmanian waters (see Section 3.14 of Addendum 1). Based on deterministic modelling scenarios a maximum of 438 km^2 of surface oil >10 g/m^2 would be present during a single day during the spill event; therefore, exposure pathway would be limited to contact within this area. There is also a migration BIA within nearshore waters along the Victorian coast for the Southern Right Whale; and a foraging BIA for the Humpback Whale and a breeding BIA for the Indian Ocean Bottlenose Dolphin, both extending northwards from the Victoria/NSW border. However, all these areas have a <10% probability of being exposed to surface concentrations of >10 g/m^2. Over time, persistent compounds and wax content of the Baster Crude will solidify to form small waxy flakes. Due to the nature of the oil, there is not expected to be an exposure pathway to oiling of cetaceans; however, the potential for ingestion or inhalation exposure pathways will still be present.	transfer of contaminants to embryos (NRDA, 2012). Baleen whales (e.g. Blue Whales) are more susceptible to ingestion of surface oil as they feed by skimming the surface; whereas toothed whales and dolphins are less susceptible as they feed at depth. Evidence suggests that many cetacean species are unlikely to detect and avoid spilled oil (Harvey & Dahlheim 1994, Matkin et al. 2008). However, as highly mobile species, it is not expected that these animals will be constantly exposed to concentrations of hydrocarbons for continuous durations (e.g. >96 hours) that would lead to chronic effects. Note also, many marine mammals appear to have the necessary liver enzymes to metabolise hydrocarbons and excrete them as polar derivatives Due to the waxy flake-like nature of the oil once solidified, minimal impact from direct oiling is expected, and therefore this is not considered a significant impact at a population level. Habitat degradation caused by marine pollution is listed as a threat for several cetaceans in the relevant conservation advice / recovery plans (refer to Table 2-5). Activities within this Environment Plan will not be inconsistent with the conservation and management actions outlined in this advice. Consequently, the potential impacts and risks to cetaceans are considered to be **Level 2**, as they could be expected to result in localised short-term impacts to species/habitats of recognised conservation value but not affecting local ecosystem functioning.
Social Receptors			
Natural Systems	Commonwealth Areas, Parks and Reserves	East Gippsland Marine Park is the only AMP within the area predicted to be exposed to >10 g/m^2 surface oil. The major conservation values for this AMP are identified as foraging areas for some species of birds (e.g. petrels, shearwaters, albatross), and a migration path for the Humpback Whale. Over time, persistent compounds and wax content of the Baster Crude will solidify to form small waxy flakes. Due to the nature of the oil, there is not expected to be an exposure pathway to oiling of marine fauna; however, the potential for ingestion and/or inhalation exposure pathways will still be present.	Based on the potential risks of key receptors (i.e. seabirds, cetaceans), the potential impacts and risks to Commonwealth Marine Parks are considered to be **Level 2**, as they could be expected to result in localised short-term impacts to species/habitats of recognised conservation value but not affecting local ecosystem functioning. Relatively low concentrations of hydrocarbon can be toxic to plankton. Plankton risk exposure through ingestion, inhalation and dermal contact. Refer also to: • Seabirds and Shorebirds; and • Marine mammals (Cetaceans).

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
	State Marine Protected Areas	Cape Howe Marine Park, Point Hicks Marine Park and Ninety Mile Beach Marine Park are within the area predicted to be exposed to >10 g/m^2 surface oil. Values associated with these areas include providing habitats for a diverse range of invertebrates, fish, mammals and birds. Over time, persistent compounds and wax content of the Baster Crude will solidify to form small waxy flakes. Due to the nature of the oil, there is not expected to be an exposure pathway to oiling of marine fauna; however, the potential for ingestion and/or inhalation exposure pathways will still be present.	Based on the potential risks of key receptors (e.g. seabirds, cetaceans), the potential impacts and risks to State marine protected areas are considered to be **Level 2**, as they could be expected to result in localised short-term impacts to species/habitats of recognised conservation value but not affecting local ecosystem functioning. Refer also to: Refer also to: • Seabirds and Shorebirds; and • Marine mammals (Pinnipeds, Cetaceans).
Human Systems	Coastal Settlements	Nearshore waters from Victoria to southern Queensland are within the area potentially exposed to >0.5 g/m^2 surface oil; however, the stretch of coast along eastern Victoria and southern NSW has the highest probability of exposure. Key locations within this section of coast include Marlo and Mallacoota. Over time, persistent compounds and wax content of the Baster Crude will solidify to form small waxy flakes. Therefore, due to the nature of the oil, a visible sheen is not expected to be observed as the material will be in a solid form. Due to its solid state, a more credible threshold for visibility may be >10 g/m^2. At this threshold, the oil is not expected to the visible from most coastal settlements; it may be visible at Mallacoota although it has a low probability of exposure at this concentration.	Visible surface hydrocarbons have the potential to reduce the visual amenity of the area for public use and activities. Given the nature of the oil, it is expected to remain in /waxy flake-like state; and in most cases surface oiling is not expected to the visible from shore. Consequently, the potential impacts and risks to coastal settlements from a LOWC event are considered to be **Level 2** as they could be expected to result in localised short-term impacts
	Recreation and Tourism	Nearshore waters from Victoria to southern Queensland are within the area potentially exposed to >0.5 g/m^2 surface oil; however, the stretch of coast along eastern Victoria and southern NSW has the highest probability of exposure. Popular recreation and tourism locations within this stretch of coast includes the area around Mallacoota. Over time, persistent compounds and wax content of the Baster Crude will solidify to form small waxy flakes. Therefore, due to	Visible surface hydrocarbons have the potential to reduce the visual amenity of the area for tourism, and discourage recreational activities. It is expected that the majority of these activities are undertaken in coastal waters, not at large distances offshore. Given the nature of the oil, it is expected to remain in waxy flake-like state; and in most cases surface oiling is not expected to the visible from shore. Consequently, the potential impacts and risks to recreation and tourism from a LOWC event are considered to be **Level 2** as they could be expected to result in localised short-term impacts

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
		the nature of the oil, a visible sheen is not expected to be observed as the material will be in a solid form. Due to its solid state, a more credible threshold for visibility may be >10 g/m^2. At this threshold, the oil is not expected to the visible from most of the coast; it may be visible at Mallacoota although it has a low probability of exposure at this concentration.	Refer also to: • Coastal Settlements; • Marine Mammals (Pinnipeds, Cetaceans); and • State Marine Protected Areas.
	Heritage	Nearshore waters from Victoria to southern Queensland are within the area potentially exposed to >0.5 g/m^2 surface oil; however, the stretch of coast along eastern Victoria and southern NSW has the highest probability of exposure. Specific locations of spiritual and ceremonial places of significance, or cultural artefacts, are often unknown, but are expected to be present along the mainland coast. Over time, persistent compounds and wax content of the Baster Crude will solidify to form small waxy flakes. Therefore, due to the nature of the oil, a visible sheen is not expected to be observed as the material will be in a solid form. Due to its solid state, a more credible threshold for visibility may be >10 g/m^2. At this threshold, the oil is not expected to the visible from most of the coast; it may be visible at Mallacoota although it has a low probability of exposure at this concentration.	Visible surface hydrocarbons have the potential to reduce the visual amenity of known heritage sites along the coast. Given the nature of the oil, it is expected to remain in waxy flake-like state; and in most cases surface oiling is not expected to the visible from shore. Consequently, the potential impacts and risks to heritage from a LOWC event are considered to be **Level 2** as they could be expected to result in localised short-term impacts Refer also to: • Coastal Settlements.

Table 6-26 Consequence evaluation for Basker Crude hydrocarbon exposure – In-water

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
Ecological Receptors			
Habitat	Seagrass	Seagrass meadows are predicted to be within the area potentially exposed to in-water concentrations above the environmental impact thresholds.	Seagrasses can exhibit lethal and sub-lethal effects from direct contact (i.e. smothering), or indirect contact (e.g. chemical update from oil affected sediments or through plant membranes). Once internal, the toxic components of the oil tend to accumulate in the

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
		Within shallower coastal waters, there is a low probability of seagrass exposure (e.g. for seagrass meadows around Gabo Island, there is a <2% probability of exposure). The light components of Basker Crude will quickly evaporate, leaving the persistent components and wax content which will solidify into small waxy flakes. Entraining of oil within the water column depends upon winds; moderate winds (> 10 knots) allow oil to remain entrained within the water column, whilst lower wind conditions result in majority surface exposure. Due to the nature of the oil, there is not expected to be an exposure pathway to the smothering of seagrass.	chloroplasts, therefore affecting photosynthesis abilities. Studies report that the phytotoxic effect of petroleum oil on seagrasses can lead to a range of sub-lethal responses including reduced growth rates (Howard & Edgar, 1994), bleaching, decrease in the density of shoots, and reduced flowering success (den Hartog & Jacobs, 1980; Dean *et al.,* 1998). Exposure does not always induce toxic effects, with variability in impact in both laboratory studies and actual spill events. There is the potential that exposure could result in sub-lethal impacts, more so than lethal impacts, possibly because much of seagrasses biomass is underground in their rhizomes (Zieman *et al.* 1984). 'Seagrass Dominated' habitat can be found within the spill EMBA (areas with greater than 5% coverage of seagrass; OzCoasts 2015). Consequently, the potential impacts to seagrass are considered to be **Level 2**, as they could be expected to result in localised short-term impacts to species/habitats of recognised conservation value, but not affecting local ecosystem functioning.
	Macroalgae	Macroalgae communities are predicted to be within the area potentially exposed to in-water concentrations above the environmental impact thresholds. Within shallower coastal waters, there is a low probability of macroalgae exposure (e.g. for seagrass meadows around Gabo Island, there is a <2% probability of exposure). Known locations of the Giant Kelp Marine Forrest of Southeast Australia TEC are not expected to be exposed above threshold. The light components of Basker Crude will quickly evaporate, leaving the persistent components and wax content which will solidify into small waxy flakes. Entraining of oil within the water column depends upon winds; moderate winds (> 10 knots) allow oil to remain entrained within the water column, whilst lower wind conditions result in majority surface exposure. Due to the nature of the oil, there is not expected to be an exposure pathway to the smothering of macroalgae.	The effect of hydrocarbons however is largely dependent on the degree of direct exposure and how much of the hydrocarbon adheres to algae. Toxic responses of macroalgae to oils include a variety of physiological changes to enzyme systems, photosynthesis, respiration, and nucleic acid synthesis (Lewis & Pryor 2013). A review of field studies conducted after spill events by Connell *et al* (1981) indicated a high degree of variability in the level of impact, but in all instances, the algae appeared to be able to recover rapidly from even very heavy oiling. Other studies have indicated that oiled kelp beds had a 90% recovery within 3-4 years of impact, however full recovery to pre-spill diversity may not occur for long periods after the spill (French-McCay, 2004). Areas of macroalgae are known to occur within the spill EMBA. Consequently, the potential impacts to macroalgae are considered to be **Level 2**, as they could be expected to result in localised short-term impacts to species/habitats of recognised conservation value, but not affecting local ecosystem functioning.

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
Marine Fauna	Plankton	Plankton are predicted to be within the area potentially exposed to in-water concentrations above the environmental impact thresholds. Plankton are found throughout nearshore and open waters, and are typically more abundant in surface waters. Increased abundance may also occur around upwelling features (e.g. the Upwelling East of Eden KEF). The light components of Basker Crude will quickly evaporate, leaving the persistent components and wax content which will solidify into small waxy flakes. Entraining of oil within the water column depends upon winds; moderate winds (> 10 knots) allow oil to remain entrained within the water column, whilst lower wind conditions result in majority surface exposure. Due to the nature of the oil, there is not expected to be an exposure pathway to the smothering of plankton; however, the potential for ingestion or inhalation exposure pathways will still be present.	Phytoplankton are typically not sensitive to the impacts of oil, though they do accumulate it rapidly (Hook et al., 2016). Phytoplankton exposed to hydrocarbons may directly affect their ability to photosynthesize and impact for the next trophic level in the food chain (Hook *et al.*, 2016). Zooplankton (microscopic animals such as rotifers, copepods and krill that feed on phytoplankton) are vulnerable to hydrocarbons (Hook *et al.,* 2016). Water column organisms that come into contact with oil risk exposure through ingestion, inhalation and dermal contact (NRDA, 2012), which can cause immediate mortality or declines in egg production and hatching rates along with a decline in swimming speeds (Hook et al., 2016). Plankton is generally abundant in the upper layers of the water column and is the basis of the marine food web, so an oil spill in any one location is unlikely to have long-lasting impacts on plankton populations at a regional level. Reproduction by survivors or migration from unaffected areas is likely to rapidly replenish losses (Volkman et al., 2004). Oil spill field observations show minimal or transient effects on plankton (Volkman *et al.,* 2004). Once background water quality is re-established, plankton takes weeks to months to recover (ITOPF, 2011a). Consequently, the potential impacts to plankton are considered to be **Level 2**, as they could be expected to cause short-term and localised impacts, but not affecting local ecosystem functioning.
	Invertebrates	Invertebrates are predicted to be within the area potentially exposed to in-water concentrations above the environmental impact thresholds. Invertebrates of value have been identified to include squid, crustaceans (rock lobster, crabs) and molluscs (scallops, abalone). Several commercial fisheries for marine invertebrates are within the area predicted to be exposed above the impact threshold: • Cth Southern Squid Jig Fishery • Cth Bass Strait Central Zone Scallop Fishery, however the areas fished for scallops in 2019 was centred around the eastern Bass Strait, adjacent to Kind Island, and not within the predicted exposure area.	Acute or chronic exposure, through direct contact, and/or ingestion can result in toxicological impacts, reproductive impacts, smothering and potentially cause death. However, the presence of an exoskeleton (e.g., crustaceans) will reduce the impact of hydrocarbon absorption through the surface membrane. Other invertebrates with no exoskeleton and larval forms may be more sensitive to impacts from hydrocarbons. If invertebrates are contaminated by hydrocarbons, tissue taint can remain for several months, but can eventually be lost. Consequently, the potential impacts and risks to invertebrates from a LOWC event are considered to be **Level 2**, as they could be expected to result in localised short-term impacts to species/habitats of recognised conservation value but not affecting local ecosystem functioning.

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
		• The Victorian fisheries that have jurisdiction into Commonwealth waters are either currently not active in the area (e.g. no current licences for Giant Crab in the eastern zone), or the exposed area is beyond the typical water depths of the target species (e.g. Abalone, Rock Lobster). Note, those fisheries that are benthic based (i.e. scallops, rock lobster) are not expected to be exposed given the predicted in-water hydrocarbons are in surface waters only. The light components of Basker Crude will quickly evaporate, leaving the persistent components and wax content which will solidify into small waxy flakes. Entraining of oil within the water column depends upon winds; moderate winds (> 10 knots) allow oil to remain entrained within the water column, whilst lower wind conditions result in majority surface exposure. Due to the nature of the oil, there is not expected to be an exposure pathway to the smothering of invertebrates; however, the potential for ingestion or inhalation exposure pathways will still be present.	
	Fish and Sharks	Listed marine, threatened and/or migratory fish and shark species have the potential to be migrating, resting or foraging within the area predicted to exposed to in-water concentrations above the environmental impact thresholds. A foraging BIA for the great white shark occurs in the area predicted to be above impact threshold; however, it has a <10% probability of exposure. The BIA is one of a number of small foraging BIAs within Victorian and Tasmanian waters (see Section 3.12 of Addendum 1). The light components of Basker Crude will quickly evaporate, leaving the persistent components and wax content which will solidify into small waxy flakes. Entraining of oil within the water column depends upon winds; moderate winds (> 10 knots) allow oil to remain entrained within the water column, whilst lower wind conditions result in majority surface exposure.	Fish can be exposed to oil through a variety of pathways, including direct dermal contact (e.g. swimming through oil); ingestion (e.g. directly or via food base); and inhalation (e.g. elevated dissolved contaminant concentrations in water passing over the gills). Exposure to hydrocarbons in the water column can be toxic to fishes. Studies have shown a range of impacts including changes in abundance, decreased size, inhibited swimming ability, changes to oxygen consumption and respiration, changes to reproduction, immune system responses, DNA damage, visible skin and organ lesions, and increased parasitism. However, many fish species can metabolize toxic hydrocarbons, which reduces the risk of bioaccumulation of contaminants (NRDA, 2012). Pelagic free-swimming fish and sharks are unlikely to suffer long-term damage from oil spill exposure because dissolved/entrained hydrocarbons in water are not expected to be sufficient to cause harm (ITOPF, 2010). Pelagic species are also generally highly mobile and as such are not likely to suffer extended exposure (e.g. >96 hours) at concentrations that would lead to chronic effects due to their patterns of movement. Demersal fish are not expected to be impacted given the presence of in-water hydrocarbons in surface layers only.

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
		Due to the nature of the oil, there is not expected to be an exposure pathway to oiling of fish and sharks; however, the potential for ingestion or inhalation exposure pathways will still be present.	Fishes are most vulnerable to hydrocarbon discharges during their embryonic, larval and juvenile life stages. Impacts on eggs and larvae entrained in the upper water column are not expected to be significant given the temporary period of water quality impairment, and the limited areal extent of the spill. As egg/larvae dispersal is widely distributed in the upper layers of the water column it is expected that current induced drift will rapidly replace any oil affected populations. Consequently, the potential impacts and risks to fish and sharks are considered to be **Level 2**, as they could be expected to result in localised short-term impacts to species/habitats of recognised conservation value but not affecting local ecosystem functioning.
	Cetaceans	Listed threatened and/or migratory cetacean species have the potential to be migrating, resting or foraging within the area predicted to exposed to in-water concentrations above the environmental impact thresholds. A foraging BIA for the pygmy blue whale occurs in the area with the greatest probability of being exposed; this BIA is a broad area extending through Victorian and Tasmanian waters (see Section 3.14 Addendum 1). There is also a migration BIA within nearshore waters along the Victorian coast for the southern right whale; and a foraging BIA for the humpback whale and a breeding BIA for the Indian ocean bottlenose dolphin, both extending northwards from the Victoria/NSW border. However, all these areas have a <10% probability of being exposed to in-water concentrations above the environmental impact thresholds. The light components of Basker Crude will quickly evaporate, leaving the persistent components and wax content which will solidify into small waxy flakes. Entraining of oil within the water column depends upon winds; moderate winds (> 10 knots) allow oil to remain entrained within the water column, whilst lower wind conditions result in majority surface exposure. Due to the nature of the oil, there is not expected to be an exposure pathway to oiling of cetaceans; however, the potential	Exposure to in-water hydrocarbons can result in physical coating as well as ingestion. Cetaceans can be exposed to the chemicals in oil through internal exposure by consuming oil or contaminated prey; external exposure by swimming through oil and having oil directly on the skin and body; and maternal transfer of contaminants to embryos (NRDA, 2012). Baleen whales (e.g. Blue Whales) are less susceptible to ingestion of in-water hydrocarbons as they feed by skimming the surface; whereas toothed whales and dolphins are more susceptible as they feed at depth. Evidence suggests that many cetacean species are unlikely to detect and avoid spilled oil (Harvey & Dahlheim 1994, Matkin et al. 2008). However, as highly mobile species, it is not expected that these animals will be constantly exposed to concentrations of hydrocarbons for continuous durations (e.g. >96 hours) that would lead to chronic effects. Note also, many marine mammals appear to have the necessary liver enzymes to metabolise hydrocarbons and excrete them as polar derivatives. Consequently, the potential impacts and risks to cetaceans are considered to be **Level 2**, as they could be expected to result in localised short-term impacts to species/habitats of recognised conservation value but not affecting local ecosystem functioning.

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
		for ingestion or inhalation exposure pathways will still be present.	
Social Receptors			
Natural System	Commonwealth Areas, Parks and Reserves	No AMP are within the area predicted to be exposed to in-water concentrations above the environmental impact thresholds.	Based on the potential risks of key receptors (e.g. cetaceans, plankton), the potential impacts and risks to State marine protected areas are considered to be **Level 2**, as they could be expected to result in localised short-term impacts to species/habitats of recognised conservation value but not affecting local ecosystem functioning. Refer also to: • Plankton; and • Marine Mammals (Cetaceans).
	State Parks and Reserves	Batemans Marine Park, Jervis Bay Marine Park and Port Stephens – Great Lakes Marine Park are within the area predicted to be exposed to in-water concentrations above the environmental impact thresholds. The marine reserve has a range of habitats, including seagrass beds in the shallow waters, and sponge gardens in deeper waters. The area supports a high diversity of marine biota, particularly fish species. The light components of Basker Crude will quickly evaporate, leaving the persistent components and wax content which will solidify into small waxy flakes. Entraining of oil within the water column depends upon winds; moderate winds (> 10 knots) allow oil to remain entrained within the water column, whilst lower wind conditions result in majority surface exposure. Due to the nature of the oil, there is not expected to be an exposure pathway to the smothering of marine flora; or the oiling of marine fauna (however, the potential for ingestion and/or inhalation exposure pathways will still be present).	Based on the potential risks of key receptors (e.g. fish), the potential impacts and risks to State marine protected areas are considered to be **Level 2**, as they could be expected to result in localised short-term impacts to species/habitats of recognised conservation value but not affecting local ecosystem functioning. Refer also to: • Seagrass; • Macroalgae; and • Fish and Sharks.
Human System	Commercial Fisheries	Offshore waters of eastern Victoria area within the area potentially exposed to in-water concentrations above the environmental impact thresholds.	Commercial fishing has the potential to be impacted through exclusion zones associated with the spill, the spill response and subsequent reduction in fishing effort. Exclusion zones may impede access to commercial fishing areas, for a short period of time, and nets and lines may become oiled.

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
		Commercial fisheries with management areas overlapping this area of predicted exposure includes: • Cth Southern Squid Jig Fishery • Cth Southern and Eastern Scalefish and Shark Fishery; • The Victorian fisheries that have jurisdiction into Commonwealth waters are either currently not active in the area (e.g. no current licences for Giant Crab in the eastern zone), or the exposed area beyond the typical water depths of the target species (e.g. Rock Lobster). Note, those fisheries that are benthic based (e.g. rock lobster) are not expected to be exposed given the predicted in-water hydrocarbons are in surface waters only. The light components of Basker Crude will quickly evaporate, leaving the persistent components and wax content which will solidify into small waxy flakes. Entraining of oil within the water column depends upon winds; moderate winds (> 10 knots) allow oil to remain entrained within the water column, whilst lower wind conditions result in majority surface exposure. Due to the nature of the oil, there is not expected to be an exposure pathway to oiling of fish and sharks; however, the potential for ingestion or inhalation exposure pathways will still be present.	Actual or potential contamination of seafood can affect commercial and recreational fishing, and can impact seafood markets long after any actual risk to seafood from a spill has subsided (NOAA, 2002) which can have economic impacts to the industry. In-water exposure to hydrocarbons may result in a reduction in commercially targeted marine species, resulting in impacts to commercial fishing (refer to previous assessment of impacts to fish and sharks). Consequently, the potential impacts and risks to cetaceans are considered to be **Level 2**, as they could be expected to result in some impact on business reputation and/or localised short-term impacts to species/habitats of recognised conservation value but not affecting local ecosystem functioning. Refer also to: • Fish and Sharks.
	Recreation and Tourism	Offshore waters of eastern Victoria are within the area predicted to be exposed to in-water concentrations above the environmental impact thresholds. Offshore recreational fishing (defined as > 5km from the coast) only accounts for ~4% of national fishing activity (Addendum 1); therefore, exposure to the Basker Crude is expected to be limited. Similarly, exposure to whale watching charters or other tourism-based charters, are expected to be limited within the area with high probability of exposure, given the distance (55 km) offshore.	In-water hydrocarbons have the potential to affect ecological receptors (e.g. fish, cetaceans) that form the basis of offshore recreational and tourism activities. However, given that recreation and tourism is expected to be minimal in offshore areas, no significant disruption to these industries from in-water hydrocarbon is expected. Consequently, the potential impacts and risks to recreation and tourism are considered to be **Level 2** as they could be expected to result in localised short-term impacts. Refer also to: • Fish and Sharks; and • Marine mammals (Cetaceans).

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
		The light components of Basker Crude will quickly evaporate, leaving the persistent components and wax content which will solidify into small waxy flakes. Entraining of oil within the water column depends upon winds; moderate winds (> 10 knots) allow oil to remain entrained within the water column, whilst lower wind conditions result in majority surface exposure. Tourism and recreation activities can be indirectly exposed to impacts from in-water hydrocarbons, as the activities are often linked to the presence of ecological features, such as marine fauna (e.g. whale watching, recreational fishing).	

Table 6-27 Consequence evaluation for Basker Crude hydrocarbon exposure - Shoreline

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
Ecological Receptors			
Habitat	Rocky Shoreline	Rocky shores are predicted to be within the area potentially exposed to >100 g/m^2 hydrocarbon ashore; however, within the stretch of coast along northern Victoria and southern NSW that has the highest probability of exposure, there is no sheltered rocky coasts (i.e. those rocky coasts more sensitive to shoreline oiling). Under most wind conditions, the Basker Crude is expected to remain as small waxy flakes. However, in warmer ambient conditions (e.g. some summer days) it is possible that the solidified oil could temporarily melt. As the volatile components evaporate and the oil weathers, the oil will resolidify and the risk of exposure decreases. Oil can become concentrated as it strands ashore. However, as on all types of shoreline, most of the oil is concentrated along the high tide mark while the lower/upper parts are often untouched (IPIECA, 1995).	The sensitivity of a rocky shoreline to oiling is dependent on a number of factors including its topography and composition, position, exposure to oceanic waves and currents etc. Exposed rocky shorelines are less sensitive than sheltered rocky shorelines. One of the main identified values of rocky shores/scarps is as habitat for invertebrates (e.g. sea anemones, sponges, sea-squirts, molluscs). Rocky areas are also utilised by some pinniped and bird species; noting that foraging and breeding/nesting typically occurs above high tide line. Due to the waxy flake-like nature of the oil, it is not expected to coat rocky shores, or subsequently the littoral/intertidal organisms, or marine fauna using these shorelines. However, if the oil does melt, some temporary coating and/or impacts due to toxicity and/or smothering of fauna may occur. As oil weathers it becomes less toxic, often leaving little but a small residue of tar on upper shore rocks. This residue can remain as an unsightly stain for a long time but it is unlikely to cause any more ecological damage. Oil tends not to remain on wet rock or algae but is likely to stick firmly if the rock is dry (IPIECA, 1995). The impact of oil on any organism depends on the toxicity, viscosity and amount of oil, on the sensitivity of the organism and the length of time it is in contact with the oil. Even where the

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
		In its solid state, the oil is not expected to coat rocky shores. If the oil does melt, some coating may occur, leaving a waxy residue when it resolidifies.	immediate damage to rocky shores from oil spills has been considerable, it is unusual for this to result in long-term damage and the communities have often recovered within 2 or 3 years (IPIECA, 1995). Consequently, the potential impacts and risks to rocky shores from a LOWC event are considered to be **Level 3**, as they could be expected to result in localised medium-term impacts to species or habitats of recognized conservation value or to local ecosystem function. Refer also to: • Marine Invertebrates; • Seabirds and Shorebirds; • Pinnipeds.
	Sandy Shoreline	Sandy beaches are predicted to be within the area potentially exposed to >100 g/m^2 oil ashore. Sandy beaches are the predominant habitat type within the stretch of coast along northern Victoria and southern NSW that has the highest probability of exposure. Under most wind conditions, the Basker Crude is expected to remain as small waxy flakes. However, in warmer ambient conditions (e.g. some summer days) it is possible that the solidified oil could temporarily melt. As the volatile components evaporate and the oil weathers, the oil will resolidify and the risk of exposure decreases. Oil can become concentrated as it strands ashore. However, as on all types of shoreline, most of the oil is concentrated along the high tide mark while the lower/upper parts are often untouched (IPIECA, 1995). In its solid state, the oil is not expected to penetrate into the sediment profile on a sandy beach. However, if the oil does melt, some penetration into the sediment profile may occur, also subsequently exposing any infauna present. While in liquid state, exposure to marine fauna (e.g. birds, pinnipeds) using the sand surface may also occur.	Sandy beaches are considered to have a low sensitivity to hydrocarbon exposure. Sandy beaches provide potential foraging and breeding habitat for numerous bird and pinniped species; however these activities (except haul outs) primarily occur above the high tide line. They also provide habitat for a diverse assemblage (although not always abundant) of infauna (including nematodes, copepods and polychaetes); and macroinvertebrates (e.g. crustaceans). Due to the waxy flake-like nature of the oil, it will remain on the beach surface, and thus no impact from smothering of infauna. However, if the oil does melt, some temporary penetration into the sediment profile, and therefore impacts due to toxicity and/or smothering of infauna may occur. Similarly, coating of seabirds and pinnipeds using the shoreline is not expected under most conditions; but may occur if they come into contact with liquid-state oil. Consequently, the potential impacts and risks to sandy shores from a LOWC event are considered to be **Level 3**, as they could be expected to result in localised medium-term impacts to species or habitats of recognized conservation value or to local ecosystem function. Refer also to: • Marine Invertebrates; • Seabirds and Shorebirds; • Pinnipeds.

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
	Gravel/Cobble Shoreline	Small areas categorised as gravel beaches are predicted to be within the area potentially exposed to >100 g/m^2 oil ashore; however, within the stretch of coast along northern Victoria and southern NSW that has the highest probability of exposure, there is no shoreline of this type. Under most wind conditions, the Basker Crude is expected to remain as small waxy flakes. However, in warmer ambient conditions (e.g. some summer days) it is possible that the solidified oil could temporarily melt. As the volatile components evaporate and the oil weathers, the oil will resolidify and the risk of exposure decreases. Oil can become concentrated as it strands ashore. However, as on all types of shoreline, most of the oil is concentrated along the high tide mark while the lower/upper parts are often untouched (IPIECA, 1995). In its solid state, the oil is not expected to penetrate into the sediment profile on a gravel beach. However, if the oil does melt, some penetration into the sediment profile may occur, also subsequently exposing any infauna present.	Gravel beaches are considered to have a low sensitivity to hydrocarbon exposure. The physical impact to a gravel beach is similar to a sandy beach, except with greater permeability (when the oil is in liquid state) there is the higher potential for the oil penetration and burial in the sediment profile. However, given the decreased presence of interstitial water in a gravel beach, infauna is typically less abundant than sandy beaches. Due to the waxy flake-like nature of the oil, it will remain on the beach surface, and thus no impact from smothering of infauna. However, if the oil does melt, some temporary penetration into the sediment profile, and therefore impacts due to toxicity and/or smothering of infauna may occur. Consequently, the potential impacts and risks to gravel shores from a LOWC event considered to be **Level 3**, as they could be expected to result in localised medium-term impacts to species or habitats of recognized conservation value or to local ecosystem function. Refer to: • Sandy Beaches; • Invertebrates.
	Tidal Flats	Tidal flats are predicted to be within the area potentially exposed to >100 g/m^2 oil ashore; however, within the stretch of coast along northern Victoria and southern NSW that has the highest probability of exposure, there is no shoreline of this type. Under most wind conditions, the Basker Crude is expected to remain as small waxy flakes. However, in warmer ambient conditions (e.g. some summer days) it is possible that the solidified oil could temporarily melt. As the volatile components evaporate and the oil weathers, the oil will resolidify and the risk of exposure decreases. Oil can become concentrated as it strands ashore. However, as on all types of shoreline, most of the oil is concentrated along the high tide mark while the lower/upper parts are often untouched (IPIECA, 1995).	Tidal flats can occur in both exposed coasts (typically low wave energy coasts), or sheltered bays/inlets. Sensitivity of the tidal flats can vary from moderate (those on exposed coasts) to very high (sheltered environments). The physical impact to tidal flats is similar to a sandy beach, except with less permeability (and subsequently less potential for the oil penetration) due to the finer sediments. Tidal flats can also provide foraging habitat for birds. Due to the waxy flake-like nature of the oil, it will remain on the sediment surface, and thus no impact from smothering of infauna. However, if the oil does melt, some temporary penetration into the sediment profile, and therefore impacts due to toxicity and/or smothering of infauna may occur. Similarly, physical coating of birds, or ingestion of the oil by birds is not expected under most conditions; but may occur if they come into contact with liquid-state oil. Consequently, the potential impacts and risks to tidal flats from a LOWC event are considered to be **Level 3**, as they could be expected to result in localised medium-term

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
		In its solid state, the oil is not expected to penetrate into the sediment profile. However, if the oil does melt, some penetration into the sediment profile may occur, also subsequently exposing any infauna present. While in liquid state, exposure to marine fauna (e.g. birds, invertebrates) using the sediment surface may also occur.	impacts to species or habitats of recognized conservation value or to local ecosystem function. Refer to: • Sandy Beaches. • Shorebirds and Seabirds. • Invertebrates.
	Mangroves	Strands of mangroves are predicted to be within the area potentially exposed to oil shore >1,000 g/m^2; however, within the stretch of coast along northern Victoria and southern NSW with the highest probability of exposure, there is no coastal habitat mapped as this vegetation type. Oil can enter mangrove forests when the tide is high and be deposited on the aerial roots and sediment surface as the tide recedes. This process commonly leads to a patchy distribution of the oil and its effects because different places within the forests are at different tidal heights (IPIECA 1993, NOAA, 2014). Under most wind conditions, the Basker Crude is expected to remain as small waxy flakes. However, in warmer ambient conditions (e.g. some summer days) it is possible that the solidified oil could temporarily melt. As the volatile components evaporate and the oil weathers, the oil will resolidify and the risk of exposure decreases. In its solid state, the oil is not expected to smother the aerial roots or seedlings within a mangrove strand. However, if the oil does melt, some coating may occur, leaving a waxy residue when it resolidifies.	Mangroves are considered to have a high sensitivity to hydrocarbon exposure. Mangroves can be killed by heavy or viscous oil, or emulsification, that covers the trees' breathing pores thereby asphyxiating the subsurface roots, which depend on the pores for oxygen. Mangroves can also take up hydrocarbons from contact with leaves, roots or sediments, and it is suspected that this uptake causes defoliation through leaf damage and tree death (Wardrop et al., 1987). Acute impacts to mangroves can be observed within weeks of exposure, whereas chronic impacts may day months to years to detect. Due to the waxy flake-like nature of the oil, it will remain on the surface, and thus minimal impact from smothering of aerial roots or seedlings. However, if the oil does melt, some impact to the root systems and seedlings may occur. Consequently, the potential impacts and risks to mangroves from a LOWC event are considered to be **Level 3**, as they could be expected to result in localised medium-term impacts to species or habitats of recognized conservation value or to local ecosystem function.
	Saltmarsh	Communities of saltmarsh are predicted to be within the area potentially exposed to oil shore >1,000 g/m^2; and is present within estuaries and inlet/riverine systems (e.g. Wingan Inlet, Mallacoota Inlet) within the stretch of coast along northern Victoria and southern NSW that has the highest probability of exposure. Some of the saltmarsh habitat along this coast will be	Saltmarsh is considered to have a high sensitivity to hydrocarbon exposure. Saltmarsh vegetation offers a large surface area for oil absorption and tends to trap oil. Where thick deposits of viscous oil or mousse accumulate on the marsh surface, vegetation is likely to be killed by smothering and recovery delayed because persistent deposits inhibit recolonization (IPIECA, 1994). Evidence from case histories and experiments shows that the damage resulting from oiling, and recovery times of oiled marsh vegetation, are very variable. In areas of light to moderate

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
		representative of the Subtropical and Temperate Saltmarsh TEC. Oil can enter saltmarsh systems during the tidal cycles if the estuary/inlet is open to the ocean. Similar to mangroves, this can lead to a patchy distribution of the oil and its effects, because different places within the inlets are at different tidal heights. Oil (in liquid form) will readily adhere to the marshes, coating the stems from tidal height to sediment surface. Heavy oil coating will be restricted to the outer fringe of thick vegetation, although lighter oils can penetrate deeper, to the limit of tidal influence. Under most wind conditions, the Basker Crude is expected to remain as small waxy flakes. However, in warmer ambient conditions (e.g. some summer days) it is possible that the solidified oil could temporarily melt. As the volatile components evaporate and the oil weathers, the oil will resolidify and the risk of exposure decreases.	oiling where oil is mainly on perennial vegetation with little penetration of sediment, the shoots of the plants may be killed but recovery can take place from the underground systems. Good recovery commonly occurs within one to two years (IPIECA, 1994). Due to the waxy flake-like nature of the oil, it will remain on the surface, and thus minimal impact from smothering of vegetation or penetration into the sediment profile. However, if the oil does melt, some impact to the perennial vegetation may occur. Consequently, the potential impacts and risks to saltmarsh from a LOWC event are considered to be **Level 3**, as they could be expected to result in localised medium-term impacts to species or habitats of recognized conservation value or to local ecosystem function.
Marine Fauna	Invertebrates	Invertebrates that live in intertidal zones include crustaceans, molluscs and infauna. These fauna can be present in a wide range of habitats including sandy beaches and rocky shores (refer also the exposure evaluation for these habitats). Exposure to hydrocarbons for invertebrates is typically via direct contact and smothering but can also occur via ingestion. As described in the habitat sections, the nature of the Basker Crude is such that smothering is unlikely unless ambient conditions cause the oil to temporarily melt.	The impact of oil on any marine organism depends on the toxicity, viscosity, and amount of oil, on the sensitivity of the organism and the length of time it is in contact with the oil. Acute or chronic exposure, through surface contact, and/or ingestion can result in toxicological impacts, reproductive impacts, smothering and potentially cause death. However, the presence of an exoskeleton (e.g., crustaceans) will reduce the impact of hydrocarbon absorption through the surface membrane. Other invertebrates with no exoskeleton and larval forms may be more sensitive to impacts from hydrocarbons. If invertebrates are contaminated by hydrocarbons, tissue taint can remain for several months, but can eventually be lost. Due to the waxy flake-like nature of the oil, it will typically remain on the surface, and thus minimal impact from smothering or through ingestion. However, if the oil does melt, some impact to the sensitive invertebrates may occur. Consequently, the potential impacts and risks to invertebrates from a LOWC event are considered to be **Level 3**, as they could be expected to result in localised medium-term impacts to species or habitats of recognized conservation value or to local ecosystem function.

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
	Seabirds and Shorebirds	Listed marine, threatened and/or migratory bird species have the potential to be resting, feeding or nesting within the area predicted to be exposed to >100 g/m^2 oil ashore. This fauna can be present in wide range of habitats including sandy beaches and rocky shores (refer also the exposure evaluation for these habitats). The majority of breeding habitat is associated with the small oceanic islands of Bass Strait, which have a lower probability of shoreline exposure. However, there is a breeding BIA for the Little Penguin and White-faced Storm-Petrel (both listed marine species; no threatened status) on Gabo and Tullaberga Islands off the northern coast of Victoria; i.e. within the stretch of coast with the highest probabilities of being exposed above the impact threshold. Little Penguins have a higher risk of exposure as they use the intertidal area to access the beach. There are several foraging BIAs throughout the area, however these species are oceanic foragers, not shoreline foragers. Shorebirds will still utilise intertidal and onshore zones for feeding (no BIAs have been identified). As described in the habitat sections, the nature of the Basker Crude is such that oiling of birds is unlikely unless ambient conditions cause the oil to temporarily melt. Similarly, with transfer of oil to eggs from oiled nesting adults is unlikely unless ambient conditions cause the oil to temporarily melt. General exposure (e.g., surface contact or ingestion) remains an exposure pathway for birds; particularly for shorebirds utilizing the intertidal area. Noting that these events will be temporary, so length of exposure is limited.	Direct contact with hydrocarbons can foul feathers, which may result in hypothermia due to a reduction in the ability of the bird to thermo-regulate and impair water-proofing. Oiling of birds can also suffer from damage to external tissues, including skin and eyes, as well as internal tissue irritation in their lungs and stomachs. Toxic effects may result where the oil is ingested as the bird attempts to preen its feathers, or via consumption of oil-affected prey. Fresh crude has been shown to be more toxic than weathered crude to birds. Marine pollution is listed as a threat for several migratory shorebirds and seabird conservation advice / recovery plans (refer to Table 2-5), however management actions mostly relate to nesting locations. Due to the waxy flake-like nature of the oil, minimal impact from direct oiling is expected; however, if the oil does melt, some coating may occur. Consequently, the potential impacts and risks to seabirds from a LOWC event are considered to be **Level 3**, as they could be expected to result in localised medium-term impacts to species or habitats of recognized conservation value or to local ecosystem function.
	Marine Reptiles	Listed marine, threatened and/or migratory marine turtle species have the potential to present within the area predicted to be exposed to >100 g/m^2 oil ashore. Turtles nesting on exposed shores would be exposed by direct contact with skin/body. However, there are no areas identified as	Marine turtles are vulnerable to the effects of oil at all life stages; effects on nesting populations include increased egg mortality, developmental defects, skin irritation, or mortality of hatchlings or adults.

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
		critical habitat, known turtle nesting beaches, or spatially defined aggregations (i.e., no BIAs) within the vicinity. Therefore, shoreline exposure to marine turtles is considered unlikely. As described in the habitat sections, the nature of the Basker Crude is such that oiling of marine turtles (if present) is unlikely unless ambient conditions cause the oil to temporarily melt. Noting that these events will be temporary, so length of exposure is also limited.	However, turtles are pelagic species and only go onshore for nesting. As nesting colonies of turtles are not expected to be present, any potential impact would be limited to individuals, with population impacts not anticipated. Marine pollution is listed as a threat to marine turtle in the Recovery Plan for Marine Turtles in Australia, 2017- 2027, particularly in relation to shoreline oiling of nesting beaches. There are no nesting beaches within the EMBA, and the activity will be conducted in a manner which is not inconsistent with the relevant management actions. Consequently, the potential impacts and risks to marine turtles are considered to be **Level 2**, as they could be expected to result in localised short-term impacts to species/habitats of recognised conservation value but not affecting local ecosystem functioning.
	Marine Mammals (Pinnipeds)	Listed marine and/or threatened pinniped species have the potential to present within the area predicted to be exposed to >100 g/m^2 oil ashore. Pinnipeds hauling out or breeding on exposed shores would be exposed by direct contact with skin/body. However, it is not identified as critical habitat, and there are no spatially defined aggregations (i.e., is not a BIA). Haul-outs (e.g., Beware Reef) and breeding (e.g., The Skerries) locations for the Australian and New Zealand Fur-Seal are known to be present within the area that has a higher probability of exposure above the impact threshold. Fur seal colonies are typically occupied year-round, but activity increases over the summer breeding season. As described in the habitat sections, the nature of the Basker Crude is such that direct oiling of pinnipeds is unlikely unless ambient conditions cause the oil to temporarily melt. Noting that these events will be temporary, so length of exposure is also limited.	Pinnipeds have high site fidelity and can be less likely to exhibit avoidance behaviours, thus staying near established colonies and haul-out areas. Exposure to surface oil can result in skin and eye irritations and disruptions to thermal regulation. Fur seals are particularly vulnerable to hypothermia from oiling of their fur – however the solidified tar balls/waxy flake-like nature of the oil mean this is not likely under most conditions. Exposure to oil may also results in physiological effects from toxic fume inhalation, biological impacts from ingestion of the oil, and may reduce reproduction levels. Conservation Listing Advice for the *Neophoca cinerea* (Australian sea lion) (TSSC, 2010) identifies oil spills as a potential threat to habitat. Activities within this Environment Plan will be inconsistent with the conservation and management priorities outlined in this advice. Consequently, the potential impacts and risks to pinnipeds from exposure from a LOWC event are considered to be **Level 3**, as they could be expected to result in localised medium-term impacts to species or habitats of recognized conservation value or to local ecosystem function.
Social Receptors			
Natural System	State Parks and Reserves	There are State Parks and Reserves predicted to be within the area potentially exposed to oil shore >100 g/m^2. Within the stretch of coast along northern Victoria and southern NSW with	For those parks and reserves with boundaries that extend into the intertidal zone, any impact is expected to be restricted to the area seaward from the high tide line, and therefore represent a small proportion of the overall park or reserve area. Based on the potential risks

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
		the highest probability of exposure, this includes the Croajingolong National Park (Victoria) and Ben Boyd National Park (NSW). Both these parks have boundaries that extend to mean low water mark. It is expected that most of the oil on shorelines will be concentrated along the high tide mark while the lower/upper parts of the shore are often untouched (IPIECA, 1995). As described in the habitat sections, the nature of the Basker Crude is such that the oil is not expected to penetrate into the sediment profile. However, if the oil does melt, some penetration into the sediment profile may occur. While in liquid state, exposure to marine fauna (e.g. birds, pinnipeds) using the surface may also occur.	of key ecological receptors (e.g. sandy beaches, pinnipeds), the potential impacts and risks to State marine protected areas are considered to be **Level 3**, as they could be expected to result in localised short-term impacts to species/habitats of recognised conservation value but not affecting local ecosystem functioning. Refer also to: • Sandy Beaches; • Seabirds and Shorebirds; and • Marine Mammals (Pinnipeds).
	Wetlands	Wetlands are predicted to be within the area potentially exposed to oil shore >1,000 g/m^2; however, within the stretch of coast along northern Victoria and southern NSW with the highest probability of exposure, there is no nationally or internationally important wetland present. The two closest marine/coastal internationally important (Ramsar) wetlands are Corner Inlet and Gippsland Lakes with 16% and 26% probability of exposure respectively. Under most wind conditions, the Basker Crude is expected to remain as small waxy flakes. However, in warmer ambient conditions (e.g. some summer days) it is possible that the solidified oil could temporarily melt. As the volatile components evaporate and the oil weathers, the oil will resolidify and the risk of exposure decreases. In its solid state, the oil is not expected to smother the wetland vegetation. However, if the oil does melt, some coating may occur, leaving a waxy residue when it resolidifies.	The impacts of hydrocarbons on wetlands are generally similar to those described for mangroves and saltmarshes. The degree of impact of oil on wetland vegetation are variable and complex, and can be both acute and chronic, ranging from short-term disruption of plant functioning to mortality. Spills reaching wetlands during the growing season will have a more severe impact than if oil reaches wetlands during the times when many plant species are dormant. Wetland habitat can be of particular importance for some species of birds and invertebrates. As such, in addition to direct impacts on plants, oil that reaches wetlands also affects these fauna utilising wetlands during their life cycle, especially benthic organisms that reside in the sediments and are a foundation of the food chain. Due to the waxy flake-like nature of the oil, it will remain on the surface, and thus minimal impact from smothering of vegetation or penetration into the sediment profile. However, if the oil does melt, some impact to the perennial vegetation may occur. Consequently, the potential impacts and risks to wetlands from a LOWC event are considered to be **Level 3,** as they could be expected to result in localised medium-term impacts to species or habitats of recognized conservation value or to local ecosystem function. Refer also to: • Seabirds and Shorebirds; • Marine Invertebrates.

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
Human System	Coastal Settlements	Coastal settlements are within the area potentially exposed to >100 g/m^2 hydrocarbon ashore; however, the stretch of coast along northern Victoria and southern NSW that has the highest probability of exposure is not densely settled, with key locations including Mallacoota and Cape Conran. As described in the habitat sections, the nature of the Basker Crude is such that it is expected to remain solid unless ambient conditions cause the oil to temporarily melt. Noting that these events will be temporary, so length of exposure is also limited. In either state, the oil will be visible. Most of the oil will be concentrated along the high tide mark while the lower/upper parts are often untouched (IPIECA, 1995).	Visible hydrocarbons have the potential to reduce the visual amenity of the area for tourism, and discourage recreational activities. Given the characteristics of the oil, it is expected to remain in predominately solid/waxy state. Consequently, the potential impacts and risks to coastal settlements from a LOWC event are considered to be **Level 2** as they could be expected to result in localised short-term impacts. Refer also to: • Rocky Shores; • Sandy Beaches; and • Gravel/Cobble Beaches.
	Recreation and Tourism	Recreational and tourism activities will occur within the area potentially exposed to >100 g/m^2 hydrocarbon ashore; however, the stretch of coast along northern Victoria and southern NSW that has the highest probability of exposure is not densely settled, as such the volume of recreation/tourism is not as high as other places. Key locations within this area would include Mallacoota and Cape Conran. As described in the habitat sections, the nature of the Basker Crude is such that it is expected to remain solid unless ambient conditions cause the oil to temporarily melt. Noting that these events will be temporary, so length of exposure is also limited. In either state, the oil will be visible. Most of the oil will be concentrated along the high tide mark while the lower/upper parts are often untouched (IPIECA, 1995).	Shoreline accumulation of hydrocarbons have the potential to reduce the amenity of the area for tourism, and discourage recreational activities. Disruption of traditional coastal activities (e.g. beach use for swimming or fishing), can have subsequent impacts on adjacent businesses (e.g. accommodation) due to a decrease in patronage. The physical disturbance to coastal areas and recreational activities from a single spill is usually comparatively short; and once shorelines are clean, normal trade and activity would be expected to resume (ITOPF, 2014). Given the characteristics of the oil, it is expected to remain in predominately solid/waxy state. Consequently, the potential impacts and risks to recreation and tourism from a LOWC event are considered to be **Level 2** as they could be expected to result in localised short-term impacts. Refer also to: • Rocky Shores; • Sandy Beaches; • Gravel/Cobble Beaches; • Coastal Settlements.
	Heritage	Specific locations of spiritual and ceremonial places of significance, or cultural artefacts, are often unknown, but are expected to be present along the mainland coast. Therefore, there is the potential that some of these sites may be within the area potentially exposed to >100 g/m^2 hydrocarbon ashore	Visible hydrocarbons have the potential to reduce the visual amenity of known heritage sites. Given the characteristics of the oil, it is expected to remain in predominately solid/waxy state. Consequently, the potential impacts and risks to heritage from a LOWC event are considered to be **Level 2** as they could be expected to result in localised short-term impacts.

Receptor Group	Receptor Type	Exposure Evaluation	Consequence Evaluation
		As described in the habitat sections, the nature of the Basker Crude is such that it is expected to remain solid unless ambient conditions cause the oil to temporarily melt. Noting that these events will be temporary, so length of exposure is also limited. In either state, the oil will be visible. Most of the oil will be concentrated along the high tide mark while the lower/upper parts are often untouched (IPIECA, 1995).	Refer to: • Rocky Shores; • Sandy Beaches; • Gravel/Cobble Beaches; • Coastal Settlements.

6.7.5 Control Measures, ALARP and Acceptability Assessment

Table 6-28 provides a summary of the control measures and ALARP and Acceptability Assessment relevant to seabed disturbance.

Table 6-28 Accidental Hydrocarbon Release ALARP, Control Measures and Acceptability Assessment

Accidental Hydrocarbon Release	
ALARP Decision Context and Justification	**ALARP Decision Context: B** Cooper Energy has been operating the facilities within the Gippsland Basin since 2017 and the activities proposed that could lead to a loss of containment are not new and have been undertaken by Cooper Energy in the time since they become titleholder and operator. The wells are operated as per the regulatory accepted WOMP and the pipeline as per the regulatory accepted safety case. The risks associated with vessel collision and loss of well control are well understood, however the spatial and temporal nature of a worst-case discharge has the potential to result in **Level 3** consequences. Consequently, Cooper Energy believes that ALARP Decision Context B should be applied. However, from the outset of the planning phase, due to inherent complexity and some uncertainty associated with this aspect for this project, Context C has also been applied, and is reflected in: - the conservative assumptions used to characterise WCD scenarios for LOWC, - detailed assessment of potential impacts and risks, - detailed assessment of control measures and selection of contingency measures in line with a precautionary approach, - preparation of detailed response plans.
Control Measure	**Source of good practice control measures**
C1: Marine exclusion and caution zones	PSZs are in place throughout the NPP phase and will remain in place for well abandonment. As is industry practice, the MOU will also have a vessel exclusion zone which will extend the PSZ in some areas of the field out to 500m.
C5: Ongoing consultation	Under the Navigation Act 2014 (Cth), the Australian Hydrographic Service (AHS) are responsible for maintaining and disseminating hydrographic and other nautical information and nautical publications including: • Notices to Mariners • AUSCOAST warnings Relevant details will be provided to the Joint Rescue Coordination Centre (JRCC) to enable AUSCOAST warnings to be disseminated.
C11: SIMOPS Procedure	SIMOPS procedure is developed to manage activities operating simultaneously in close proximity.
C12: Planned Maintenance System	PMSs ensure that safety-critical equipment (specifically the BOP) is maintained in accordance with manufacturer specifications to enable optimal performance.
C3: Marine Order 27: Safety of navigation and radio equipment	AMSA MO 27: Safety of navigation and radio equipment gives effect to SOLAS regulations regarding radiocommunication and safety of navigation, and provides for navigation safety measures and equipment and radio equipment requirements.
C30: Marine Order 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
C31: Vessel compliant with MARPOL Annex I,	In accordance with MARPOL Annex I and AMSA MO 91 [Marine Pollution Prevention – oil], a Shipboard Marine Pollution Emergency Plan (SMPEP) or Shipboard Oil Pollution Emergency Plan (SOPEP) (according to class) is required to be developed based upon the Guidelines for the

Accidental Hydrocarbon Release	
as appropriate to class (i.e. SMPEP or equivalent)	Development of Shipboard Oil Pollution Emergency Plans, adopted by IMO as Resolution MEPC.54(32) and approved by AMSA. To prepare for a spill event, the SMPEP/SOPEP details: • response equipment available to control a spill event; • review cycle to ensure that the SMPEP/SOPEP is kept up to date; and • testing requirements, including the frequency and nature of these tests. • in the event of a spill, the SMPEP/SOPEP details: • reporting requirements and a list of authorities to be contacted; • activities to be undertaken to control the discharge of hydrocarbon; and • procedures for coordinating with local officials. Specifically, the SMPEP/SOPEP contains procedures to stop or reduce the flow of hydrocarbons to be considered in the event of tank rupture.
C29: Marine Order 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.
C7: Marine Order 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.
C21: 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. Cooper Energy's NOPSEMA-accepted WOMP describes Cooper Energy's minimum requirements for well barriers during operations. The accepted WOMP (and its implementation) is therefore considered a key component of the environmental risk management for the campaign.
C17: NOPSEMA accepted safety cases and safety case revision	Under Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations 2009 the following safety cases will be required for the campaign: • MOU facility safety case • Campaign Safety Case Revision • BMG Field Safety Case Each safety case will identify all hazards having the potential to result in major accident events (MAEs) associated with the respective facility. Safety cases therefore address major source control events associated with both the wells and the facilities (MOU) including surface and subsea well releases, and vessel collision. As part of MAE prevention and control, formal safety assessments are details and systematic assessment of the risk associated with each of those hazards, including the likelihood and consequences of each potential major accident event; and identifies the technical and other control measures that are necessary to reduce that risk to ALARP. The accepted safety cases (and their implementation) are therefore considered key components of the environmental risk management for the campaign.
C35: Cooper Energy Management System	The Cooper Energy Management System inclusive of well engineering management, ensures all aspects of well construction, operation, intervention and abandonment are managed to internal and external standards.
C32: Source Control Emergency Response Plan	A source control emergency response plan (SCERP) will be developed and tested prior to the campaign commencing. Where applicable to the campaign, the SCERP will address: • Arrangements for the provision of the Source Control IMT personnel (numbers, competency, capability for the duration of the response)

Accidental Hydrocarbon Release	
	• Arrangements for the provision of equipment and supplies • Arrangements for equipment and personnel monitoring and tracking • Activation and mobilisation plans, including activation and expenditure authority and regulatory approval processes • Logistics plans and providers • SIMOPS planning process • Deployment and installation plans • Well kill and shut-in plans.
C36: OSMP	Cooper Energy's OSMP details the arrangements and capability in place for: • operational monitoring of a hydrocarbon spill to inform response activities • scientific monitoring of environmental impacts of the spill and response activities. Operational monitoring will allow adequate information to be provided to aid decision making to ensure response activities are timely, safe, and appropriate. Scientific monitoring will identify if potential longer-term remediation activities may be required and potential breaches of protected places management objectives, specifically those of Australian Marine Parks.
C33: OPEP	Under the OPGGS(E) Regulations, NOPSEMA require that the petroleum activity have an accepted Oil Pollution Emergency Plan (OPEP) in place before the activity commences. In the event of a LOWC, the OPEP will be implemented. The BMG Closure Project (Phase 1) OPEP has been developed and includes activities described under this EP. By committing to implement this EP, Cooper Energy acknowledges that any response will be implemented in accordance with the requirements described within the OPEP.
Likelihood	An assessment of LOWC incidents was undertaken using SINTEF records (2013). This provided an indicative probability of a LOWC from well intervention or drilling that can be reasonably expected to occur, based on previous incidents. Statistics indicate the chances of the activity resulting in a LOWC are 1×10^{-4}; this aligns to a likelihood rating D (Unlikely) under the Cooper Energy risk matrix. The identified control measures to prevent a LOWC event include clear design and assurance standards, and consequently, it is considered Unlikely (D) that a LOWC would occur that as a rare combination of factors would be required for an occurrence; the event is conceivable and could occur at some time; and could occur during the activity.
Residual Risk	Moderate
Demonstration of Acceptability	
Principles of ESD	The potential impact associated with this aspect is limited to a localized medium-term impacts to species or habitats of recognized conservation value or to local ecosystem function; remedial, recovery work to land/water systems over months/year. The activities were evaluated as having the potential to result in a **Level 3** consequence. Consequently, no further evaluation against the principles of ESD is required.
Legislative and conventions	Legislation and other requirements considered relevant control measures include: • API Standard 53 • NOPSEMA accepted WOMP • NOPSEMA accepted Facility Safety cases • SCERP • OPGGS (Resource Management and Administration) Regulations 2011 • OPGGS(E)R 2009 – Cooper Energy BMG Closure Project (Phase 1) OPEP and Offshore Victoria Operations OSMP

Accidental Hydrocarbon Release	
Internal context	The environmental controls proposed reflects the Cooper Energy HSEC Policy goals of utilising best practice and standards to eliminate or minimise impacts and risks to the environment and community to a level which is ALARP. Relevant management system processes adopted to implement and manage hazards to ALARP include: • Risk Management (MS03) • Technical Management (MS08) • Health Safety and Environment Management (MS09) • Incident and Crisis Management (MS10) • Supply Chain and Procurement Management (MS11) • External Affairs & Stakeholder Management (MS05)
External context	No objections or claims have been raised during stakeholder consultation. Suggestions from State emergency agencies have been adopted unless otherwise discussed and agreed.
Acceptability Outcome	Acceptable

7 Oil Spill Response Overview

7.1 Oil Spill Response Strategies

This section presents the risk assessment for oil spill response options as required by the OPGGS(E) Regulations. This section informs the Cooper Energy BMG Closure Project (Phase 1) OPEP (BMG-ER-EMP-0004).

7.1.1 Hydrocarbon Spill Risks associated with the Activity

Table 7-1 summarises the spill scenarios identified in Section 6.7 during the activities associated with this EP, and the relevant level. Spill levels are described in Table 2-1 of the BMG Closure Project (Phase 1) OPEP.

Table 7-1 Hydrocarbon spill risks associated with the activity

Spill Risk	Spill Level	Fluid Type
Minor spill LOC	Level 1	MDO, hydraulic oil, chemical
Bunkering LOC	Level 1	MDO, hydraulic oil, chemical
Vessel Collision LOC	Level 1 or 2	MDO (Group II)
Subsea release up to LOWC	Level 1, 2 or 3	Inhibited seawater / diesel / gas / light crude

7.1.2 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.

Net Environmental Benefit Analysis (NEBA) is the process of considering advantages and disadvantages of different spill response options (including no response) to arrive at a spill response decision resulting in the lowest overall environmental and social impacts. NEBA is undertaken at a strategic level to identify pre-determined recommended response strategies, and an operational NEBA is undertaken throughout the emergency response. The process requires the identification of sensitive environmental receptors and the prioritisation of those receptors for protection so that the strategic objectives of the response can be established.

Table 7-2 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.

7.2 Response Priority Areas

To support the identification of priority response areas, shoreline sensitivity analysis and mapping was undertaken guided by IPIECA principles and informed by the regional description of the environment and understanding of receptor presence in the region (Addendum 1). The Response Priority Areas are detailed in the OPEP Section 4.4. Priority Protection Areas.

7.3 Pre-spill Net Environmental Benefits Assessment (NEBA)

Location specific information was used for each of the priority response planning areas to further refine receptor presence, with these receptors ranked based upon the sensitivity criteria detailed in the OPEP Section 4.4. Priority Protection Areas. An assessment of the effective spill response strategies and the net benefit they offer, specific to the sensitivities located within each of the priority response planning areas is provided in the OPEP Section 4.4. Priority Protection Areas.

Table 7-2 Suitability of Response Options

Response Option	Description	LOC – Vessel Collision (MDO)	Viable Response?	Strategic Net Benefit?	LOC – Basker Crude	Viable Response?	Strategic Net Benefit?
Source Control	Limit flow of hydrocarbons to environment.	Achieved by vessel SMPEP/SOPEP.	✓	✓	Implement offshore inspection to assess and determine remedial option. In accordance with the campaign Source Control Emergency Response Plan.	✓	✓
Monitor & Evaluate	Direct observation – Aerial or marine; Vector Calculations; Oil Spill Trajectory Modelling; Satellite Tracking Buoys. To maintain situational awareness, all monitor and evaluate options suitable.	MDO spreads rapidly to thin layers. Aerial surveillance is considered more effective than vessel to inform spill response and identify if oil has contacted shoreline or wildlife. Vessel surveillance is limited in effectiveness in determining spread of oil. Manual calculation based upon weather conditions will be used at the time to provide guidance to aerial observations. Oil Spill Trajectory Modelling may also be used to forecast impact areas. Deployment of oil spill monitoring buoys at the time of vessel incident will assist in understanding the local current regime during the spill event.	✓	✓	Monitor and evaluate is applicable to all types of emergency spills as it provides a suite of non-invasive activities that aid to provide observations and data to inform operational awareness and support response decisions and tool selection. For a continuous significant spill event (well blowout) hydrocarbons will be present at the surface for the duration of the release. To maintain situational awareness, all monitor and evaluate techniques will be considered during condensate spill incidents to understand the possible impacts.	✓	✓
Dispersant Application	Breakdown surface spill & draw droplets into upper layers of water column. Increases biodegradation and weathering and provides benefit to sea-surface air breathing animals.	MDO, while having a small persistent fraction, spreads rapidly to thin layers. Insufficient time to respond while suitable surface thicknesses are present. Dispersant application can result in punch-through where dispersant passes into the water column without breaking oil layer down if surface layers are too thin. Application can contribute to water quality degradation through chemical application without removing surface oil. Considered not to add sufficient benefits.	×	×	Dispersant application is generally applied for one of two reasons. 1. Reduce volatile organic compounds above within vicinity of the LOWC event source; and 2. Reduce the volume of surface hydrocarbons to minimise surface oil exposure and shoreline loading of oil. Basker Crude has a high pour point; oil at surface is expected to solidify at the temperatures of the Bass Strait (any time of year) and is not expected to be amenable to dispersant once cooled. Subsea dispersant application will be retained as a contingency measure, whereby application of dispersant at the wellhead, whilst the oil is warm may provide some level of dispersion. No dispersant efficacy testing could be located for Basker Crude from the production testing. No fresh samples are available to be able to undertake testing. Based on Bass Strait analogues and testing results made available by Esso, subsea dispersant application has the potential to be effective.	Surface application: x Subsea application: ✓	Possible
Contain & Recover	Booms and skimmers to contain surface oil where there is a potential threat to environmental sensitivities.	MDO spreads rapidly to less than 10 µm and suitable thicknesses for recovery are only present for the first 36 hours for a large offshore spill, and there is insufficient mobilisation time to capture residues. In general, this method only recovers approximately 10-15% of total spill residue, creates significant levels of waste, requires significant manpower and suitable weather conditions (calm) to be deployed.	×	×	Offshore containment and recovery is considered to be an unlikely response strategy given typical high energy conditions offshore Gippsland versus the consistently calm conditions required for containment and recovery. Containment and Recovery is more likely to be undertaken as part of the protect and deflect strategy close to shore in protected bays and inlets, and is described in more detail in applicable Technical Response Plans (TRPs).	Possible	Possible
Protect & Deflect	Booms and skimmers deployed to protect environmental sensitivities.	MDO spreads rapidly to less than 10 µm and suitable thicknesses for recovery are only present for the first 36 hours for a large offshore spill. There may be insufficient mobilisation time to capture residues prior to hydrocarbons reaching the shore. In addition, corralling of surface hydrocarbons close to shore may not be effective for MDO depending on sea surface conditions. However, if operational monitoring indicates river mouths and inlets are potentially exposed to actionable levels of hydrocarbons and accessible to response personnel and equipment, protection and deflection may be an effective technique for reducing oil within these inland water ways.	✓	✓	Basker crude will tend to solidity at the temperatures of the Bass Strait, and expected to be present as a slick consisting of solid waxy sheets or balls. Consequently, the hydrocarbons are expected to be effectively corralled and contained by nearshore booms where access is possible to deploy this equipment.	✓	✓
Shoreline Clean-up	Shoreline clean-up is a last response strategy due to the potential environmental impact.	As shoreline exposure is possible depending on the spill location, and as there are various shoreline techniques that are appropriate for this type of hydrocarbon, a shoreline clean-up may be an effective technique for reducing shoreline loadings where access to shorelines is possible.	✓	✓	As modelling indicates shoreline exposure is possible, and as there are various shoreline techniques that are appropriate for this type of hydrocarbon, a shoreline clean-up would be an effective technique for reducing shoreline loadings where access to shorelines is possible.	✓	✓

Response Option	Description	LOC – Vessel Collision (MDO)	Viable Response?	Strategic Net Benefit?	LOC – Basker Crude	Viable Response?	Strategic Net Benefit?
Oiled wildlife Response (OWR)	Consists of capture, cleaning and rehabilitation of oiled wildlife. May include hazing or pre-spill captive management. In Victoria, this is managed by DELWP.	Given limited size and rapid spreading of the MDO spill, large scale wildlife response is not expected. However, individual birds could become oiled in the vicinity of the spill. OWR is both a viable and prudent response option for this spill type.	✓	✓	OWR may offer net benefits to both seabirds which come into contact and area affected by residues. OWR is both a viable and prudent response option for this spill type.	✓	✓

7.4 Spill Response: Source Control

7.4.1 Overview

Source control arrangements for significant vessel spills resulting from fuel tank perforation includes:

- closing water tight doors
- checking bulkheads;
- determining whether vessel separation will increase spillage;
- isolating penetrated tanks;
- tank lightering, etc.

Source control relies heavily upon the activation of the vessels SOPEP / SMPEP (or equivalent).

Well-related source control activities are described in Section 7.4.2.

7.4.2 Source Control (LOWC)

Well source control activities, including methodologies and resources to implement source control and limit the hydrocarbon released to the environment will be detailed in the campaign Source Control Emergency Response Plan. Figure 7-1 shows a conceptual timeline of key activities associated with source control planning. Table 7-3 provides an overview of the applicability of LOWC source control response options for the BMG P&A campaign. The subsequent sections provide further details on the scope of the activities and the resources required to implement them.

Figure 7-1: *Source Control Conceptual Timeline (after IOGP Report 594 Jan 2019)*

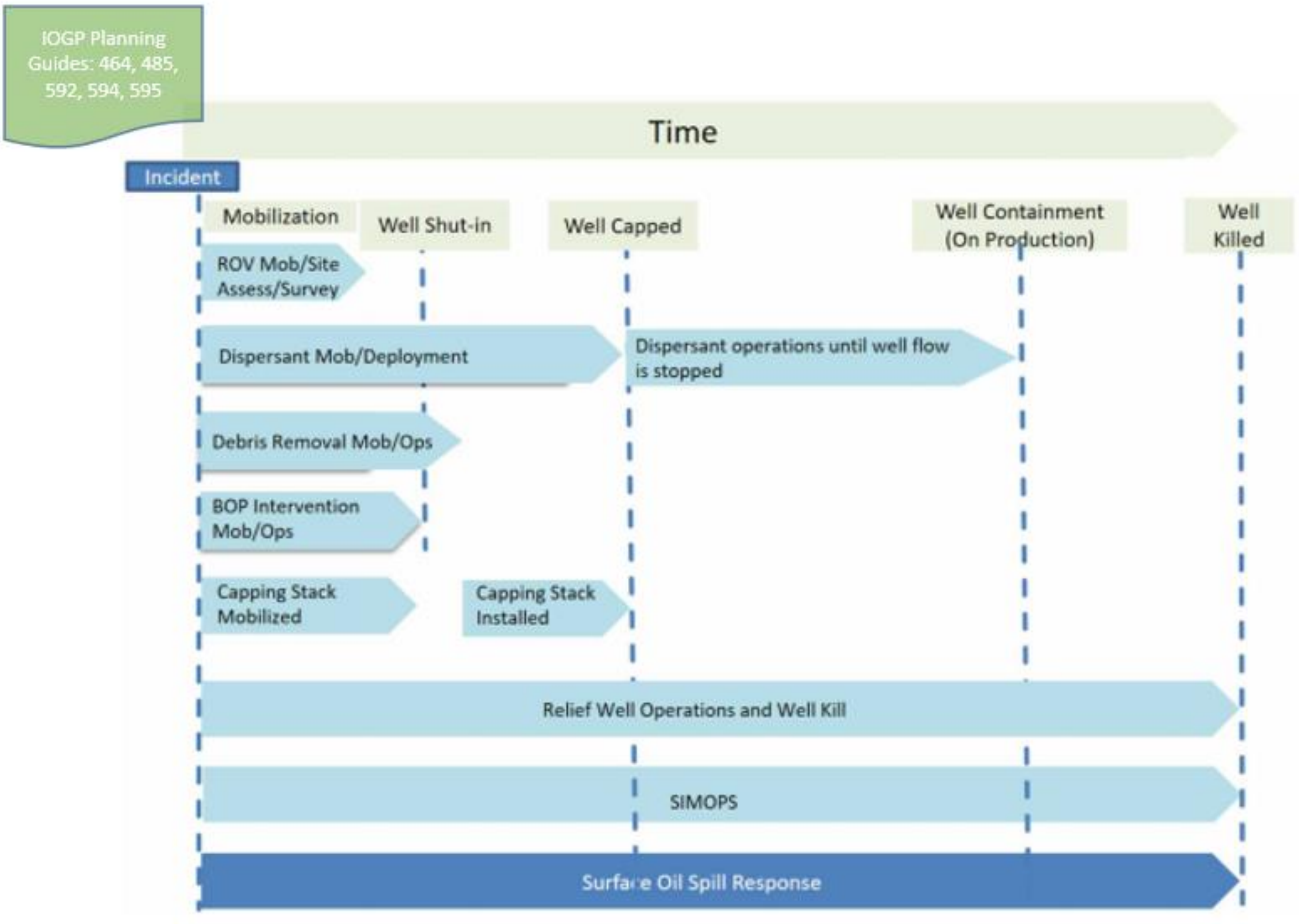


Table 7-3 Overview of Level 3 Source Control Options Applicable to BMG

Parameter	Site Survey and debris clearance.	Subsea Dispersant Application	Manual Intervention of Well Control Equipment	Well Capping	Relief Well
Suitability/Functionality Feasibility *How does the response strategy perform to achieve its required risk reduction?*	Site survey assists in identifying equipment status and hazards. Debris clearance equipment is used to enable access to the well if obstructed. This option enables data to be gathered and the site to be prepared to both select and enable subsequent source control options.	Subsea dispersant application may assist in reducing shoreline loading of oil by increasing dispersion into the water column, enhancing dilution and weathering. By reducing shoreline loading of oil, the risks to shoreline receptors can be reduced. The equipment to perform the task is available. Monitoring is required during the response to confirm optimum treatment rates and overall efficacy.	Capability to manually intervene the well control equipment will be maintained throughout the campaign when well control equipment is deployed.	Well capping can curtail the hydrocarbon flow prior to permanent plugging of the well. In the context of the BMG wells, this source control option is possible given the pressures anticipated in the BMG wells and will be considered for use. Option requires clear vertical access with a crane and establishing a seal over the subsea receptor – the subsea interfaces and load allowances change throughout the program and requires different capping solutions. The well capping solution is only an option if the tree body has integrity and suitable vertical access to the subsea connector.	This source control technique has been proven successful in Australia (e.g. Montara) and internationally (Macondo). Considered technically feasible and effective on blowout scenarios on BMG wells. Stemming the flow of hydrocarbons from a well by injecting kill density fluid into the well bore is a proven method of regaining control of a well. This is often achieved by directionally drilling a relief well to intercept the wellbore and then pumping fluid to stem the flow. Once the well is stabilised, cement can be pumped into the well to form a permanent barrier to isolate the flow zone.
Dependencies Effectiveness *Does the response strategy rely on other systems to perform its intended function?*	Response is reliant on availability of equipment and trained / experienced personnel to undertake activities: • Subsea decommissioning / debris removal equipment and operators.	Response is reliant on availability of equipment and trained / experienced personnel to undertake activities: • Subsea decommissioning / dispersant application equipment and operators.	Response is reliant on availability of equipment and trained / experienced personnel to undertake activities: • Subsea intervention equipment and operators. • Construction and/or Support vessel. • Safety Case and/or Revision.	Response is reliant on availability of equipment and trained / experienced personnel to undertake activities: • Construction and/or Support vessel. • Well capping solution/vendor. • Well Control Specialist Company (including	Response is reliant on availability of equipment and trained / experienced personnel to undertake activities: • Drill rig and trained staff. • Well engineering services and management contractor. • Well Control specialists. • Well Equipment availability.

Parameter	Site Survey and debris clearance.	Subsea Dispersant Application	Manual Intervention of Well Control Equipment	Well Capping	Relief Well
	• Construction and/or Support vessel. • Safety Case and/or Revision.	• Construction and/or Support vessel. • Safety Case and/or Revision.		emergency air freight capability). • Safety Case and/or Revision.	• Safety Case and/or Revision.
Availability and Timely *The response strategy is available to perform its function, in sufficient time?*	Survey and debris clearance equipment is available within Australia as part of the AMOSC Subsea First Response Toolkit (SFRT). Similar packages are also available internationally including from Wild Well Control. Much of the equipment within the SFRT will already be available as part of the equipment mobilised for the campaign. Section 7.4.2.1 provides a comparison of equipment that will be mobilised for the campaign vs. the SFRT.	Subsea Dispersant equipment is available within Australia as part of the AMOSC. Other subsea dispersant equipment packages are available internationally including from Wild Well Control. Dispersant stocks are available within Australia through AMOSC and the National Plan. Refer to Section 7.6.	The campaign will have the capability to mount an intervention response. At least two work-class ROVs and tooling compatible with the subsea wells and project pressure control equipment will be mobilised for the campaign.	Capping stack through Wild Well Control is available in Scotland, and can be sea or air freight to Australia. Suitable CSVs are typically located in Singapore, NWS and within the region depending on industry activity. Estimated timeline to achieve successful capping option (if deemed suitable for the incident) is provided below.	Relief well MODU, services and equipment can be sourced via APPEA Mutual Aid MoU. Timeline breakdown is provided in below.

7.4.2.1 Site Survey, Debris Clearance and Intervention - Scope of Activity

Site survey and debris clearance are key preliminary tasks that assist in selecting subsequent source control options.

- Survey allows the response team to understand any issues which may preclude installation of equipment or other constraints to safely enter and work in the area.
- The need for debris removal activities will dependent upon the scenario, damage to the subsea facilities such as subsea well components, MOU riser and well control equipment. Debris clearance may involve the use of ROVs and cutting of equipment to ensure a clear path for manual intervention and/or capping.
- Intervention and is likely the earliest opportunity to stem or stop the release of hydrocarbons. Intervention would include the use of ROVs and tooling which can interface with the BMG wells and project subsea pressure control equipment.

Various options are available for equipment supply. Response specialists such as AMOSC/Oceaneering and Wild Well control can provide equipment packages. Comparison of the AMOSC SFRT equipment list against the planned equipment scope of supply indicates that Cooper Energy will already have the applicable survey, debris clearance and intervention equipment available for the planned activities (refer to the BMG Closure Project (Phase 1) OPEP).

Cooper Energy maintains agreements and/or service provider prequalification's to facilitate quick mobilisation of additional equipment, should it be necessary (refer to the BMG Closure Project (Phase 1) OPEP). A high-level response time model for the mobilisation of survey, debris clearance and intervention responses is provided within Section 7.6.

Table 7-4 Indicative equipment available for planned activities

Response Options	Campaign equipment applicable to source control options
Survey Debris clearance Intervention	Cameras inspection ROV operated ROVs Grinders / super grinders Impact wrenches Multipurpose cleaning tools Remote control units Hydraulic cutters Chopsaws Diamond wire cutters Hydraulic power units ROV dredges Torque tools Test jig Pressure control equipment intervention skid and operating equipment Linear valve override tools Manipulator knife Flying lead orientation tool 2" black eagle hose

7.4.2.1.1 Site Survey, Debris Clearance and Intervention RTMs

Table 7-5 outlines the key activities and estimated response time model (RTM) associated with gaining access to inspection, debris clearance, intervention and subsea dispersant equipment. The RTM reflects an optimal case given equipment available on the project, with additional equipment (i.e. SSD and application hardware) available within Australia via AMOSC or internationally from WWC. The RTM considers response times for:

- Utilising project equipment which will be located on project vessels or at a local port facility. Cooper Energy will mobilise decommissioning equipment for the campaign and has access to ROV debris removal equipment through tooling manufacturers and ROV providers. Experienced personnel are available to manage the onshore and offshore scopes from Oceaneering, Helix and internal contractors.
- Sourcing applicable debris removal equipment and subsea dispersant will be through a 3rd party provider such as AMOSC (SFRT based in Western Australia); hardware may alternatively be mobilised via WWC (Houston) where it supports best case response times. Table 7-5 shows the RTM for the AMOSC SRFT equipment.
- Dispersant stores are available in Victoria (Geelong) and available through AMOSC's warehousing facilities who will also manage inventory levels through the response. The project RTM is aligned to industry RTM with the project variable component transportation time from warehouse to port facility.

Table 7-5 RTM Subsea First Response Tools

Activity – Mobilisation of SFRT	Cumulative Time (days)	
	Project equipment	**3rd Party (AMOSC)**
Notification process with provider	-	0.08
Prepare equipment for loading	-	0.17
Mobilise haulage company	-	0.42
Load hardware onto trucks 1 - 5	-	0.48
Transport to Port Facility (Barry Beach Marine Terminal)	-	3.98
Unload trucks 1-5 at Port Facility	-	4.04
Charge Subsea Accumulator Module (SAM) if required	-	6.04
Load SFRT to vessel	0.21*	6.25
Sea fastening	0.25*	6.50
Transit from Port Facility to Well site	0.6*	0.6
Set-up at site and deploy	1	1
Total Time (days)	**2.06**	**8.1**
Additional time to mobilise project vessel (base case)	0	0
Additional time to mobilise additional vessel (contingency)	3-5	0-2

Notes:
Project equipment excludes SSD and application equipment, this is accessed through 3rd party.
**Time provision included for transfer of tools either from port to vessel or vessel-vessel transfer.*

7.4.2.2 Capping – Scope of Activity:

Capping provides a means to hydraulically seal a well and stop the flow of oil during a LOWC, prior to the completion of a relief well should intervention be unsuccessful. Capping may not be suitable in all scenarios or under all environmental conditions; relief well drilling remains the primary source control solution in the event of a LOWC.

Various well capping solutions have been considered for responding to a LOWC during the BMG P&A activity and a solution to cap during the BMG P&A campaign will be maintained whilst there is a risk of LOWC.

7.4.2.2.1 Capping feasibility and solutions for the BMG P&A campaign

A study for capping stack suitability has been completed by Wild Well Control to assess the feasibility for capping a well in the event of LOWC during the abandonment activities. The study found the bending moments due to the installation of a Global Capping Stack (110MT) was the limiting factor and could result in a leak at the 152.4 mm (6”) connection flange.

The study reviewed the installation points at various stages during an intervention riser system (IRS) activity at BMG and well capping solutions and associated challenges:

- Capping stack deployed onto the XT is not feasible due to the bending moments. A well intervention package is the recommended option to cap the well, allowing multiple options to establish permeant barriers.

- A capping stack can be deployed directly onto the wellhead. However prior to removing the vertical subsea tree, the well barriers will be verified. An alternative capping solution, providing the Q7000 is used, is the Riserless Open water Abandonment Module (ROAM). This would eliminate the need to mobilise a capping stack and is advantageous due to reduction in loading and deployment timeline. If the well is capped with the ROAM a relief well will most likely be required to establish permanent barriers.
- A capping stack deployed onto the IRS after a LRP disconnection is not deemed feasible. The primary option to cap the well is to close the IRS values, SSSV and / or XT valves. Dependant on the stage of downhole abandonment multiple options would be available to establish permanent barries wither via direct interaction with well bore or via a relief well.
- The capping stack can be deployed onto the ROAM system if LOWC; however at this stage of the activity numerous failures would need to occur including the verified reservoir abandonment plugs and ROAM. Dependant on the stage of downhole abandonment multiple options would be available to establish permanent barries either via direct interaction with well bore or via a relief well.

The compatible capping solutions with the BMG wells during P&A include:

- Project Equipment (available locally)
  - Re-run Intervention Riser System
  - Re-run Emergency Disconnect Package
  - Re-run Subsea Tree Cap
  - Re-run Subsea Tree
  - Run Riserless Open-water Abandonment Module (ROAM)
  - Re-run ROAM Running Tool
- Third-party emergency response equipment (located internationally)
  - Wild Well Control Light Weight Capping Stack

A compatibility matrix (scenario vs capping solution is provided within the BMG Closure Project (Phase 1) OPEP) scenario in which each of the capping solutions would be applicable. Capping solutions derived from project equipment provide a more expedient way of stopping the flow of oil from the well.

7.4.2.2.2 Deployment Vessels

The campaign MOU is expected to be capable of running capping equipment. Cooper Energy also monitors the marine market and access to active vessels with a range of specifications that may be required for cap deployment. Vessels of the type and specification that would be required for this activity can typically be sourced from Singapore if not already in country.

The prerequisites for a capping vessel include:

- CSV type vessel or similar
- DP2 minimum
- Minimum 65T heave compensated crane
- Work class ROV Installed
- Australian Safety Case

7.4.2.2.3 Capping RTMs

Table 7-6 outlines the key activities and estimated timeframe associated with capping utilising a capping stack and vessel sourced internationally. This is expected to reflect a conservative case given the number of options available during the project to cap the well. The timeline also considers sourcing a vessel from the region, providing the ‘local case’ or using the campaign DP MOU for deployment. The presence of a suitable vessel in the region is dependent on other operator activities and schedules; vessel availability will be monitored by Cooper Energy and response time models adjusted to reflect best available timeframes.

Table 7-6 Capping System Installation Timeline

Activity Description - Capping Stack source control	Base Case	Mid Case	Local Case	Local Case	Local Case

	Capping Vessel Mobilisation Point	International (Asia)	Northwest shelf	Victorian waters	Victorian waters	Victorian waters
	Capping Vessel Type	CSV	CSV	CSV	Q7000	Q7000
	Capping Stack / Campaign Equipment (IRS / ROAM)	Light Weight Capping Stack	Light Weight Capping Stack	Light Weight Capping Stack	Light Weight Capping Stack	Campaign Equipment
No.	Activity description	Estimated days	Estimated days	Estimated days	Estimated days	Estimated days
	Loss of containment event – Capping Stack required					
1	Activate well control team and commence planning	2	2	2	2	2
2	Prepare capping stack package mobilisation from Scotland	5.5	5.5	5.5	5.5	0
3	Contract and mobilise CSV & transit to Port Facility Concurrent with activities No. 2-7	13	8	5	0	0
4	Air freight capping stack from Scotland (Prestwick Airport) to Melbourne (Airport)	1.5	1.5	1.5	1.5	0
5	Unload capping system and customs clearance	1	1	1	1	0
6	Transit capping stack / equipment to Port Facility	1	1	1	1	0
7	Assemble, perform functionality and pre-deployment checks	1.5	1.5	1.5	1.5	0.5
8	Load-out and sea fasten on CSV	1	1	1	1	0
9	Transit from Port Facility to Well site	0.6	0.6	0.6	1.1	0
10	Position and deploy capping stack to well and perform shut-in operations	3	3	3	3	1
	Well no longer flowing – source controlled	-	-	-	-	-
	Total Time (days)	**30.1**	**25.1**	**22.1**	**17.6**	**3.5**

Notes:
Capping response concurrent with Inspection and Debris clearance response; cap deployment follows confirmation of suitable deployment pathway.
Vessel with AU Safety Case preferentially selected.

The Cooper Energy well engineering team and well control partners would collectively assess the situation and evaluate equipment and logistics needs. Installing a subsea well cap requires access to personnel with specialised knowledge on the operation of such systems. Cooper Energy maintains contracts with well control companies (such as Wild Well Control) to supply technical services and guidance, equipment, specialised well control and capping installation.

7.4.2.3 Relief Well – Scope of Activity

The scope of drilling a relief well is the same as drilling a standard well although it will be a deviated well due to the need to drill at distance from the original flowing well. A relief well is typically drilled as a straight hole down to a planned kick-off point, where it is turned towards the target using directional drilling technology and tools to get within 30-60 m of the original well. The drilling assembly is then pulled from hole and a magnetic proximity ranging tool is run on wireline to determine the relative distance and bearing from the target well. Directional drilling continues with routine magnetic ranging checks to allow for the original well to be intersected. Once the target well is intersected dynamic kill commences by pumping kill weight mud and cement downhole to seal the original well bore.

Planning for the relief well will begin simultaneously with other well intervention options. Outline relief well plans, and methodology are contained in the activity SCERP. This plan details the process for relief well design with key activities prioritised as part of the immediate response operations:

- Mobilisation of well control and relief well specialists.
- Confirmation of relief well strategy with well specialist to define MODU/vessel requirements:
  - Confirm relief well location using geophysical site survey data. This will consider the prevailing weather at the time of the incident; seabed infrastructure in the area and directional drilling requirements for well intersection.

– Validate relief well casing design.

- Screen available MODUs in the region with current Australian Safety Case and select MODU with appropriate technical specifications to execute the strategy. A memorandum of understanding has been established between Australian operators (including Cooper Energy) to expedite access to suitable MODUs, equipment and services for relief well drilling. If required Cooper Energy is able to request the use of a MODU, equipment and services, that may be under contract to another operator. Minimum technical specifications for the well kill are assessed in the Well Control Modelling Report for the BMG field, the selected MODU will meet these requirements and be capable of operating in the Metocean conditions at the relief well location.
- Prepare and submit regulatory documentation required for relief well activities.
- Mobilise necessary equipment and services such as directional drilling equipment and appropriate ranging tools for relief well strategy.

7.4.2.3.1 Relief well design

The SCERP and relief well plan includes technical details as to the design and equipment requirements to drill a relief well at BMG. The APPEA relief well complexity assessment provides an overview of some of the key planning considerations which are addressed within these documents. BMG relief wells score 32 / medium complexity (Table 7-7).

Detailed well kill modelling has demonstrated that the BMG wells can be killed via a single relief well, a kill weight mud of 1.15 sg and a pump rate of 636 L/min (4bbl/min). Relief wells are expected to have similar formation strength as existing wells at BMG, hence modelling and planning has provided for formation fracture gradients recorded during historical drilling at BMG.

The basic design (based on Basker-2 well kill) is for a directional relief well targeting the targeting the 244 mm (9-5/8") wellbore above the 178 mm (7") liner hanger. The relief well architecture would comprise:

- 660 x 1067 mm (26" x 42") conductor hole drilled to ~206m TVDRT (45-60m below seabed - sufficient depth as required for conductor loading and fatigue mitigation). 914 mm (36") conductor will be installed and cemented to seabed.
- 445 mm (17-1/2") surface hole directionally drilled riserless to ~1050 mMDRT / 1000 mTVDRT in Gippsland Limestone before running 340 mm (13-3/8") surface casing, inclination at TD ~ 30 degrees.
- 311 mm (12-1/4") hole directionally drilled with BOPs installed to ~2687 mMDRT / 2450 mTVDRT before running 244 mm (9-5/8") intermediate casing. The sail angle from the surface casing shoe is 30 degrees until reaching proximity of the target well and dropping to inclination at TD ~ 0 degrees.
- 216 mm (8-1/2") hole drilled to well TD ~3038 mMDRT / 2800 mTVDRT. This section of the well is designed to intercept the target wellbore, which may be iterative until success.

Table 7-7 Relief Well Complexity Assessment (after APPEA 2021)

Design Parameter	Complexity Category								
	Low			Medium			High		
Flow potential	Low pressure well (MASP < 5kpsi) and/or tight reservoir.			Low - moderate pressure well (MASP < 10kpsi), conventional reservoir. *[B2 RW1 MASP <5kpsi, but conventional reservoir capable of flowing]*			High pressure well (MASP > 10kpsi) and/or high permeability reservoir.		
Score	1	2	3	**4**	5	6	7	8	9
Reservoir Fluids	Dry Gas			Wet Gas / Condensate			Crude Oil		
Score	1	2	3	4	5	6	**7**	8	9
Trajectory (relief well)	- Max. inclination <30˚			- Max. inclination >60˚			- Max. inclination >60˚		
	- Max. DLS < 2.5˚/30m			- Directional plan achievable with standard tools.			- Short radius or high build rate through shallow formations.		

Design Parameter	Complexity Category								
	Low			Medium			High		
	- Nearest offset >5km			- Offset wells <5km that required A/C screening.			- Multi-well location e.g. subsea drill-centre or platform.		
Score	1	2	3	4	5	6	7	8	9
Surface location	No constraints on surface location			Seabed features, subsea or surface infrastructure limit choice of surface location			Detailed risk assessment or mooring design required to choose suitable relief well location due to existing infrastructure.		
Score	1	2	3	4	5	6	7	8	9
Temperature	Max. BHST < 150˚C			- 150˚C < Max. BHST < 180˚C - and/or SBM required.			BHST > 180˚C		
Score	1	2	3	4	5	6	7	8	9
Long-lead equipment (casing & wellheads)	Standard casing and wellheads specs – same as source well.			Standard casing and wellheads specs – different from source well.			Unusual casing and/or wellhead specs. May require additional effort to assure timely supply.		
Score	1	2	3	4	5	6	7	8	9
Availability of technically suitable relief well rigs	Multiple suitable rigs likely to be operating offshore Australia			At least one suitable MODU likely to be operating offshore Australia, with alternative rigs available in the region.			Limited availability of suitable rigs.		
Score	1	2	3	4	5	6	7	8	9
Hazardous formation fluids (H2S or CO2)	None expected.			Expected, but not likely to affect material selection or relief well location.			Expected and may require special safety precautions, well materials, or affect the location of a relief well.		
Score	1	2	3	4	5	6	7	8	9

7.4.2.3.2 MODU considerations

The default surface location offset distance of the relief well is 1 km from the flowing well. The Metocean conditions (prevailing wind and currents) are considered when finalising the surface location. The location of the relief well is positioned to ensure the relief well MODU is upwind for as much time as possible to limit potential exposure to hydrocarbons from the LOWC. This places a relief well in water depths between approximately 130 – 270 m, depending on the target well.

The relief well can be executed using a semi-submersible MODU (moored) similar to that used for drilling the development wells (drilled by the Ocean Patriot moored MODU).

Moorings are expected to extend approximately 2 km from the MODU, and may therefore extend beyond the distance of the EP Activity operational area, which may expand by approximately 1-2 km radius under emergency conditions.

MODU mooring and anchor suitability analysis have been completed previously for the BMG area and has concluded that MODU anchors (e.g. 15mT Stevpris Mk6, a commonly available size) or rental anchors of the same or higher performance would be appropriate for the BMG location, and will be available. At least two anchor handling and tow support (AHTS) vessels would be required to tow the MODU (if not self-propelled) and install the moorings. An active MODU would already be supported by AHTS vessels and hence would likely be accompanied by those vessels during relief well drilling. AHTS vessels could also be sourced from hubs such as NWS and Singapore.

There are typically multiple semi-submersible MODUs capable of drilling such wells within Australian waters. Higher activity is typical in the NWS, though drilling MODU's have also been active in the SE region through much of the period 2017-22.

For planning purposes Cooper Energy assesses four mobilisation scenarios for sourcing a relief well MODU:

- Regional semi-submersible MODU in Victorian waters.
- Northwest Shelf semi-submersible MODU in West Australian waters.

- International (Asia) semi-submersible MODU in Singapore waters.
- International (Pacific) semi-submersible MODU in New Zealand waters.

The mobilisation case of a relief well semi-submersible MODU from New Zealand has been reviewed and should a suitable MODU be available it would also be considered as part of the relief well planning. Access to MODU in New Zealand would depend on MODU contract commitments at the time and Title holder / Joint Venture and MODU owner willingness to release MODU, and the existence of a valid Australian Vessel Safety Case.

- *Base time case – MODU is mobilised from Singapore*

The base case model has been developed to assess mobilising a suitable MODU from outside of Australian waters. This may be due to a number of reasons for example:

- No active working MODU in Australian waters
- Deficient MODU capabilities to drill and kill the well
- MODU unable to be released due to restrictions (such as biosecurity, kick, equipment failure, weather, regulator enforcement etc.)
- Complex scopes to suspend well and demobilise from location i.e. deep-water mooring recovery

While other suitable MODU options are likely available closer to the relief well site there should not be a requirement to look further than the area of Singapore which continually services the oil and gas and maritime industries.

It is assumed that a MODU in Singapore would not be operational but awaiting deployment to the next operator hence the requirement to complete the current work scope has been reduced from the standard APPEA SCERP assumption of 6 days to 3 days. The base case transit time is the longest of all cases presented. Additionally, the selected MODU should have a current Australian Vessel Safety Case and no restrictions to enter the county.

- *Mid time case – MODU is mobilised from Northwest Shelf*

The mid case model has been developed to assess bringing in a suitable MODU from the Northwest Self (NSW) (location Exmouth). This may be due to a number of reasons for example:

- No active suitable working MODU in local Victorian waters
- Deficient MODU capabilities to drill and kill the well
- MODU unable to be released due to restrictions (such as biosecurity, kick, equipment failure, weather, regulator enforcement etc.)
- Complex scopes to suspend well and demobilise from location i.e. deep-water mooring recovery

The Exmouth point of departure for the mobilisation is a nominal position in the NWS; a MODU further North in the area would require additional transit time. However, this would not be excessive or warrant a separate RTM estimate.

The NWS is the presently the main activity hub for oil and gas operations in Australia, multiple companies have continuous MODU operations on the NWS. Hence the area is likely to hold multiple options for securing relief well semi-submersible MODU. Additionally, transit time is improved when compared to the base case transit time.

- *Local time case – MODU is mobilised from Victorian waters*

The local case model has been developed to assess a technically capable and locally available semi-submersible MODU in the offshore Victoria area. Transit time is improved for the local case when compared to the base and mid case. A suitable local rig would be the preferred option during a relief well operation but may not be selected for several reasons for example:

- Lack of appropriate MODU capabilities to drill and kill the well
- RTM favours selection of alternate MODU (Complex scope to suspend well and demobilise from local location, stacked or requirement for hull inspection prior to mobilisation)

- MODU unable to be released due to restrictions (such as kick, equipment failure, weather, regulator enforcement etc.)
- No MODU available locally during activities.

The Victorian offshore oil and gas sector is serviced sporadically by semi-submersible MODUs with Tittle holders mobilising more frequently to NWS (Mid case) from Asia (Base case). Therefore should a relief well MODU be required it will likely be mobilised from either the NWS or Asia. Response Time Model (RTM) estimates have been developed and will continue to be reviewed and updated to reflect the most favourable case mobilisation of relief well MODU to the relief well location.

7.4.2.3.3 Relief Well RTMs

Cooper Energy RTM models contain the same activities and time for well construction, dynamic kill and abandonment of the well. The time model only changes due to mobilisation point of the MODU.

Cooper Energy has estimated the following timeframes for the total relief well installation and well kill scope (refer Table 7-8). The series of cases is used to help understand critical activities to undertaking the relief well scope. Cooper Energy has assessed and selected a number of measures to debottleneck source control contingencies (ALARP assessment below).

Table 7-8 Relief Well Installation Timeline

	Response Time Model – Relief Well Drilling & Well Kill	**Base Case**	**Mid Case**	**Local Case**	**Region Case**
	MODU Mobilisation Point	Asia - Singapore	Northwest shelf	Victorian waters	New Zealand waters
No.	Activity description	Estimated days	Estimated days	Estimated days	Estimated days
	Source Control Relief Well Activation Phase	-	-	-	-
1	Activated Well Control team, commence planning & notifications	2	2	2	2
2	Select MODU, Inspect & complete contracting and work scope.	3	6	6	6
3	Demobilise equipment from MODU	1	1	1	1
4	MODU Move preparations (includes anchor handling)	2	2	2	2
	MODU Transit Phase	-	-	-	-
5	MODU mobilisation to relief well location	51	29	3	16
	Well Construction, Ranging & Intercept, Well Kill Phase	-	-	-	-
6	Preparations for spud (includes anchor handling)	2	2	2	2
7	Mobilise equipment to rig	1	1	1	1
8	Drill 42” Top Hole	0.5	0.5	0.5	0.5
6	Run and Cement 36” Conductor	1	1	1	1
7	Drill 17-1/2” Directional Surface Hole	1.6	1.6	1.6	1.6
8	Run and Cement 17-1/2” Surface Casing	1.2	1.2	1.2	1.2
9	Run and Test BOP	1.6	1.6	1.6	1.6
10	Drill 12-1/4” Directional Intermediate Hole	18	18	18	18
11	Run and Cement 9-5/8” Intermediate Casing	2.5	2.5	2.5	2.5
12	Drill 8-1/2” Directional hole, Ranging Run #1-4	18	18	18	18
16	Pre-kill preparation	0.5	0.5	0.5	0.5
17	Well kill operations, attempt #1	1.2	1.2	1.2	1.2
18	Pre-kill preparation	0.5	0.5	0.5	0.5
19	Well kill operations, attempt #2, flow stopped	1.5	1.5	1.5	1.5
20	**Time to Complete Well Kill (days)**	**107.1**	**91.1**	**65.1**	**78.1**
	Relief Well Abandonment Phase	-	-	-	-

21	Lower Abandonment	2.4	2.4	2.4	2.4
22	Upper Abandonment	2.4	2.4	2.4	2.4
23	Pull BOPs	1.5	1.5	1.5	1.5
24	Remove Wellhead	1	1	1	1
25	Retrieve Anchors and release MODU	2	2	2	2
	Total Relief Well duration (days)	**116.4**	**100.4**	**74.4**	**87.4**

7.4.2.3.4 Regulatory approval timing considerations

Planning for relief well drilling will occur in parallel to other tertiary well control responses. A key component of the relief well drilling will be the preparation, submission, and approval of the regulatory documents. Generally, for well operations the regulatory and risk management processes fall on critical path hence in an emergency these documents will require a high level of focus immediately to ensure they are in place prior to arrival of the MODU.

To ensure that relief well time frame is met and were possible expediated Cooper Energy maintains several contracts and agreements with personnel agencies and engineering houses that can provide technical writer's and risk engineering services to support regulatory documentation workflows, submission, and review process such as ADD Energy, AZTECH Well Construction, Airswift, Access Human Talent and Wild Well Control.

The following documents will require consideration:

- Vessel Safety Case (VSC)
  - The selected MODU is expected to have a valid VSC, and it is not expected to affect response times.
- Scope of Validation (SoV)
  - Any proposed significant change to an offshore facility (i.e. MODU or Vessel) will require a SoV to be proposed to NOPSEMA and agreed prior to submission of a SCR. Depending on the level of changes the time to complete and gain approval could possibly affect the response time to have regulatory documentation in place prior to start of relief well operations.
- Safety Case Revision (SCR)
  - The SCR will require preparation, submission and approval prior to operations and is expected to be on critical path for relief well activities (Table 7-9).
- Well Operations Management Plan (WOMP)
  - The in force WOMP is expected to be suitable for relief well drilling and not expected to require a revision and resubmitted.
- Environmental Plan (EP)
  - The EP is designed to provide for source control response activities. Significant changes may require resubmission subject to initial change assessment, though is not expected to affect overall response time.
- Well Activity Notice (WAN)
  - WAN is not expected to affect response time.

As part of the preparation of the above documentation a number of formal safety assessments will be conducted as part of risk management these include:

- Hazard Identification (HAZID) workshop (identity's risks, assesses hazards and mitigations to control works site hazards with aim to remove major accident events).
- Hazard Operations (HAZOP) workshop (risk assesses the operational sequence and place controls to reduce hazards to ALARP).
- Risk Assessments for safety critical equipment (Vessel Equipment, BOP, Mooring, Fluids Handling).

Table 7-9 Safety Case Revision Preparation and Approval Timeline

	Safety Case Revision Submission Key Steps (standard MODU)	Time Estimate (days)
1	Planning, regulatory consultation, HAZID/HAZOP Workshops, document preparation	2 weeks
2	Internal review cycle and submit	1 weeks
3	Priority Regulatory Assessment Period	1 week
	Total Time	**4 weeks (28 days)**

7.4.2.3.5 Response Agreements

Cooper Energy maintains contracts/agreements with specialist resources to supply well control expertise and support for drilling a relief well. This includes:

- Well engineering support services such as AZTECH Well Construction, Airswift, Access Human Talent and Wild Well Control.
- Technical writing and risk engineering services to support regulatory documentation workflows and submissions is provided by experienced specialists such as ADD Energy.
- Wild Well Control: Well control specialists with experience in relief wells and the coordination of installation activities.
- Wellhead and casing materials supplier.
- Cooper Energy is party to the Industry Memorandum of Understanding to share drilling rigs, equipment and resources (well site services) in the event of an emergency. The MoU provides for the timely transfer of third party contractual arrangements involved in the release of a MODU and well site services to the Title holder for relief well drilling.
- Equipment and materials needed to construct a relief well will be able to be sourced either directly from suppliers or through the industry APPEA Mutual Aid MoU. All equipment and materials are tracked and identified prior to the commencement of the offshore activity through the “relief well readiness form” process (refer to OPEP Section 6.2 Source Control Resource Availability). All equipment and materials are expected to be sourced and transported to site during the SCR approval RTM, MODU transit and anchoring phase for the base and mid case response time model estimates. For the local MODU mobilisation case; an operational MODU would also have equipment and services, with additional equipment and services available via APPEA MoU.
- Cooper Energy will conduct a “relief well readiness check” and engage Tittle holders to ascertain and confirm the level of critical equipment inventories during the operational period for the purpose of drilling a relief well.

7.4.2.3.6 MODU activity outlook and monitoring

Cooper Energy keeps a watching brief on vessel availability through industry forums and vessel broker updates, and is also a participant of the Australian Drilling Industry Steering Committee (DISC). Through DISC, Cooper Energy receives regular updates on the location and operational status of MODU’s operating in Australian waters, which could be made available for a source control response.

7.4.3 Source Control ALARP Evaluation

Source Control ALARP considerations are included in Table 7-10: Source Control ALARP Evaluation.

Table 7-10: Source Control ALARP Evaluation

Control Measures Considered	Related Risk Event	Benefit	Recognised Good Practice?	Sacrifice	Introduced Risks	Conclusion
Risk Avoidance						
Do not undertake activity	Moderate Risk Worst Case Loss of Well Control	Deferral of other (relatively minor impacts and risks associated with the activity)	No. Wells must be P&A'd noting Industry Standards, Regulations and General Direction 824.	N/a	Containment ultimately fails over time resulting in ongoing leaks to sea and legacy risk. Moderate Risk Worst Case Loss of Well Control.	Reject Rationale: The BMG wells were originally shut-in between 2009 and 2011. The wells require P&A to eliminate legacy risks. This project is necessary to eliminate those legacy risks.
Response Preparedness						
Build or purchase Capping Stack and (pre-position) have on Standby at Project Shorebase.	As above	Could ensure capping equipment is not critical path, may allow for reduction in response time model of approx. 5 days (Table 7-6, time required to mobilise rental capping stack additional to other RTM elements) in the instance project equipment and vessel not available to cap. Environmental risks reduced but remain Moderate.	No. Not typical in the offshore industry in Australia. Typically, where necessary, operators sign up to capping stack accessible from overseas. Stacks are strategically placed around the globe to enable rapid deployment to other regions.	$2M-$20M. Build times likely to be 1-2 years. ($2M is to build a category 1 cap with capability to plug and kill the well but limited or no intervention capability), cost increases with complexity including ability to intervene post capping to estimated $20M. Considerable time (1-2yrs) and resources required to commission and fabricate bespoke capping stack for the BMG project and then maintain near to field. Current IRS system (integrated into the project) provides first response option to stop LOWC.	No significant introduced risks.	Reject Rationale: Provides no additional benefit over the capping provisions integrated into the project. Provides small reduction in time to cap compared to utilising industry capping solution but at significant additional cost and resource burden. Costs are considered to be grossly disproportionate to the potential reduction in environmental risks.
Equipment available on board the Q7000 which can be utilised to cap the well.	As above	Capping solution including IRS and tree cap immediately available on the Q7000. The mobility of the Q7000 allows the vessel to move off and back on location under its own thrust. Likely to offer quickest response. May reduce source control to <1 week	Yes, expected practice to run suitable and available equipment to control leak.	Already captured in vessel rates / designed into the project.	No significant introduced risks.	Implement Rationale: Provides the quickest means to cap the well. Potentially significant reduction in time to cap the well, may prevent significant volumes of oil reaching the ocean and shorelines and therefore reduce

		(depending on survey, debris clearance and intervention) and reduction in risks from Moderate to Minor.				consequence and overall risk from moderate to minor. Costs are currently integrated into current project design via DP MOU selection and associated engineering, and are not grossly disproportionate to the environmental risk reduction. Integrated via: • OPEP C8 SCR Equipment • OPEP C15 Capping Solution
Capping Stack equipment maintained in 'ready deploy status' by Service Provider.	As above	Mobilisation time is minimised. Note RTM is based on mobilisation times advised by third party provider and hence reflect 'ready to deploy status'. Risks reduced but remain Moderate.	Yes. Service is available and utilised by multiple operators.	Approx. $500K to sign-up. Capping suitability assessment indicates a suitable (light) capping stack can be contracted in ready to deploy status; sent by air freight from Scotland to Melbourne, loadout to Port of Melbourne (or similar) and sail to site.	No significant introduced risks.	Implement Rationale: Provides rapid access to alternate (back-up) means to cap the well. Potentially significant reduction in time to control source though given high initial WCD flow profiles and risks is within the Moderate category. Costs are not grossly disproportionate to the potential environmental risk reduction. Integrated via: • OPEP C8 SCR Equipment • OPEP C15 Capping Solution
Mobilise capping stack vessel to standby in region.	As above	Combined with a local capping stack, having a vessel available on standby ready to deploy a stack has the potential to reduce response times by approx. 19 days depending on survey, debris clearance and intervention (operations which would be initiated in the first instance). Risks may be reduced from Moderate to Minor.	No. Not typical in the offshore industry in Australia. Typically operators will source vessels as needed either vessel of opportunity or via MoU. For this project the Q7000 and available equipment already provides capping solutions to accelerate source control.	Estimated >$5M for the duration of the campaign plus $2 - $20M for the capping stack on standby in the region.	No significant introduced risks.	Reject Rationale: Provides no additional benefit over the capping provisions integrated into the project. As a back-up, this option is unlikely to save significant time unless integrated with local capping stack. Any time saving with this option is unlikely to achieve capping before tapering of the high initial WCD flow rate and associated shoreline accumulation. Costs are considered to be grossly disproportionate to the potential reduction in environmental risks.

Select primary project vessel (Q7000) capable of deploying capping equipment	As above	Capping solution immediately available on the Q7000 whereby existing project equipment could be run to stop flow from a well. The mobility of the Q7000 allows the vessel to manoeuvre / maintain safe position during response. Likely to offer quickest response. May reduce source control to within a few days (depending on survey, debris clearance and intervention) and reduction in risks from Moderate to Minor.	This measure is not always available for offshore campaigns but selection of Q7000 and spread for this current project provides this capability.	Already captured in vessel rates / designed into the project.	No significant introduced risks.	Implement Rationale: Provides the quickest means to cap the well. Potentially significant reduction in time to cap the well, reducing consequence and overall risk from moderate to minor. Costs are currently integrated into current project design via DP MOU selection and associated engineering and are not grossly disproportionate to the environmental risk reduction. Integrated via: • OPEP C8 SCR Equipment • OPEP C15 Capping Solution
Relief well MODU, services and equipment on standby in the region	As above	This option could remove a significant proportion of time associated with the RTM MODU activation phase and transit phase (between 12 and 57 days) depending on options available on the day. Time to drill a relief well remains >40 days by which time the well flow is predicted to have peaked and shoreline contact occurred (noting intervention and capping attempts to stop flow in the interim). Volume of oil ashore and risks would be reduced, but would remain Moderate.	No. Not typical in the offshore industry in Australia. Typically operators will plan to source vessels as needed either vessel of opportunity or via MoU. Wells complexity assessment shows well can be drilled with typical MODU.	Estimated >$50M for the duration of the campaign. Increased work load on project team to coordinate / maintain through critical planning and execution phases.	Operational environmental impacts and risks and safety risks at standby location. Increase biosecurity risks having MODU on standby.	Reject Rationale: Any time saving with this option would not achieve source control before either intervention/ capping or prevent high initial WCD flow rate and associated shoreline accumulation. The significant costs and planning burden are considered to be grossly disproportionate to the potential environmental risk reduction.
Wait to undertake project at a time when a MODU is drilling in the region and could support a relief well.	As above	This option could remove a significant proportion of time associated with the RTM MODU activation phase and transit phase (between 12 and 57 days) depending on options available on the day. Time to drill a relief well remains >40 days by which time the well flow is predicted to have peaked and shoreline contact occurred	No. Not typical in the offshore industry in Australia. Typically operators will plan to source MODU as needed e.g. via industry MoU or directly with MODU operators. Wells complexity assessment shows well can be drilled with typical MODU.	Committing to only undertaking the P&A work when a MODU is in the region would severely restrict operational flexibility and would (likely) lead to the exceedance of decommissioning deadlines set in General Direction 824.	Exceedance of deadlines set in General Direction 824.	Reject Rationale: Any time saving with this option would not achieve source control before tapering of the high initial WCD flow rate and associated shoreline accumulation. The significant costs, planning burden and risk to regulatory deadlines are considered to be grossly

		(unless intervention or capping is successful in the interim) Volume of oil ashore and risks would be reduced, but would remain Moderate.				disproportionate to the potential environmental risk reduction.
Pre-drill relief well top holes for the multiple existing BMG well sites.	As above	Estimated time saving of 1.5 days if section pre-drilled and conductor cemented. Unless combined with a MODU being on standby this option is not considered to provide significant benefit, noting time to move the MODU and drill the remaining well would still exceed the peak well flow period. The is also a real risk that the top hole location would no longer appropriate or safe depending on the scenario and conditions offshore.	No. Not typical in the offshore industry in Australia.	Estimated at $35M just to mobilise MODU and drill top hole for the 3 x well site locations. Plus $5M to cut and recover wellheads at the end of campaign. Increased work load on project team to coordinate.	Increased SIMOPS Risk, Drilling risks. Operational Environmental Impacts and Risks. Safety Risks.	Reject Rationale: Any time saving with this option would not achieve source control before tapering of the high initial WCD flow rate and associated shoreline accumulation. Costs are considered to be grossly disproportionate to the potential reduction in environmental risks.
Maintain complete inventory (all materials and consumables) to drill relief well.	As above	Ensures no equipment or consumables are critical path to drill a relief well. Unlikely to significantly reduce times unless combined with MODU being on standby, noting well site services and equipment are available through the APPEA MoU. BMG relief well can utilise standard equipment. Slight reduction in risk.	No. Not typical for individual operators to maintain their own inventory to drill a relief well unless undertaking well construction project where they may have spares available and/or complex wells.	Estimated at >$10M to purchase + $0.75M to store and maintain per annum. Increased work load on project team to maintain.	Yard HSEQ risks. Consumable expiry / maintenance.	Reject Rationale: Any time saving with this option would not achieve source control before tapering of the high initial WCD flow rate and associated shoreline accumulation. Costs are considered to be grossly disproportionate to the potential reduction in environmental risks.
Long leads: Purchase and maintain inventory of casing to drill relief well.	As above	Ensures these long leads are not critical path to drill a relief well. Unlikely to significantly reduce times unless combined with MODU being on standby, noting well site services and equipment are available through the APPEA MoU. BMG relief well can utilise standard equipment. Slight reduction in risk.	No. Not typical for individual operators to maintain their own inventory to drill a relief well unless undertaking well construction project where they may have spares available and/or complex wells.	Estimated at >$5M to purchase + $0.5M to store and maintain per year. Increased work load on project team to maintain.	Yard HSEQ risks.	Reject Rationale: Any time saving with this option would not achieve source control before tapering of the high initial WCD flow rate and associated shoreline accumulation. Costs are considered to be grossly disproportionate to the potential reduction in environmental risks.

Long leads: Purchase and maintain wellhead and conductor	As above	Ensures these long leads are not critical path to drill a relief well. Unlikely to significantly reduce times unless combined with MODU being on standby, noting well site services and equipment are available through the APPEA MoU. BMG relief well can utilise standard equipment. Slight reduction in risk.	No. Not typical for individual operators to maintain their own inventory to drill a relief well unless undertaking well construction project where they may have spares available and/or complex wells.	Estimated at >$2M to purchase, + 0.1M to store and maintain per year. Increased work load on project team to maintain.	Yard HSEQ risks.	Reject Rationale: Any time saving with this option would not achieve source control before tapering of the high initial WCD flow rate and associated shoreline accumulation. Costs are considered to be grossly disproportionate to the potential reduction in environmental risks.
Project equipment to include survey and debris clearance and intervention capability	As above	Debris clearance and intervention equipment being available on the project provides the quickest means for controlling the source. The mobility of the Q7000 allows the vessel to manoeuvre / maintain safe position during response. Likely to offer quickest response, commencing with survey, clearance and intervention. Likely to offer quickest response. May shift Risks from Moderate to Minor.	Industry practice is currently to sign up to industry debris clearance package which can be transported to site in approx. 7 days.	Already captured / designed into the project.	No additional risk	Implement Provides means to immediately progress source control. Potentially significant reduction in time to control the well, may help prevent significant volumes of oil reaching the ocean and shorelines and therefore reduce consequence and overall risk from moderate to minor. Costs are currently integrated into current project design via project vessel and equipment selection, and are not grossly disproportionate to the environmental risk reduction. Integrated via: • OPEP C8 SCR Equipment • OPEP C12 Survey Capability • OPEP C14 Debris Clearance and Intervention
Project vessel available with ROV and debris clearance capability	As above	Debris clearance equipment being available on the project provides the quickest means of implementing this response aspect. Likely to offer quickest response (within hours/days). Supports a shift in risk from Moderate to Minor.	Industry practice is currently to sign up to industry debris clearance package which can be transported to site in approx. 7 days and to source vessel of opportunity.	Already captured in vessel rates / designed into the project.	No additional risk	Implement Provides means to immediately progress source control. Potentially significant reduction in time to control the well, may help prevent significant volumes of oil reaching the ocean and shorelines and therefore reduce consequence and overall risk from moderate to minor. Costs are currently integrated into current

						project design via project vessel and equipment selection, and are not grossly disproportionate to the environmental risk reduction. Integrated via: • OPEP C8 SCR Equipment • OPEP C14 Debris Clearance and Intervention
Access to shared industry dispersant application toolkit.	As above	Project equipment does not include dispersant or dispersant application equipment. Required to support implementation of OPEP strategies. Reduction is risks if successful though likely to remain in the moderate category overall.	Yes, if project equipment is not available.	Approx. $400K for duration of campaign.	No introduced risks	Implement Rationale: subsea dispersant application has the potential to reduce the volume of oil contacting shorelines, and associated impacts could be reduced significantly for some shoreline receptors. Costs are not grossly disproportionate to the potential environmental risk reduction. Integrated via: • OPEP C8 SCR Equipment
Industry MoU for Mutual Aid for offshore incident.	As above	This could provide quickest access to a relief well MODU. Time to make well safe may add approx. 3-days to overall activation timeframe before transit phase. Time to drill a relief well remains >40 days by which time the well flow is predicted to have peaked and shoreline contact occurred. Risks remain Moderate.	Yes. Industry initiative commonly adopted. Likely to provide the quickest possible timeframe to implement source control response. MoU for Mutual Aid: "To Facilitate the Release and Transfer of Drilling Units and Well-Site Services between Operators in Australian and Timor-Leste-administered Waters in preparedness for an offshore incident". This includes: a) Drilling Unit; and/or b) to the extent suitable for use in connection with the Offshore Incident, third party contractor	Costs upon activation. In accepting a MODU from another operator the recipient is liable for the costs incurred by that operator, which are difficult to quantify but could be significant, nominally $50M to re-instate their drilling campaign.	No introduced risks	Implement Rationale: likely to provide the quickest means to drill relief well. Though relief well drilling does not reduce risks below the moderate level, a relief well would reduce overall volumes released and eliminate any legacy issues (e.g. due to recharge). Costs upon activation are not grossly disproportionate to the environmental risk reduction. Integrated via: • OPEP C8 SCR Equipment • OPEP C16 Relief Well

			personnel, equipment, materials, consumables and other well-site services (including, but not limited to, logistical support, cementing, well intervention and vessel support used in connection with such Drilling Units (collectively, "Well-Site Services").			
Monitoring of drilling inventories available including through APPEA MoU for the purposes of drilling relief well.	As above	Verification of available inventory which can be reflected in RTMs to identify and address potential bottlenecks. Slight reduction in risk.	Yes, good practice to verify and to reflect in RTMs.	Administrative effort only	No additional risk	Implement Rationale: identifies potential bottlenecks to relief well drilling prior to and during P&A to then consider alternate arrangements. Though relief well drilling does not reduce risks below the moderate level, a relief well would reduce overall volumes released. Costs of this option are not grossly disproportionate to the environmental risk reduction. Integrated via: • OPEP C8 SCR Equipment • OPEP C9 SCR Resources Monitoring • OPEP C16 Relief Well
MODU / Vessel contract tracking and forecasting via Vessel brokerage monthly (during P&A) MODU / vessel updates and/or participation with DISC.	As above	Save approximately 1-2 days in identifying suitable/ready MODUs and vessels. Slight reduction in risk.	Yes. Industry initiative commonly adopted.	Minor administrative costs.	No additional risk	Implement Rationale: maintains awareness of vessels and MODU's capable of supporting a source control response providing a small reduction in overall response times. Costs are not grossly disproportionate to the environmental risk reduction. Integrated via: • OPEP C9 SCR Resources Monitoring • OPEP C16 Relief Well

Source Control Contingency Response Plan developed, tested and utilised in the event of a source control incident.	As above	Clear response plans, allowing basis for managing the source control response to best case timeframes on the day. Risks reduced but remain Moderate.	Yes. Required. APPEA DISC provides content guidelines.	Estimated $100K	No additional risk	Implement Rationale: Enables source control strategies to be clearly communicated and expedited. Costs are not grossly disproportionate to the environmental risk reduction. Integrated via: • C41 SCERP • OPEP C6 SCERP
WOMP and field safety case accepted which provide for source control activities.	As above	Saves time and personnel resources during a response. Can be completed during the planning phase avoiding significant rework of plans in the event of a source control response. Slight reduction in risk.	Yes	Estimated $100K	No additional risk	Implement Rationale: Enables source control strategies to be clearly communicated and expedited. Costs are not grossly disproportionate to the environmental risk reduction. Integrated via: • OPEP C6 SCERP
Cooper Energy to maintain contracts with well control specialists	As above	This could save days required to contract required resources. Risks reduced but remain Moderate.	Yes. All operators rely on contractors for ramp-up support.	Estimated $100K	No additional risk	Implement Rationale: Enables source control strategies to be expedited. Costs are not grossly disproportionate to the environmental risk reduction. Integrated via: • OPEP C7 SCER Personnel • OPEP C13 Source Control Diagnostics
Pre-Mobilisation of Relief Well (Source Control) Personnel prior to P&A.	As above	This could save days required to form the broader source control team. May be of limited benefit considering expertise to commence a response are already available in the project team and ramp up via project and emergency response contractors. Slight reduction in risk.	No. All operators rely on contractors for ramp-up support as needed.	Estimated >$100K/day (>$10M for the duration of the campaign).	No additional risk	Reject Rationale: A contingent of source control personnel are obtained though service providers who are also available to support other companies and projects in emergency conditions. Mobilisations can occur quickly and advice sought remotely in the interim, such that time savings (if any) are likely minimal. Costs are considered

						to be grossly disproportionate to the potential reduction in environmental risks.
Relief Well (Source Control) personnel resourcing plan in place prior to P&A.	As above	Of benefit to identify where resources would be coming from / key contacts and roles. Slight reduction in risk.	Yes	Estimated $20K. Mapped out as part of the SCERP.	No additional risk	Implement Rationale: Enables source control strategies to be expedited. Costs are not grossly disproportionate to the environmental risk reduction. Integrated via: • OPEP C7 SCER Personnel
Pre-identify a quadrant for suitable relief well locations covering all exiting well clusters.	As above	Assists in making decision on the area for optimal location for relief well based on weather conditions and subsea hazards. Risks reduced but remain Moderate.	Yes	As part of nominal relief well plans.	No additional risk	Implement Rationale: Enables source control strategies to be expedited. Costs are largely accounted for through existing project planning work, and are not grossly disproportionate to the environmental risk reduction. Integrated via: • OPEP C6 SCERP
Nominal mooring analysis for drilling in field from moored MODU.	As above	Nominal mooring analysis completed for 2018 P&A campaign prior to cancellation, provides information which can be utilised for rig specific mooring analysis which would be undertaken at the time. Note: A site survey will be required at the time of LOWC to confirm location position and a new mooring analysis will be completed for the selected rig. Risks reduced but remain Moderate.	Not typical for solely for relief well purposes.	Already available to project. Mooring analysis completed as part of 2018 preparations.	No additional risk	Implement Rationale: Enables source control strategies to be expedited. Costs are largely accounted for through existing project planning work, and are not grossly disproportionate to the environmental risk reduction. Integrated via: • OPEP C6 SCERP
Pre lay of relief well MODU moorings.	As above	May save 2-3 days, only if laid in correct locations. Locations may change at the time depending on scenario and offshore conditions. Risks reduced but remain Moderate.	Not typical for solely for relief well purposes.	Estimated >$7M for coverage of all 3 well centres.	Additional impacts to seabed. Additional Risk to other sea users if RW outside existing PSZs (fisheries snag risk)	Reject Rationale: Any time saving with this option would not achieve source control before tapering of the high initial WCD flow rate and associated shoreline accumulation. Significant additional costs and project planning

						capacity are considered to be grossly disproportionate to the potential environmental risk reduction.
Pre-accepted safety case revision for possible relief well MODUs and source control vessels.	As above	Time saving and may assist in developing relationship with MODU operator. Multiple variables mean a particular MODU may not be available on the day, hence SCR of no benefit but significant effort and cost. MODU's / vessels for which safety cases were developed may not be available at the time, hence industry has utilised the MoU model which generally allows access to a range of MODUs and well site services. No risk reduction afforded.	No, no known examples of an accepted SCR specifically for a relief well MODU and vessels.	Estimated $500K + Regulator Levies. Increased work load on project team during critical planning and execution phase.	Risk of obscuring / overlooking optimal relief well MODU and source control vessels available at the time.	Reject Rationale: Any time saving with this option would not achieve source control before tapering of the high initial WCD flow rate and associated shoreline accumulation. MODUs and response vessel availability will change with time; facilities may be unavailable, or may not be the most expedient option to support a response at the time one may be needed. There is a significant risk of wasted planning effort where directed at a single facility. There is also a risk of obscuring optimal (most expedient) options to drill a relief well where plans become tailored to a particular option. Costs are considered to be grossly disproportionate to the potential reduction in environmental risks.
Prepare outline safety case revision for MoU MODU prior to P&A.	As above	Unlikely to accelerate SCR times significantly noting that MODU selection is uncertain until the time of the event. There are pre-exiting safety cases which provide a basis for format. Major part of development of SCR is workforce engagement with the service partners for the scope, which is based on the MODU selected at the time. No risk reduction afforded.	Not typical but at least one example of this recently.	Estimated $100K. Increased work load on project team during critical planning and execution phase.	No additional risk	Reject Rationale: Any time saving with this option would not achieve source control before tapering of the high initial WCD flow rate and associated shoreline accumulation. MODUs and response vessel availability will change with time; facilities may be unavailable, or may not be the most expedient option to support a response at the time one may be needed. There is a significant risk of wasted planning effort where directed at a single facility. There is

						also a risk of obscuring optimal (most expedient) options to drill a relief well where plans become tailored to a particular option. Costs are considered to be grossly disproportionate to the potential reduction in environmental risks.
Contract in place for Safety Case Expertise to expedite development.	As above	Accelerates preparation times noting personnel familiarity with Titleholder systems, processes and field. Slight reduction in risk.	Yes	In place with Add Energy	No additional risk	Implement Rationale: Enables source control strategies to be expedited. Costs are not grossly disproportionate to the environmental risk reduction. Integrated via: • OPEP C7 SCER Personnel • OPEP C16 Relief Well
In the event a suitable MODU not available through APPEA MoU, prepare mobilisation plan for nominal MODU outside of Australia.	As above	Identifies pathway to bring suitable MODU for relief well drilling into Australia and to the region. Some reduction in risk but remains Moderate.	Good practice as part of relief well planning.	Estimated $100K as part of relief well planning.	No additional risk	Implement Rationale: Assists in expediting source control strategies. Costs are not grossly disproportionate to the environmental risk reduction. Integrated via: • OPEP C10 SCR Logistics • OPEP C16 Relief Well
Identify pathway for biosecurity clearance of a nominal MODU and vessels from southeast Asia prior to commencing well P&A.	As above	Time saving (accelerated biosecurity clearance) and reduction in HSEC risk - MODU able to mobilise directly to well site.	Yes, if MODU known.	Estimated $100K	Additional time for project team to maintain MODU/vessels in ready-to go state.	Implement Rationale: Assists in expediting source control strategies. Costs are not grossly disproportionate to the environmental risk reduction. Integrated via: • OPEP C10 SCR Logistics OPEP C16 Relief Well
Invasive Marine Species (IMS) Risk Assessment (RA) of most suitable relief well MODU prior to	As above	Assists in identifying IMS actions to be completed during mobilisation. Reduces risk of IMS transfers if mobilised. Only of benefit if MODU is	Standard practice in the prequalification phase.	Estimated $50K	Additional time for project team to maintain IMS assessment.	Implement Rationale: Assists in expediting source control strategies. Costs are

commencing well P&A (and updated if MODU changes)		known/contracted otherwise of no value.				not grossly disproportionate to the environmental risk reduction. Integrated via: • OPEP C10 SCR Logistics • OPEP C16 Relief Well

7.4.4 Source Control Impact and Risk Evaluation

Vessel-based source control options (ROV Intervention and capping deployment) are vessel-based and the impacts and risks associated with those activities relate to:

- Vessel discharges and emissions (sound, air emissions, bilge, etc.);
- Vessel risks (discharges of deck drainage, IMS introduction, megafauna strikes, equipment loss to the environment, etc.); and
- Seabed disturbance.

MODU-based source control activities have common impacts and risks from plug and abandonment described in Section 6, including:

- Subsea operational discharges
- Surface operational discharges.

No additional evaluation is required.

The environmental performance outcomes, standards and measurement criteria for response preparedness and implementation of source control activities are shown in Table 6-4 of the BMG Closure Project (Phase 1) OPEP.

7.5 Spill Response: Monitor and Evaluate

7.5.1 Overview

Ongoing monitoring and evaluation of the oil spill is a key strategy and critical for maintaining situational awareness and to complement and support the success of other response activities. In some situations, monitoring and evaluation may be the primary response strategy where the spill volume/risk reduction through dispersion and weathering processes is considered the most appropriate response. Monitor and evaluate will apply to all marine spills. Higher levels of surveillance such as vessel/aerial surveillance, oil spill trajectory modelling and deployment of satellite tracking drifter buoys will only be undertaken for Level 2/3 spills given the nature and scale of the spill risk.

It is the responsibility of the Control Agency to undertake operational monitoring during the spill event to inform the operational response. Operational monitoring may include the following:

- Aerial observation;
- Vessel observation;
- Computer-based tools:
  - Oil spill trajectory modelling;
  - Vector analysis (manual calculation); and
  - Automated Data Inquiry for Oil Spills (ADIOS) (a spill weathering model).
- Utilisation of satellite tracking drifter buoys.

For vessel-based spills, the responsibility for operational monitoring lies with AMSA (Commonwealth waters). For a LOWC event the responsibility lies with Cooper Energy.

7.5.2 Resources Required and Availability

To understand the response equipment and personnel associated with a monitor and evaluate response technique, Cooper identified the quantity and type of equipment and personnel required for the proposed optimum response.

In the event of a LOWC event, Satellite Tracking Buoys would be deployed to provide an understanding in real time of environmental conditions. The outcomes from this will feed into both Oil Spill Trajectory Modelling and Manual Trajectory Calculations to provide situational awareness and an understanding of the spill trajectory and sensitivities that have the potential to be exposed.

Whilst this can be done rapidly, additional vessel and aerial surveillance may take more time to initiate dependant on the time of the spill. Vessel surveillance can be conducted from any offshore vessel under Cooper Energy's control which may be engaged immediately in the event of a spill depending on the time of day. Vessel observations will assist in determining if additional response actions are required, however vessel observation is generally considered to be less effective than aerial observation due to the limited distance in which observations can be conducted. However, vessel surveillance activities also incorporate operational monitoring studies as outlined in the OSMP; which will involve various monitoring and sampling methodologies of water to determine the extent of surface, entrained and dissolved hydrocarbons in the water column and near sensitive receptors.

Vessel surveillance may assist in determining if additional response actions are required. Minimum requirements are:

- 1 vessel surveillance team comprising:
  - 1 x visual observer; and
  - 1 x vessel.

Aerial surveillance may be undertaken from specially mobilised aircraft. Trained observers are to be present on the surveillance aircraft who can be sourced from the Australian Marine Oil Spill Centre (AMOSC) and/or AMSA.

If aerial surveillance is required, an over-flight schedule is developed. The frequency of flights will be sufficient to ensure that the information collected during each flight (i.e. observer log and spill mapping) meets the information needs to validate dispersion of the spill.

Aerial surveillance would be used at the start of spill to gain situational awareness assess including trajectory of spill, size of slick and thickness to enable a baseline quantity to be established. Initial reconnaissance may be basic to enable a level of understanding of the spill within 24 hours without waiting for trained observers to arrive, whilst later observations may require more skill/calculations to estimate behaviour, therefore trained observers are critical.

Given the relatively small distance offshore, the proximity to pre-qualified aircraft supplier, and that 24 hour surveillance is not required to track spill trajectory, minimum requirements are:

- 1 aerial surveillance team
  - 1 x visual observer; and
  - 1 x aircraft (helicopter or fixed wing).

The feasibility/effectiveness of a monitor and evaluate response is provided in Table 7-11.

Table 7-11 Feasibility / Effectiveness of Proposed Monitor and Evaluate Response

Parameter	Monitor and Evaluate
Suitability/Functionality **Feasibility** *How does the response strategy perform to achieve its required risk reduction?*	Implementation of monitoring is fundamental in informing all of the remaining response strategies. The response activity validates trajectory and weathering models providing forecasts of spill trajectory, determines the behaviour of the oil in the marine environment, determines the location and state of the slick, determines the effectiveness of the response options and confirms the impact on receptors. Monitoring and evaluation activities will continue throughout the response until the termination criteria have been met.
Dependencies **Effectiveness** *Does the response strategy rely on other systems to perform its intended function?*	The successful execution of monitoring relies on of the pre-planning of monitoring assets being completed to enable the shortest mobilization time of personnel, and equipment required for gaining situational awareness. To ensure the IMT can maintain the most accurate operating picture the monitoring data collected in the field will be delivered to the IMT as soon as possible,
Availability and Timely *Time the response strategy is available to perform its function?*	Time to be operational - Monitoring from aerial platforms will only operate in daylight hours; all other options are capable of 24-hour operations. Access to ADIOS is available within 1 hour of the establishment of the IMT with initial results available within 1 hour of accessing the system. Initial external modelling results are available 2 hours after initial request. The addition of alternative monitoring techniques Personnel downtime will be planned and managed to ensure appropriate levels of response personnel are maintained and rotated as required or until the response is terminated.

Table 7-2 of the OPEP details the resource capability to undertake monitor and evaluate activities in accordance with the identified required resources above, their availability and hence Cooper Energy's capability to support a 'monitor and evaluate' response.

Cooper Energy maintains operational monitoring capability and implements operational monitoring for Level 2 or 3 infrastructure-based incidents and this response capability would be available to assist the Control Agencies in an MDO spill if requested. Cooper Energy would initiate Type II (scientific) monitoring in the event of any Level 2 or 3 spill.

Through this resourcing Cooper Energy is capable of:

- Acquiring knowledge of the spill conditions from any vessel-based MDO spill via deployed tracking buoys and undertaking manual trajectory calculations within 1 hour of EMT mobilisation;
- Activating and obtaining modelling forecast within 4 hours of spill;
- Deploying aircraft within 24 hours to verify modelling/vector calculation forecast and provide real-time feedback of impacts/predicted impacts.

Cooper Energy considers that during a 'worst-case' spill event, there are sufficient monitoring resources to respond in sufficient time to allow Cooper Energy to understand if any sensitivities have the potential to be threatened by spill residue (i.e. via satellite tracking buoy deployment; manual and computerised trajectory calculation and finally via aerial observation). The operational constraints and termination criteria for a 'Monitor and Evaluate' response is provided in Section 6 of the BMG Well Abandonment OPEP.

7.5.3 Monitor & Evaluate ALARP Evaluation

Monitor and evaluate ALARP considerations are included in Table 7-12.

Table 7-12 Monitor and Evaluate ALARP Evaluation

Additional control measures	Benefit	Cost	Outcome
Utilise additional vessels and aircraft for spill observations during initial response stages	Although additional surveillance activities will provide additional information, continuous monitoring of the spill has limited benefit given significant changes in trajectory are influenced by oceanic currents and wind direction that is being continuously monitored via both tracking buoys and Meteye services. Consequently, a single aerial and vessel MES Team is expected to be sufficient for the initial stages of the response planning and using additional platforms is not considered to provide a considerable environmental benefit.	Cooper Energy have arrangements in place to enable additional platforms to be deployed for Monitoring, Evaluation and Surveillance (MES) activities if required and thus the cost of deploying additional platforms is not expected to be significant. However, during the initial stages of the response, deploying additional platforms increases SIMOPS risk whilst the emergency management structure and communication protocols are being initiated. Consequently, as there is no considerable benefit of scaling up MES during the initial stages of the response implementation of this control measures has not been considered further. As the response progresses, scaling up or down of the response effort will be considered in accordance with the OPEP which reviews the effectiveness of each strategy. Cooper Energy has demonstrated in Table 7-9 that existing arrangements are in place (such as with both vessel and aircraft providers) to access additional resources (not just that required for the initial stages of the response) if required by this process.	Not selected
Use unmanned aerial vehicles (UAV) to provide a more rapid monitoring	The cost associated with purchasing this equipment is not considered to be significant.	This control measure is not expected to provide significant environmental benefit as BMG wells are located offshore and as drone range is expected to be minimal, it is not expected to be practicable. In addition to this there is immediate in-field monitoring via supply	Not selected

Additional control measures	Benefit	Cost	Outcome
response with reduced safety risks		vessel (with one being along-side the MODU at all times), and aerial surveillance will be implemented rapidly given access to helicopters via existing contracts.	
Night-time monitoring - infrared	The cost associated with utilising infra-red monitoring is not considered to be significant. As infra-red monitoring needs to be deployed from an aerial platform, this activity creates significant health and safety risks.	Infrared may be used to provide aerial monitoring at night time, however the benefit is minimal given trajectory monitoring (and infield monitoring during daylight hours) will give good operational awareness. In addition to this, satellite imagery may be used (is already provided for) at night to provide additional operational awareness.	Not selected

7.5.4 Monitor & Evaluate Impact and Risk Evaluation

7.5.4.1 Cause of the aspect

The following hazards associated with operational monitoring have the potential to interfere with marine fauna:

- Aircraft use for aerial surveillance (fixed wing or helicopter).

7.5.4.2 Impact or Risk

The potential impacts of underwater sound emissions in the marine environment are:

- Localised and temporary fauna behavioural disturbance that significantly affects migration or social behaviours; and
- Auditory impairment, Permanent Threshold Shift (PTS).

7.5.4.3 Consequence Evaluation

The potential impacts associated with aircraft activities shave been evaluated in Section 6.4 of this EP. Based upon the nature and scale of the activities, the evaluation is considered appropriate for any aerial or marine surveillance undertaken and thus has not been considered further.

7.5.4.4 Environmental Impact and Risk Assessment

Table 7-13 provides a summary of the EIA / ERA for monitoring and evaluation activities.

Table 7-13 Monitor and Evaluate EIA / ERA

ALARP Decision Context and Justification	**ALARP Decision Context A** The use of aircraft in offshore area is well practiced with the potential impacts and risks from these activities well understood. There is a good understanding of control measures used to manage these risks from aircraft. There is little uncertainty associated with the potential environmental impacts and risks, which have been evaluated as **Level 1**. No objections or concerns were raised during stakeholder consultation regarding this activity or its potential impacts and risks. As such, Cooper Energy believes ALARP Decision Context A should apply.
Control Measure	**Source of good practice control measures**
Consultation	Consultation in the event of a spill will ensure that relevant government agencies support the monitor and evaluate strategy thus minimising potential impacts and risks to sensitivities.

Likelihood	The likelihood of a LOWC event was determined to be Unlikely (D) (Section 6.15.6). As such, the likelihood of impacts from underwater noise from response activities in the event of a LOWC have been determined to be **Remote (E)**.
Residual Risk Severity	**Low**
Demonstration of Acceptability	
Principles of ESD	The potential impact associated with this aspect is limited to a localised short-term impact, which is not considered as having the potential to affect biological diversity and ecological integrity. The activities were evaluated as having the potential to result in a **Level 1** consequence thus is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Legislative and other requirements	Legislation and other requirements considered as relevant control measures include: • OPGGS Act 2006 (Cth); and • OPGGS Act 2010 (Vic). • EPBC Regulations 2000 (Part 8 – Interacting with cetaceans and whale watching). • Wildlife (Marine Mammals) Regulations 2009 (Vic) (R12 – Noise in vicinity of marine mammals) • Conservation Management Plan for the Blue Whale 2015–2025 (Department of Environment, 2015) • Listing Advice for the humpback whale 26 February 2022 (Threatened Species Scientific Committee, 2022) • Conservation Advice for *Balaenoptera borealis* (sei whale) (Threatened Species Scientific Committee, 2015b) • Conservation Advice for *Balaenoptera physalus* (fin whale) (Threatened Species Scientific Committee, 2015c) • Recovery Plan for marine turtles in Australia (DEE, 2017) • Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013)
Internal context	The environmental controls proposed reflects the Cooper Energy HSEC Policy goals of utilising best practice and standards to eliminate or minimise impacts and risks to the environment and community to a level which is ALARP. Relevant management system processes adopted to implement and manage hazards to ALARP include: • Risk Management (MS03) • Technical Management (MS08) • Health Safety and Environment Management (MS09) • Incident and Crisis Management (MS10) • Supply Chain and Procurement Management (MS11) • External Affairs & Stakeholder Management (MS05)
External context	No stakeholder concerns have been raised to date regarding impacts and risks from monitor and evaluate strategies. As such, Cooper Energy considers that there is broad acceptance of the impacts associated with the activity.
Environmental Performance	
The environmental performance outcomes, standards and measurement criteria for response preparedness and implementation of monitoring and evaluation activities are shown in Table 7-4 of the OPEP.	

7.6 Dispersant Application

7.6.1 Overview

Subsea Dispersant Application involves injecting dispersant into the flow of hydrocarbons at the well. SSD is injected when the oil is fresh and warm, prior to weathering. Contact and mixing between SSD and oil is maximised by injection directly at the source. SSD can be applied 24-hours/day where resources allow.

In the case of a LOWC involving Basker crude, subsea dispersant is considered likely to be the only effective dispersant application method. Surface application of dispersant is not expected to be effective given the high pour point relative to ambient sea water temperature (which results in rapid cooling and solidification of the crude), and strong winds and wave conditions in the Gippsland which are typically not favourable to surface dispersant application. The application of SSD has the effect of reducing oil droplet size, which increases the potential for dissolution within the water column (Gros *et al.* 2017).

7.6.2 Resources Required and Availability

SSD is applied via specialist materials and equipment including dispersant chemicals, dispersant distribution and routing manifolds, chemical hoses and applicators, Subsea Dispersant equipment packages and technicians are available globally via several response specialists, the closest being AMOSC / Oceaneering with equipment based in Fremantle Australia.

A vessel with ROV and capability to deploy subsea equipment is required to support SSD, such as a construction support vessel (CSV). The Source Control Emergency Response Plan will provide for hardware, materials, logistical and deployment arrangements for the strategy.

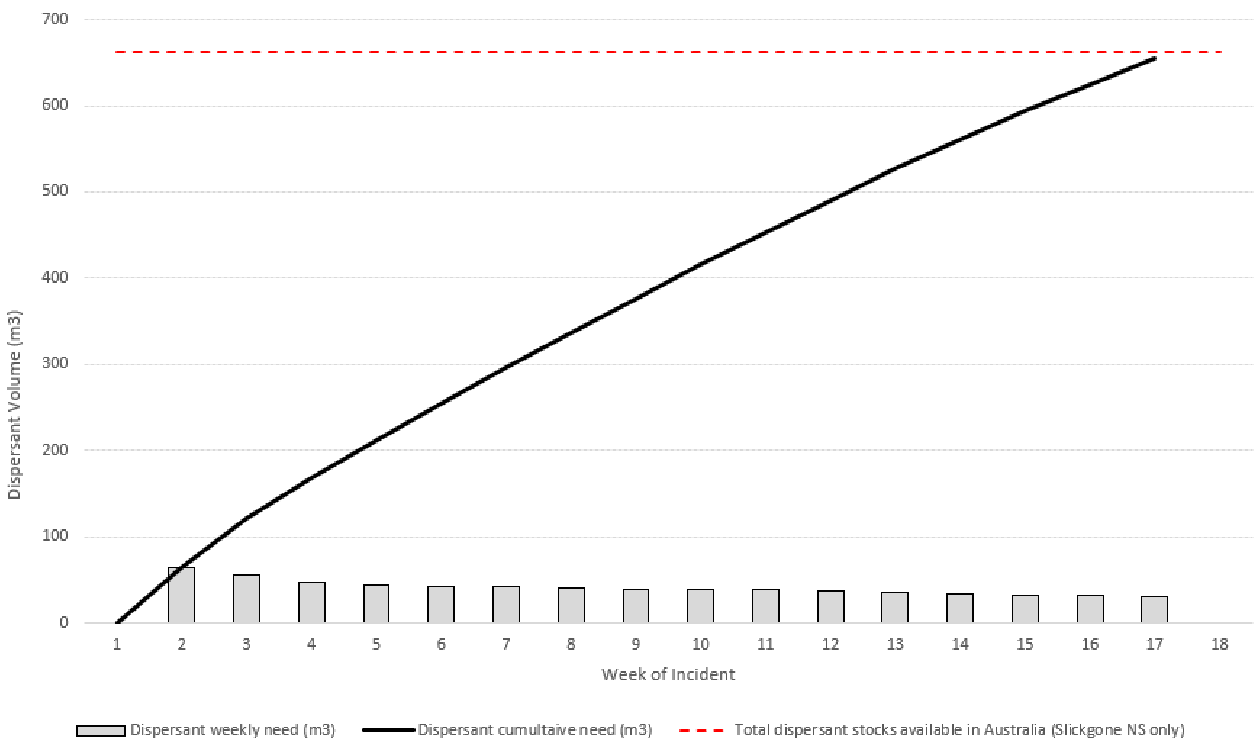
There are several dispersant products stockpiled within Australia, and which are available through AMSA and AMOSC; these are referred to as oil spill control agents (OSCA's). Those which may potentially be effective on light oils include Dasic Slickgone NS and Dasic Slickgone EW; Dasic Slickgone NS is also currently selected in Australia for subsea applications (AMSA, 2019). Given its availability, potential efficacy for a wide range of oils, including those with high wax content (Dasic, 2021), registration as an OSCA, Dasic Slickgone NS is a prime candidate for selection. This does not preclude the use of other OSCA's noting all are selected on the basis of their moderate (or lesser) toxicity (Irving and Lee 2015), noting any product would be assessed prior to use per the Cooper Energy Offshore Chemical Assessment Procedure.

For resource planning purposes it is recommended to use a 1:100 ratio as a starting point. IPECA 2015 recommends a 1:100 ratio (or lower) may be sufficient to cause substantial additional dispersion.

Work undertaken by RPS (2021) concurs that 1:100 is likely to be the optimal treatment rate for the BMG LOWC scenario, and therefore provides a basis for planning.

Based on a 1:100 treatment rate and the daily worst case discharge profile, weekly dispersant usage could range from a peak of 65 m^3/week from week 2, to 30 m^3/week at week 17 (Figure 7-2).

Figure 7-2: Dispersant Analysis: Need vs Availability



Cooper Energy proposes to use dispersants on the AMSA Register of oil spill control agents. Included on the register is Dasic Slickgone NS which is the industry dispersant of choice for SSD. AMOSC hold OSCA dispersant stocks including Dasic Slickgone NS in Geelong, Victoria. Other mutual aid dispersant stockpiles exist within Australia and may be accessed by member companies through AMOSC. Total available stocks of Dasic Slickgone NS within Australia are >660 m³ (at the time of writing), providing sufficient stock for BMG P&A LOWC response period.

During a response, initial quantities of subsea dispersant would likely be mobilised from within Victoria and additional stocks mobilised from elsewhere in Australia (e.g. Fremantle stockpile) via road haulage.

Table 7-14 indicates the SSD mobilisation timeframe. Current resource availability is described in the BMG Closure Project (P&A) OPEP.

Table 7-14 SSD Deployment Timeline

No.	Activity Description	Estimated Days
1	Campaign vessel available to support	7
2	Contract and Mobilise DSV from Singapore/NWS area to Melbourne / Gippsland* *Activity is concurrent with activities 3-6*	28
3	Contract and prepare SFRT (WA)	3-7
4	Mobilise initial stocks SSD to shorebase in SE Australia	2-7
5a	Mobilise SFRT to shorebase in SE Australia	5
5b	Contract and prepare WWC SSD package from Scotland to Melbourne (air transit), unload, mobilise to Shorebase in SE Australia *Alternate to SFRT*	9
6	Assemble and test system	1
7	*Load-out and sea fasten on vessel*	1

No.	Activity Description	Estimated Days
8	Sail to site and conduct trials / commence application	2
	Total	**12-31 days**

7.6.3 Dispersant Application ALARP Evaluation

Dispersant application ALARP considerations are included in Table 7-15.

Table 7-15: Dispersant Application ALARP Evaluation

Additional control measures	Benefit	Cost	Outcome
Maintain agreements with multiple SSD package providers	WWC SSD package can be air freighted to Australia (e.g. Melbourne); timeframes to mobilise to site when compared to road haulage of the Australian-based SSD package from Fremantle are likely to be similar. In addition, other resource requirements, such as suitable DSV / construction support vessels are currently the longer lead times, such that mobilising subsea dispersant equipment from Australia is unlikely to improve overall times to commence SSD application	Equipment and resources are available through current contracts; establishing contracts to access similar equipment in Australia is not expected to reduce overall timeframes to control the well.	Not selected Maintain agreement(s) to enable access to SSD resources.
Increase dispersant stockpile in Victoria	No clear benefit given large stocks of dispersant are available in the Melbourne Area which would be expected to support a response for at least the first few days during which time additional stocks could be mobilised via road haulage.	Cost associated with haulage, storage and upkeep upward of $100K.	Not selected
Purchase or rent Additional Gas Monitoring Equipment for the duration of the campaign	No clear benefit given gas monitoring is already available on the MODU and vessels. Gas monitoring equipment such as personal gas monitoring is also readily available either in Melbourne or through online vendors, and could be sourced in a matter of days (could be sourced in parallel with other equipment with longer lead times)	Upwards of $20K depending on the number of gas monitors purchased/rented, upkeep.	Not selected

7.6.4 Dispersant Application Impact and Risk Evaluation

7.6.4.1 Cause of the aspect

The following hazards associated with dispersant application have the potential to impact marine environment:

- Dispersant application within the marine environment (discharge to the water column)
- Vessel and ROV operations,
- Subsea dispersant package deployment to the seabed

7.6.4.2 Impact or Risk

The potential impacts and risks associated with vessel and ROV presence, and with the deployment of subsea dispersant package components to the seabed within the operational area are considered to be no different to the impacts and risks already provided for within the EP. These hazards are not therefore evaluated further within this section.

The potential impacts associated with dispersant application and discharge into the marine environment are:

- Potential chemical toxicity impacts to flora and fauna in the water column.

These impacts are evaluated further below.

7.6.4.3 Consequence Evaluation

7.6.4.3.1 Dispersant

The environmental receptors which may be impacted by elevated dispersant concentrations in the water column include pelagic fish and plankton. Demersal and benthic organisms are less likely to be exposed to high concentrations of dispersant given the buoyancy of dispersants and hydrocarbons from the flowing well relative to seawater; typically, relatively little oil reaches the seabed when compared to oil in the water column (Hook & Lee 2015, IPIECA 2015). Secondary effects such as oxygen depletion (associated with biodegradation of the product) have the potential to impact marine communities, however, are considered unlikely given the shallow water depths, dynamic nature of the environment resulting in continual mixing within the water column and replenishment of oxygen. Potential effects due to dispersant ecotoxicity are considered further below.

Table 7-16 provides representative ecotoxicity profiles for available OSCA's (dispersants) in Australia, using data from supplier safety data sheets for Dasic Slickgone NS and Dasic Slickgone EW (AMSA 2019; Dasic 2018, Dasic 2017). Neither product is expected to bioaccumulate or persist within environmental matrices; the evaluation below therefore focuses on impacts related to in-water concentrations which have the potential to manifest in direct toxic effect.

Table 7-16: Dispersant Ecotoxicity Profiles

Dispersant	Lowest EC50	Persistence	Bioaccumulation Potential
Dasic Slickgone NS	2.6ppm (96-hr EC50)	Expected to readily biodegrade	Not expected to be bioaccumulating
Dasic Slickgone EW	22.1 (48-hr EC50)	Expected to readily biodegrade	Not bioaccumulating

The Cooper Energy Offshore Chemical Assessment Procedure (CMS-EN-PCD-0004) requires that chemicals that will be or have the potential to be discharged to the environment are assessed and approved prior to use. This process is used to ensure the lowest toxicity, most biodegradable and least accumulative chemicals are selected which meet the technical requirements.

To help inform the evaluation of toxic effects related to the discharge of dispersants subsea during a response, A quantitative chemical discharge assessment has been undertaken using the Osbourne Adams method. This method is commonly applied in the UK offshore chemical regulatory regime. The method compares the time taken for in-water concentrations of a chemical (in this case dispersant) to exceed Predicted No Effect Concentrations (PNEC) with the time needed for the water column to completely refresh. Whilst this simple assessment does not replicate actual conditions, it provides an indication of in-water exposure to potentially toxic levels of dispersant. The assessment is based on the dispersant Dasic Slickgone NS, but for conservatism uses the lowest (most toxic) LC50 provided for the chemical (from the product SDS). The input values are outlined in Table 7-17 and are considered to provide for a conservative assessment relative to likely field conditions and marine organisms which may be within the area.

Table 7-17: Chemical Discharge Assessment Inputs

Parameter	Input	Notes
Dispersant product	Dasic Slickgone NS	Dispersant nominated in Australian waters for use with subsea dispersant equipment; the product is listed as an OSCA and is available in Melbourne, with further stocks around Australia.
Treatment rate (dispersant: condensate)	1:100 for resource	At a treatment rate of 1:100 the volume of dispersant applied according to the WCD rate at 8-days post spill, giving an application rate of 9.5m3 dasic

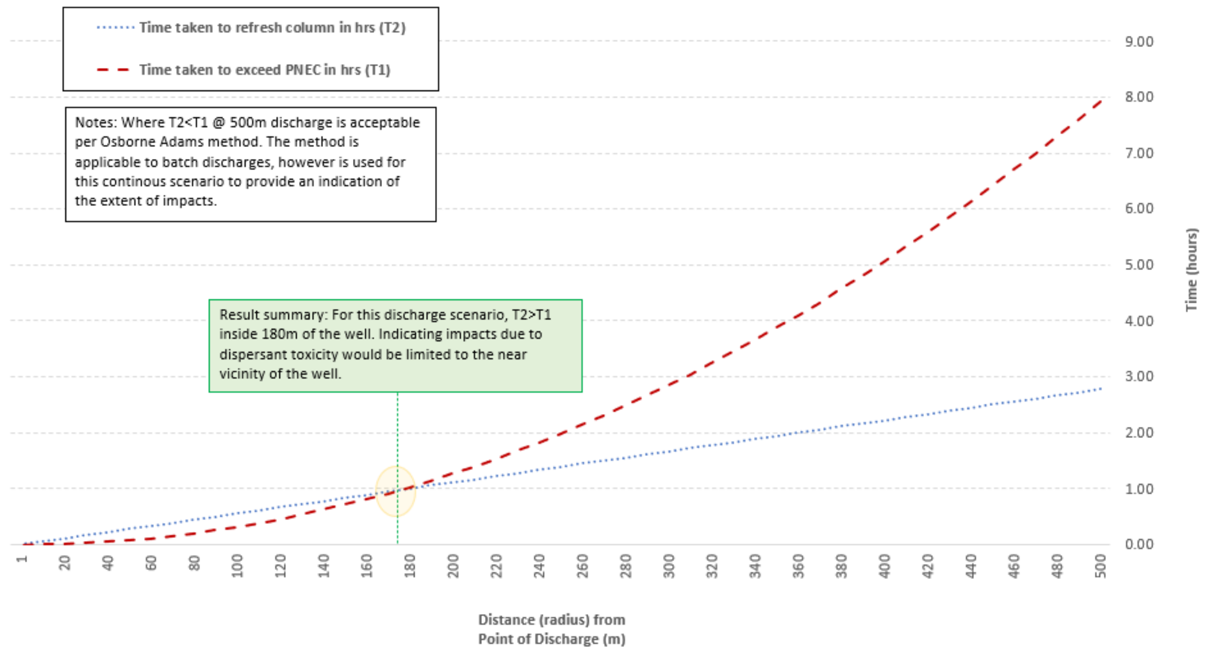
Parameter	Input	Notes
	planning purposes	slickgone/day. This is considered conservative given well flow rates may be lower at the time of first SSD application.
Dispersant LC50 (4 day)	2.6 ppm (96-hr EC50) for crustacean	The product SDS provides toxicity results for a range of Australian species representative of benthic (e.g. urchin, crustaceans, algae) and pelagic (e.g. kingfish) communities. The highest toxicity result (*Allorchestes compressa* (crustacean), 96-hr EC50, 2.6 ppm) was used for assessment purposes. The species is found in temperate waters from WA to Tasmania and NSW, and its sensitivity to Dasic slickgone is recorded as is higher than other tested species described within the SDS, and higher than toxicities described for other OSCA's (per the AMSA acceptance criteria (Irving & Lee 2015).
Water column radius	500m	Nominal / standard for Osborne Adams assessments. Additional Sensitivity analysis undertaken to identify a radius for PNEC threshold.
Discharge depth	155m	Water depth at Basker-2.
Residual current speed	0.1 m/s	Conservative, residual current speeds are likely to be greater than 0.1 m/s given the dynamic environment of the Gippsland Region; average subsea current speed range between 0.1 m/s and 0.65 m/s (see Addendum 1). Additional turbulence would also be generated by the flowing well – this is not factored into the assessment.
Notes The inputs and assessment are indicative; actual chemical selection and chemical discharge parameters would be assessed for the given situation, in accordance with the Cooper Energy Offshore Chemical Assessment Procedure (CMS-EN-PCD-0004).		

Table 7-17 indicates at a 1:100 treatment rate, the PNEC within the water column (500 m radius from the well) is not exceeded before the water column is refreshed. A sensitivity analysis indicates the time to exceed PNEC and time to refresh the water column intercept within 180 m of the well; this indicates that PNECs could be exceeded in the near vicinity of the well before the full refreshment of the water column.

The potential for toxic effect due to subsea dispersant application are considered to be limited to the near vicinity of the well location; this is given the effects of dilution upon entering the water column and currents which serve to further dilute and disperse the dispersant. Added to these factors are the dispersion action due to turbulence from the flowing well, and surface conditions including frequent moderate to high winds which serve to continually mix the water column. In addition, exposure to dispersant except in the short-term following the response operations would not be expected given the limited potential for the chemicals bioaccumulate or persist within environmental matrices (based on Dasic Slickgone NS/EW - available on the OSCA register).

Consequence evaluations for receptors that may be within the vicinity of operations (the operational area) are shown in Table 7-18.

Figure 7-3 Dispersant impact radius estimation



7.6.4.3.2 Dispersed Oil

Studies indicate modern dispersants, such as those on the AMSA OSCA register, are less toxic than oils. A literature review undertaken in 2014 by the CSRIO discusses several studies that investigate the possible synergistic effects of dispersant and oil. Whilst there are various results reported in the literature, recent studies on fish embryos indicate that the combination of oil and dispersant do not add appreciably to toxic response when compared to oil alone (Hook & Lee 2015). There are also benefits associated with dispersing oil such as accelerating the oil degradation process and thereby reducing potential exposure times.

The additional volumes of condensate which might become dispersed the water column may increase the potential for pelagic organisms to be exposed to toxic levels of dispersed hydrocarbons in the short-term. These are not expected to add significantly to the water column impacts when compared to those assessed for dispersed oil fractions for a LOWC scenario. This is given the limited geographical area over which dispersant would be used when compared to the effects of wave action and turbulence on dispersion in the open ocean (NRC 2005). Accordingly, the consequence associated with exposure to dispersed oil is not discussed further here.

Table 7-18 Consequence Evaluation for Potential Dispersant Exposure

Receptor Group	Receptors	Exposure Evaluation	Consequence Evaluation
Ecological Receptors			
Habitat	Coral	Soft corals may be present within reef and hard substrate areas in the operational area. Dispersant application is a Safety measure and only applied close to the well to lower VOCs around the response activities. Only organisms close to the dispersant application are expected to be exposed to concentrations which might have a toxic effect; these levels of dispersant would be expected to be short-lived with the water column being well mixed and relatively quick refreshment rates due to the dynamic nature of the ocean in the Gippsland Region.	Given the lack of hard coral reef formations, and the sporadic cover of soft corals in mixed reef communities, toxic impacts are considered to be limited to isolated corals. Consequently, the potential impacts to corals are considered to be **Level 2**, as they could be expected to result in localised short-term impacts to species/habitats of recognised conservation value, but not affecting local ecosystem functioning.
Marine Fauna	Plankton	Plankton are likely to be exposed to concentrations of dispersant with the potential for toxic effect in areas where dispersant is applied.	Planktonic organisms could be impacted by dispersant via a number of pathways; studies of impacts to diatoms showed that cell membranes can be damaged, impacting survivability (Hook & Osbourne 2012). Plankton are numerous and widespread; they contain a myriad of species at various life stages and is a key component of the marine food web. Plankton distribution and composition is not uniform and is in a constant state of flux – it is influenced by natural variations in the oceans such as salinity, temperature, nutrient availability and currents. Given the short-term nature of possible exposure to dispersant, and the natural variations to plankton assemblages, recovery of both biomass and diversity would be expected within the days and weeks following the response. Consequently, the potential impacts to plankton are considered to be **Level 2**, as they could be expected to cause short-term and localised impacts, but not affecting local ecosystem functioning.
	Invertebrates	Filter-feeding benthic invertebrates such as sponges, bryozoans, abalone and hydroids may be exposed dispersants, however, only within a very localised area and for a short time frame. In-water invertebrates of value have been identified to include squid, crustaceans (rock lobster, crabs) and molluscs (scallops, abalone); all may be present within the operational area.	Acute or chronic exposure through contact and/or ingestion can result in toxic impact, effecting survivability. However, given the limited extent of dispersant application, and short-term nature of response activities (which might require dispersant application), impacts would be limited to low numbers, and are unlikely to appreciably affect overall recruitment rates across the region Consequently, the potential impacts to plankton are considered to be **Level 2**, as they could be expected to cause short-term and localised impacts, but not affecting local ecosystem functioning.

Receptor Group	Receptors	Exposure Evaluation	Consequence Evaluation
		Several commercial fisheries for marine invertebrates are within the area predicted to be exposed above the impact threshold (see commercial fisheries and recreational fisheries).	
	Fish, sharks and syngnathids	Many species of fish, shark and syngnathids occur in the region and may occur within operational area; the species which may be present occupy pelagic and demersal environments. There is a known distribution and foraging BIA for the great white shark in the area predicted to be over the impact threshold. Fish, sharks and syngnathids therefore have the potential to be exposed to elevated concentrations of dispersant during response operations	Pelagic free-swimming fish, sharks are unlikely to suffer long-term damage from dispersant exposure given dispersant use would be targeted and limited to response operations around the well. Syngnathids are less likely to be exposed to toxic levels of dispersant given they occupy demersal habitats, where elevated levels of dispersant are more likely in the upper water column. Elevated concentrations of dispersant in the near vicinity of the discharge could result in acute toxicity to marine biota such as juvenile fish, larvae, and planktonic organisms, although impacts are not expected cause population-level impacts. There is the potential for localised and short-term impacts to fish communities; the consequences are ranked as **Level 2**. Impacts on eggs and larvae are not expected to be significant given the temporary period of water quality impairment, and the limited areal extent of dispersant application relative to the abundance and natural variability recruitment within a given region. Impact is assessed as temporary and localised and are considered **Level 2**.
	Marine mammals and marine turtles	Several threatened, migratory and/or listed cetacean species have the potential to occur in the operational area. Known BIAs are present for foraging for the pygmy blue whale; distribution for the southern right whale and migration for the humpback whale. The response area is located in foraging range for New Zealand fur-seals and Australian fur-seals. Marine turtle may occur within the operational area, however, there are no BIAs or habitat critical to the survival of the species within this area. Any exposure to dispersants would be temporary.	Impacts to marine mammals and turtles are not expected in relation to exposure to dispersant; the transient nature of marine mammals in the region limits their potential to be exposed to dispersant; dispersants such as Dasic Slickgone are also not expected to persist, or accumulate up the food chain (Irving & Lee, 2015) Dasic, 2017, Dasic 2018); in their review of dispersant impacts, Hook & Lee (2015) noted they did not review of the effects on marine mammals given dispersant use is accepted as providing a net benefit by reducing the probability of their exposure to surface oil slicks. Any consequences (e.g. behavioural change) would be temporary and localised, which are ranked as **Level 1.**

Receptor Group	Receptors	Exposure Evaluation	Consequence Evaluation
Social Receptors			
Human System	Commercial Fisheries and Recreational Fishing	Commercial fisheries with management areas overlapping this area of predicted exposure includes: • Cth Southern Squid Jig Fishery • Cth Southern and Eastern Scalefish and Shark Fishery; • The Victorian fisheries that have jurisdiction into Commonwealth waters are either currently not active in the area (e.g. no current licences for Giant Crab in the eastern zone), or the exposed area is beyond the typical water depths of the target species (e.g. Rock Lobster).	Any acute impacts are expected to be limited to small numbers of juvenile fish, larvae, and planktonic organisms, which are not expected to affect population viability or recruitment. Impacts from entrained exposure are unlikely to manifest at a fish population viability level. The consequence to commercial and recreational fisheries is assessed as temporary and localised, and ranked as **Level 1**. Refer also to: Fish and Sharks, and Invertebrates.
	Recreation and Tourism	Tourism and recreation is also linked to the presence of marine fauna (e.g. whales), particular habitats and locations for recreational fishing.	Any impact to receptors that provide nature-based tourism features (e.g. whales) may cause a subsequent negative impact to recreation and tourism activities. However, the relatively short duration, and distance from shore means there may be temporary and localised consequences, which are ranked as **Level 1**. Refer also to: Fish and Sharks, Cetaceans, Invertebrates and Recreational Fishing.

7.6.4.4 Environmental Impact and Risk Assessment

Table 7-19 provides a summary of the EIA / ERA for Dispersant Application activities.

Table 7-19: Dispersant Application EIA / ERA

ALARP Decision Context and Justification	**ALARP Decision Context: A** Chemical use and discharge within offshore areas is however well established, and the potential impacts and risks from these activities well understood. Whilst the use and discharge of dispersant chemicals for the purposes of emergency response is not a so common an occurrence, it is an accepted response measure and has occurred within the oil and gas industry, and other maritime sectors multiple times. There is a good understanding of control measures used to manage these risks. There is little uncertainty associated with the potential environmental impacts and risks, which have been evaluated as **Level 2**. No objections or concerns were raised during stakeholder consultation regarding this activity or its potential impacts and risks. As such, Cooper Energy believes **ALARP Decision Context A** should apply.
Control Measure	**Source of good practice control measures**
Consultation	Consultation in the event of a spill will ensure that relevant government agencies support the monitor and evaluate strategy thus minimising potential impacts and risks to sensitivities.
Maintain dispersant capability as described in BMG Closure Project (Phase 1) OPEP (BMG-ER-EMP-0004)	Maintaining the capability described in BMG Closure Project (Phase 1) OPEP (BMG-ER-EMP-0004 is key for ensuring that the any response is implemented effectively and quickly.
Cooper Energy Operational and Scientific Monitoring Plan (the OSMP)	Cooper Energy's OSMP details the arrangements and capability in place for: • operational monitoring of a hydrocarbon spill to inform response activities • scientific monitoring of environmental impacts of the spill and response activities. Operational monitoring will allow adequate information to be provided to aid decision making to ensure response activities are timely, safe, and appropriate. Scientific monitoring will identify if potential longer-term remediation activities may be required.
Likelihood	The likelihood of LOWC event requiring source control response such as dispersant application is determined to be Unlikely (D) (Section 6.18). As such, the likelihood of impacts from dispersant use during response activities have been determined to be **Unlikely (D)**.
Residual Risk	**Low**
Demonstration of Acceptability	
Cooper Energy Risk Process	The level of risk is Low (therefore is considered acceptable)
Principles of ESD	The potential impact associated with this aspect is limited to a localised short-term impact, which is not considered as having the potential to affect biological diversity and ecological integrity. The activities were evaluated as having the potential to result in a **Level 2** consequence thus is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Legislative and other requirements	Legislation and other requirements considered as relevant control measures include:

	• NOPSEMA/AMSA Australian Dispersant Acceptance Process Explanatory Note. If required for response activities - Cooper Energy anticipates using dispersants listed on the National Plan OSCA register.
	• NOPSEMA Oil Pollution Risk Management Paper, including the following guidance:
	  ○ During the planning phase consider characterisation of hydrocarbons and dispersant efficacy testing. For this campaign hydrocarbons properties are known but cannot be tested given production cessation over 10 years ago. Flounder crude provides a reasonable analogue in terms of similar wax content and pour point, and therefore potential dispersant efficacy (Leeder pers comms 2021). Esso have published data indicating dispersant is effective on flounder crude.
	  ○ Demonstration of ALARP response planning, to include controls such as dispersant selection process, application zones and monitoring. For the current campaign - each of these controls are provided for within the performance standards outlined in the OPEP
	  ○ An evaluation of the impacts and risks should be provided and demonstrate that they will be reduced to ALARP, and be of an acceptable level.
	• OPGGS(E)R 2009 – Cooper Energy Offshore Vic OPEP, OSMP.

Internal context	The environmental controls proposed reflects the Cooper Energy HSEC Policy goals of utilising best practice and standards to eliminate or minimise impacts and risks to the environment and community to a level which is ALARP. Relevant management system processes adopted to implement and manage hazards to ALARP include: • Risk Management (MS03) • Technical Management (MS08) • Health Safety and Environment Management (MS09) • Incident and Crisis Management (MS10) • Supply Chain and Procurement Management (MS11) • External Affairs & Stakeholder Management (MS05)
External context	No stakeholder concerns have been raised to date regarding impacts and risks from either chemical discharges during planned activities or raised any questions or concerns in relation to the use of dispersants for operational purposes during spill response. As such, Cooper Energy considers that there is broad acceptance of the impacts associated with the activity.
Environmental Performance	
The environmental performance outcomes, standards and measurement criteria for response preparedness and implementation of dispersant application activities are shown in Table 6-3 of the OPEP.	

7.7 Spill Response: Contain and Recover

7.7.1 Overview

Containment and recovery includes use of offshore vessels to deploy boom and skimmers to collect surface hydrocarbons. In accordance with Table 7-2, it is anticipated that this response technique may be possible and effective for LOWC events, depending upon the trajectory of the spill.

7.7.2 Resources Required and Availability

Response resources would be activated via AMOSC in the first instance, with equipment and resources selected on the basis of the TRP activation and subsequent IAPs. AMOSC has undertaken an assessment of response resource needs for this strategy (BMG-EN-REP-0023), and have determined how these needs will be met. A summary of the process undertaken is provided in Appendix 4 of the OPEP.

The feasibility/effectiveness of a contain and recover response is provided in Table 7-20.

Table 7-20 Feasibility / Effectiveness of Contain and Recover Response

Parameter	Contain and Recover
Suitability/Functionality *How does the response strategy perform to achieve its required risk reduction?*	Containment is not feasible using alternative boom types (for example fence, zoom and shoreline sealing boom are not suitable for offshore). Deployment of offshore boom is the most suitable and feasible containment strategy. The most suitable recovery method of the collected oil is via a weir due to the predicted behaviour of the oil type. The implementation of this response strategy has the potential to reduce the magnitude, probability of and extent of contact and accumulation on shorelines. This will provide an overall environmental benefit in the reduction and removal of oil from the marine environment.
Dependencies *Does the response strategy rely on other systems to perform its intended function?*	The successful execution and operational effectiveness of containment and recovery relies on the availability of monitoring data, including visual surveillance from aircraft, to inform the locations at which the deployment of the response strategy will be most effective.
Availability and limitations *Time the response strategy is available to perform its function?*	Time to be operational. Based on the availability of personnel, equipment and vessels the deployment of the response strategy will take place within 48 hours of response activation. The strategy can be undertaken in daylight hours only and maximum sea state Beaufort 4 (wave height 1.5m, winds 8m/s). Personnel downtime will be planned and managed to ensure appropriate levels of response personnel are maintained and rotated as required or until the response is terminated.

7.7.3 Containment and Recovery ALARP Evaluation

Containment and recovery ALARP considerations are included in Table 7-21.

Table 7-21 Containment and Recovery ALARP Evaluation

Additional control measures	Benefit	Cost	Outcome
Implement optimum containment and recovery sooner by storing equipment at strategic locations	The environmental benefits associated with this option are negligible; given the location of contain and recovery response equipment, and existing logistics pathways, this equipment can be mobilised to potentially impacted shorelines before shoreline contact occurs.	Any equipment mobilised to site would need to be purchased by Cooper. Most equipment proposed to be used (available via the various agreements) can only be mobilised in an emergency as it needs to be stored and available in strategic locations nationwide for the whole industry. Purchasing such equipment would result in significant costs that are considered grossly disproportionate to the level of risk reduction achieved.	Not Selected
Contract additional vessels on standby (or additional vessels to supply the MODU) to implement optimum response sooner	The current time frame for mobilising the required number of vessels to site is estimated to be in the order of 14 days. For each day a vessel is available sooner, there is the potential to recover in the order of 42 m^3. If a single additional vessel was available to implement contain and recover response from Day 1, there is a potential to recover an additional 588 m^3 of oil. Although the recovery of 364 m^3 is large, in comparison to the overall volume lost,	Estimated costs of contracting an additional vessel for the 100 day program (based upon an anchor handling support vessel) is $5 000 000, assuming a 100-day program and a day rate of $50 000. This control measure poses significant additional cost for this program, and given the small benefit that contracting a single vessel poses the cost is considered grossly disproportionate to the level of environmental benefit achieved.	Not Selected

Additional control measures	Benefit	Cost	Outcome
	this savings represents only 0.7% of the hydrocarbon lost to the environment and thus is only considered to provide a small environmental benefit.		

7.7.4 Containment and Recovery Impact and Risk Evaluation:

7.7.4.1 Cause of Aspect

The following hazards are associated with containment and recovery deflection activities:

- Additional vessel activity (over a greater area)

7.7.4.2 Impact or Risk

The potential impacts of underwater sound emissions in the marine environment are:

- Localised and temporary fauna behavioural disturbance that significantly affects migration or social behaviours; and
- Auditory impairment, Permanent Threshold Shift (PTS).

7.7.4.3 Consequence Evaluation

The potential impacts associated with vessel activities have been evaluated in Section 6.0 of this EP. Based upon the nature and scale of the activities, the evaluation is considered appropriate for any aerial or marine surveillance undertaken and thus has not been considered further.

7.7.4.4 Environmental Impact and Risk Assessment

Table 7-22 presents the EIA / ERA for containment and recovery activities.

Table 7-22 Containment and Recovery EIA / ERA

ALARP Decision Context and Justification	**ALARP Decision Context A** The use of vessels in this area is well practiced with the potential impacts and risks from these activities well understood. There is little uncertainty associated with the potential environmental impacts and risks, which have been evaluated as **Level 1**. No objections or concerns were raised during stakeholder consultation regarding this activity or its potential impacts and risks. As such, Cooper Energy believes ALARP Decision Context A should apply.
Control Measure	**Source of good practice control measures**
Maintain containment and recovery capability	Maintaining the capability described is key for ensuring that the any response is implemented effectively and quickly.
Consultation	Consultation In the event of a spill will ensure that relevant government agencies support the containment and recovery strategy thus minimising potential impacts and risks to sensitivities.
Monitor response effectiveness	Monitoring the response effectiveness will ensure response is terminated where the response is no longer effective / where a net environmental benefit is no longer present.
For risk controls see section 6 of this EP	
Likelihood	The likelihood of a LOWC event was determined to be Unlikely (D) (Section 6.15.6). As such, the likelihood of impacts from vessel response activities in the event of a LOWC have been determined to be **Remote (E)**.

Residual Risk Severity	**Low**
Demonstration of Acceptability	
Principles of ESD	• The potential impact associated with this aspect is limited to a localised short-term impact, which is not considered as having the potential to affect biological diversity and ecological integrity. • The activities were evaluated as having the potential to result in a **Level 1** consequence thus is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Legislative and other requirements	Legislation and other requirements considered as relevant control measures include: • OPGGS Act 2006 (Cth); and • OPGGS Act 2010 (Vic). • EPBC Regulations 2000 (Part 8 – Interacting with cetaceans and whale watching). • Wildlife (Marine Mammals) Regulations 2009 (Vic) (R12 – Noise in vicinity of marine mammals) • Conservation Management Plan for the Blue Whale 2015–2025 (Department of Environment, 2015) • Listing Advice for the humpback whale 26 February 2022 (Threatened Species Scientific Committee, 2022) • Conservation Advice for *Balaenoptera borealis* (sei whale) (Threatened Species Scientific Committee, 2015b) • Conservation Advice for *Balaenoptera physalus* (fin whale) (Threatened Species Scientific Committee, 2015c) • Recovery Plan for marine turtles in Australia (DEE, 2017) • Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013)
Internal context	The environmental controls proposed reflects the Cooper Energy HSEC Policy goals of utilising best practice and standards to eliminate or minimise impacts and risks to the environment and community to a level which is ALARP. Relevant management system processes adopted to implement and manage hazards to ALARP include: • Risk Management (MS03) • Technical Management (MS08) • Health Safety and Environment Management (MS09) • Incident and Crisis Management (MS10) • Supply Chain and Procurement Management (MS11) • External Affairs & Stakeholder Management (MS05)
External context	No stakeholder concerns have been raised to date regarding impacts and risks from containment and recovery strategies. As such, Cooper Energy considers that there is broad acceptance of the impacts associated with the activity.

7.8 Spill Response: Protect and Deflect

7.8.1 Overview

Booms and skimmers can be deployed to protect or deflect oil from environmental sensitivities. Noting that the effectiveness of boom operation is dependent on current, wave and wind conditions.

7.8.2 Resources Required and Availability

Response resources would be activated via AMOSC in the first instance, with equipment and resources selected on the basis of the TRP activation and subsequent IAPs. AMOSC has undertaken an assessment of response resource needs for this strategy (BMG-EN-REP-0023), and have determined how these needs will be met. A summary of the process undertaken is provided in the BMG Closure Project (Phase 1) OPEP (BMG-ER-EMP-0004).

The feasibility/effectiveness of a protect and deflect response is provided in Table 7-23.

Table 7-23 Feasibility / Effectiveness of Protect and Deflect Response

Parameter	Protect and Deflect
Suitability/Functionality *How does the response strategy perform to achieve its required risk reduction?*	Successful implementation the protection and deflection response strategy will reduce the oil reaching the shoreline. Protection strategies can be used for targeted protection of sensitive receptors. The use of zoom and beach guardian boom is the most technically suitable and feasible application of the response strategy. Alternative offshore boom types cannot be deployed successfully in shallow water due to depth of draft. Chevron, cascade and exclusion booming formations will be deployed based on the location.
Dependencies *Does the response strategy rely on other systems to perform its intended function?*	Operational effectiveness of this response is dependent on monitoring and surveillance (including deterministic modelling predictions and visual surveillance) of the floating oil before stranding which enables the prioritization and targeted protection of environmental sensitivities. This will ensure boom is deployed at the sensitivities reducing the oil reaching the shorelines.
Availability and limitations *Time the response strategy is available to perform its function?*	Time to be operational - Based on the availability of personnel, equipment and vessels the deployment of the response strategy will take place within 48 hours of response activation Protection and deflection operations will take place during daylight hours only and in appropriate weather and tide conditions. Deployed boom formations will require regular monitoring to ensure continued effectiveness. Personnel downtime will be planned and managed to ensure appropriate levels of response personnel are maintained and rotated as required or until the response is terminated.

7.8.3 Protect and Deflect ALARP Evaluation

Protect and deflect ALARP considerations are included in Table 7-24.

Table 7-24 Protect and Deflect ALARP Evaluation

Additional control measures	Benefit	Cost	Outcome
Implement optimum protect and deflect sooner by storing equipment at strategic locations	The environmental benefits associated with this option are negligible; existing logistics pathways have demonstrated that this equipment can be mobilised to potentially impacted shorelines before shoreline contact occurs.	Any equipment mobilised to site would need to be purchased by Cooper. Most equipment proposed to be used (available via the various agreements) can only be mobilised in an emergency as it needs to be stored and available in strategic locations nationwide for the whole industry. Purchasing such equipment would result in significant costs that are considered grossly disproportionate to the level of risk reduction achieved.	Not Selected

7.8.4 Protect and Deflect Impact and Risk Evaluation:

7.8.4.1 Cause of Aspect

The following hazards are associated with protection and deflection activities:

- Boom deployment and management (especially anchored boom); and
- Waste collection.

7.8.4.2 Impact or Risk

The known and potential impacts of booming activities are:

- Loss of seabed vegetation and impacts to associated fauna habitats while deploying boom;
- Disturbance to estuarine habitats from boom anchors;
- Restricting access to the area for recreational activities;

7.8.4.3 Consequence Evaluation

Potential impacts of protect and deflect vary, depending on the method used and the nearshore / shoreline habitat. Particular values and sensitivities in the area that may be affected by the spill include nearshore habitats (such as seagrass) and shoreline habitats (sandy beach habitats).

The consequence of these shoreline activities may potentially result in short-term and localised incidental damage to or alteration of habitats and ecological communities, and are ranked as **Level 2**

7.8.4.4 Environmental Impact and Risk Assessment

Table 7-25 presents the EIA / ERA for protect and deflect activities.

Table 7-25 Protect and Deflect EIA / ERA

ALARP Decision Context and Justification	**ALARP Decision Context A** The implementation of protect and deflect response techniques is standard practice for marine oil spills. There is a good understanding of potential impacts and risks from these techniques, and the control measures required to manage these. There is little uncertainty associated with the potential environmental impacts and risks, which have been evaluated as **Level 2** due to the small disturbance footprint expected with these techniques. No objections or concerns were raised during stakeholder consultation regarding this activity or its potential impacts and risks. As such, Cooper Energy believes **ALARP Decision Context A** should apply.
Control Measure	**Source of good practice control measures**
Maintain protect and deflect capability as described in BMG Closure Project (Phase 1) OPEP (BMG-ER-EMP-0004)	Maintaining the capability described in BMG Closure Project (Phase 1) OPEP (BMG-ER-EMP-0004 is key for ensuring that the any response is implemented effectively and quickly.
Consultation	Consultation in the event of a spill will ensure that relevant government agencies support the protect and deflect strategy thus minimising potential impacts and risks to sensitivities.
Monitor response effectiveness	Monitoring the response effectiveness will ensure response is terminated where the response is no longer effective / where a net environmental benefit is no longer present.
Use of Existing Tracks and Pathways	Utilising existing tracks and paths where possible will ensure the disturbance footprint associated with the implementation of this response technique is reduced to ALARP.
Likelihood	The likelihood of a LOWC event was determined to be Unlikely (D) (Section 6.15.6). As such, the likelihood of impacts from protection and deflection response activities in the event of a LOWC have been determined to be **Remote (E)**.
Residual Risk Severity	**Low**
Demonstration of Acceptability	
Principles of ESD	The potential impact associated with this aspect is limited to a localised short-term impact, which is not considered as having the potential to affect biological diversity and ecological integrity.

	The activities were evaluated as having the potential to result in a **Level 2** consequence thus is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Legislative and other requirements	Legislation and other requirements considered as relevant control measures include: • OPGGS Act 2006 (Cth); and • OPGGS Act 2010 (Vic)
Internal context	Relevant management system processes adopted to implement and manage hazards to ALARP include: • Risk Management (MS03) • Technical Management (MS08) • Health Safety and Environment Management (MS09) • Incident and Crisis Management (MS10) • Supply Chain and Procurement Management (MS11) • External Affairs & Stakeholder Management (MS05)
External context	No stakeholder concerns have been raised to date regarding impacts and risks from protect and deflect strategies. As such, Cooper Energy considers that there is broad acceptance of the impacts associated with the activity.

7.9 Spill Response: Shoreline Assessment and Clean-up

7.9.1 Overview

Any shoreline operations will be undertaken in consultation with, and under the control of the State Control Agency, and the appropriate land managers of the shoreline affected.

Shoreline clean-up consists of different manual and mechanical recovery techniques to remove oil and contaminated debris from the shoreline to reduce ongoing environmental contamination and impact. It may include the following techniques:

- Natural recovery – allowing the shoreline to self-clean (no intervention undertaken);
- Manual collection of oil and debris – the use of people power to collect oil from the shoreline;
- Mechanical collection – use of machinery to collect and remove stranded oil and contaminated material;
- Mechanical alterations to shoreline – use of machinery to temporarily move sand to close estuaries/waterways;
- Sorbents – use of sorbent padding to absorb oil;
- Vacuum recovery, flushing, washing – the use of high volumes of low-pressure water, pumping and/or vacuuming to remove floating oil accumulated at the shoreline;
- Sediment reworking – move sediment to the surf to allow oil to be removed from the sediment and move sand by heavy machinery;
- Vegetation cutting – removing oiled vegetation; and
- Cleaning agents – application of chemicals such as dispersants to remove oil.

Shorelines within the EMBA are predominantly sandy beaches with numerous estuaries present along the Victorian Coastline.

The shoreline behaviour of BMG Crude is expected to be similar to a heavy crude, where solidified hydrocarbons / tar balls wash up along the shore and persist until physically removed, (unless they melt on the shoreline) in which case they may need to be dug up and removed. Based upon this behaviour, the following clean-up methods may have environmental benefit:

- Manual clean-up; and
- Mechanical collection – use of machinery to collect and remove stranded oil and contaminated material;

7.9.2 Resources Required and Availability

The number and tasks of personnel will vary according to the quantity of spill debris, its rate of delivery to the site and the disposal method chosen.

Response resources would be activated via AMOSC in the first instance, with equipment and resources selected based on the TRP activation and subsequent IAPs. AMOSC has undertaken an assessment of response resource needs for this strategy (BMG-EN-REP-0023) and have determined how these needs will be met. A summary of the process undertaken is provided in the BMG Closure Project (Phase 1) OPEP (BMG-ER-EMP-0004).

The feasibility/effectiveness of a shoreline assessment and clean-up response is provided in Table 7-26.

Table 7-26 Feasibility / Effectiveness of Shoreline Assessment and Clean-up Response

Parameter	Shoreline Assessment and Clean-up
Suitability/Functionality *How does the response strategy perform to achieve its required risk reduction?*	Successful implementation of the shoreline assessment and clean up response strategy will result in a reduction of oil on the shoreline, assist in preventing the remobilization of oil and act to reduce the lasting impact of the oil spill on shoreline receptors. The method of clean up chosen will be selected based on shoreline type, local knowledge of the conditions and the availability of equipment and personnel. Oil clean up quantities are estimated to recover 1m3 per person/per day (manual recovery) and 24 m3 per team/per day (mechanical collection)
Dependencies *Does the response strategy rely on other systems to perform its intended function?*	Operational effectiveness of this response is dependent on the continuous use of monitoring and surveillance to help direct clean-up efforts towards the areas most affected by stranded oil which enables the prioritization and targeted clean-up of environmental sensitivities.
Availability and limitations *Time the response strategy is available to perform its function?*	Time to be operational - SCAT personnel will be available on site within 12 hours to commence terrestrial assessment. Based on the availability of personnel and equipment the clean-up activities will commence within 12 hours of response activation Personnel downtime will be planned and managed to ensure appropriate levels of response personnel are maintained and rotated as required or until the response is terminated.

7.9.3 Shoreline Assessment and Clean-up ALARP Evaluation

Shoreline Assessment and Clean-up ALARP considerations are included in Table 7-27.

Table 7-27 Shoreline Assessment and Clean-up ALARP Evaluation

Additional control measures	Benefit	Cost	Outcome
Implement shoreline assessment and clean-up sooner	Modelling indicates that shortest time to shore at levels where a shoreline response can be implemented (>100 g/m^2) is within 2 days for MDO and 3.4 days for Basker crude. Existing pathways allow for mobilising relevant shoreline assessment and clean-up resources within minimum shoreline contact times; therefore, implementing clean-up operations earlier is not expected to result in any additional environmental benefit.	Cooper Energy has demonstrated that optimum shoreline response can be implemented before shoreline contact, and there is no environmental benefit with implementing this control measure; therefore, this control measure is not considered further.	Not Selected

Additional control measures	Benefit	Cost	Outcome
Implement larger initial shoreline assessment and clean-up response	Modelling indicates that shortest time to shore at levels where a shoreline response can be implemented (>100 g/m^2) is within 2 days for MDO and 3.4 days for Basker crude. Cooper Energy has demonstrated capability to rapidly implement the planned shoreline assessment and clean-up response within the required timeframes. Deploying more resources than are required to clean-up a shoreline can incur additional risks and reduced environmental benefits; therefore, an optimum level of response has been identified, based on modelling outcomes. If shorelines are cleaned-up too soon and hydrocarbons continue to wash ashore, there is the potential that continued cleaning will sensitise habitats. Therefore, in accordance with International Petroleum Industry Environmental Conservation Association guidance, it is recommended that shoreline clean-up activities are slowly increased to ensure that techniques are effective, and impacts are minimised. Consequently, there is no environmental benefit associated with implementing this control measure.	As Cooper Energy has access to the required resources, the cost of implementing a larger response will not result in a significant cost. However, because there is no environmental benefit identified with this control measure, it is not considered further.	Not Selected

7.9.4 Shoreline Assessment and Clean-up Impact Evaluation

7.9.4.1 Cause of Aspect

The following hazards are associated with shoreline clean-up activities and may interfere with environmental sensitivities:

- Personnel and equipment access to beaches;
- Shoreline clean-up; and
- Waste collection and disposal.

7.9.4.2 Impact or Risk

The known and potential impacts of these activities are:

- Damage to or loss of vegetation;
- Disturbance to fauna habitat and fauna from noise, air and light emissions from response activities;
- Temporary exclusion of the public from amenity beaches;

Sandy beaches have been used for the consequence evaluation as they are considered to provide a comprehensive indication of possible worst-case consequences as a result of implementing shoreline response activities (due to presence of potential sensitivities and the invasive nature of techniques such as mechanical collection). This is not to say that sandy beaches themselves are considered more sensitive than other habitats.

7.9.4.3 Consequence Evaluation

The noise and general disturbance created by shoreline clean-up activities could potentially disturb the feeding, breeding, nesting or resting activities of resident and migratory fauna species that may be present (such as seabirds, penguins and fur-seals). Any erosion caused by responder access to sandy beaches, or the removal of sand, may also bury nests. In isolated instances, this is unlikely to have impacts at the population level.

Based upon the persistence and behaviour of the BMG Crude (i.e. that it solidifies and would be expected to wash up on shore in its solid form) significant vertical infiltration of oil into shoreline sediments is not expected to occur. However, over the course of the entire spill response effort there is a possibility that temperatures would increase to a point where the solid residue on the shoreline melts.

If this was to occur, then vertical migration through shoreline sediments could occur, with clean-up efforts expected to result in more of a disturbance to the coastline as mechanical recovery would then be required (resulting in excavation of shorelines). If not done correctly, any excavation of hydrocarbon contaminated materials along the coast could exacerbate beach erosion to a point where its recovery longer term recovery. The very presence of stranded oil and clean-up operations will necessitate temporary beach closures (likely to be weeks but depends on the degree of oiling and nature of the shoreline). This means recreational activities (such as swimming, walking, fishing, boating) in affected areas will be excluded until access is again granted by local authorities. Given the prevalence of rocky shorelines in the EMBA, this is unlikely to represent a significant social or tourism drawback.

Consequently, the potential impacts and risks from these activities are considered to be **Level 3**.

7.9.4.4 Environmental Impact and Risk Assessment

Table 7-28 provides the EIA / ERA for shoreline assessment and clean-up.

Table 7-28 Shoreline assessment and clean-up EIA / ERA

ALARP Decision Context and Justification	**ALARP Decision Context A** The implementation of shoreline assessment and clean-up response techniques are standard practice for marine oil spills where there is the potential for shoreline exposures. There is a good understanding of potential impacts and risks from these techniques, and the control measures required to manage these. There is little uncertainty associated with the potential environmental impacts and risks, which have been evaluated as **Level 3** due to the localised area of disturbance and (conservatively assessed) medium-term impacts associated with these response techniques. No objections or concerns were raised during stakeholder consultation regarding this activity or its potential impacts and risks. As such, Cooper Energy believes **ALARP Decision Context A** should apply.
Control Measure	**Source of good practice control measures**
Maintain shoreline assessment and clean-up capability as described in Table 7-26	Maintaining the capability described in Table 7-26 is key for ensuring that the any response is implemented effectively and quickly.
Consultation	Consultation in the event of a spill will ensure that relevant government agencies support the shoreline assessment and clean up strategy thus minimising potential impacts and risks to sensitivities.
Use of Existing Tracks and Pathways	Utilising existing tracks and paths where possible will ensure the disturbance footprint associated with the implementation of this response technique is reduced to ALARP.
Likelihood	The small volumes hydrocarbons ashore, and associated limited residual fractions indicate implementing this type of technique is low. Thus, the likelihood associated with causing a Minor Impact from this technique is considered to be **Remote (E)**.

Residual Risk Severity	**Low**
Demonstration of Acceptability	
Principles of ESD	The potential impact associated with this aspect is limited to a localised short-term impact, which is not considered as having the potential to affect biological diversity and ecological integrity. The activities were evaluated as having the potential to result in a **Level 3** consequence thus is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Legislative and other requirements	Legislation and other requirements considered as relevant control measures include: • OPGGS Act 2006 (Cth); and • OPGGS Act 2010 (Vic)
Internal context	Relevant management system processes adopted to implement and manage hazards to ALARP include: • Risk Management (MS03) • Technical Management (MS08) • Health Safety and Environment Management (MS09) • Incident and Crisis Management (MS10) • Supply Chain and Procurement Management (MS11) • External Affairs & Stakeholder Management (MS05)
External context	No stakeholder concerns have been raised to date regarding impacts and risks from shoreline assessment strategies. As such, Cooper Energy considers that there is broad acceptance of the impacts associated with the activity.

7.10 Spill Response: Oiled Wildlife Response

7.10.1 Overview

In the event of a Level 2 or 3 hydrocarbon spill, the impacts on wildlife are determined by the types of fauna present, the type of oil spilled and the extent of exposure. A review of the species likely to be present within the EMBA identifies marine birds, shorebirds and fur-seals could be affected.

Oiled wildlife response consists of a three-tiered approach involving:

- Primary: Situational understanding of the species/populations potentially affected (ground-truth species presence and distribution by foot, boat or aerial observations);
- Secondary: Deterrence or displacement strategies (e.g., hazing by auditory bird scarers, visual flags or balloons, barricade fences; or pre-emptive capture); and
- Tertiary: Recovery, field stabilisation, transport, veterinary examination, triage, stabilisation, cleaning, rehabilitation, release.

7.10.2 Resources Required and Availability

Response resources would be activated via AMOSC in the first instance, with equipment and resources selected on the basis of the TRP activation and subsequent IAPs. AMOSC has undertaken an assessment of response resource needs for this strategy (BMG-EN-REP-0023), and have determined how these needs will be met. A summary of the process undertaken is provided in the BMG Closure Project (Phase 1) OPEP (BMG-ER-EMP-0004).

Cooper Energy will not deploy any resources without first receiving a formal deployment request from relevant State agency

7.10.3 Waste Management

To understand the response equipment and personnel required to support waste management activities, Cooper Energy identified the estimated waste types associated with an Oily Wildlife response technique to provide a conservative indication as to the level of waste that may be required to be managed by this activity (Table 7-29).

Table 7-29 Estimated Waste Types and Volumes from a BMG LOWC Event

Response Technique	Waste Type	Waste Volume (m3)	Number of units?
Shoreline Clean-up – Decontamination Stations	Waste Water	1m3 per unit (1 bird = 1 unit)	
	PPE	5 kg per unit	

The feasibility/effectiveness of an oiled wildlife response is provided in Table 7-30.

Table 7-30 Feasibility / Effectiveness of Oiled Wildlife Response

Parameter	Oiled Wildlife Response
Suitability/Functionality *How does the response strategy perform to achieve its required risk reduction?*	The oiled wildlife response may lead to the survival of vulnerable wildlife populations. The level of oiled wildlife response required can be scaled based on the predicted number of animals oiled.
Dependencies *Does the response strategy rely on other systems to perform its intended function?*	Operational effectiveness of the oiled wildlife response relies on supporting monitoring information from aerial, vessel and ground surveys. This supporting information can be gathered during daylight hours only.
Availability and limitations *Time the response strategy is available to perform its function?*	Time to be operational - Once the oiled wildlife facility has been established 24-hour continuous operations are feasible where it is confirmed safe to do so. Under the direction of DELWP personnel downtime will be planned and managed to ensure appropriate levels of response personnel are maintained and rotated as required or until the response is terminated.

7.10.4 Oiled Wildlife Response ALARP Evaluation

OWR ALARP considerations are included in Table 7-31.

Table 7-31 OWR ALARP Evaluation

Additional control measures	Benefit	Cost	Outcome
Training and competencies	Personnel handling oiled wildlife are trained as fauna handlers, or are guided by OWR-trained personnel. During an oil spill there is the potential for fauna to come into contact with floating or stranded oil. If this occurs, Cooper Energy is able to draw upon the OWR arrangements and expertise developed and implemented by industry, and can also provide support to these OWR agencies	There are no significant costs associated with this control measure, however given the level of OWR expected, and the demonstrated capability to access OWR personnel, training additional personnel is expected to provide any benefit, thus has not been implemented.	Not Selected

7.10.5 Oiled Wildlife Response Impact Evaluation

7.10.5.1 Cause of Aspect:

The hazards associated with OWR are:

- Hazing of target fauna may deter non-target species from their normal activities (resting, feeding, breeding, etc.);
- Distress, injury or death of target fauna from inappropriate handling and treatment;
- Euthanasia of target individual animals that cannot be treated or have no chance of rehabilitation;

7.10.5.2 Impact or Risk

The potential impacts of this activity are disturbance, injury or death of fauna.

7.10.5.3 Consequence evaluation

Untrained resources capturing and handling native fauna may cause distress, injury and death of the fauna. To prevent these impacts, only appropriately trained oiled wildlife responders will approach and handle fauna. This will eliminate any handling impacts to fauna from untrained personnel and reduce the potential for distress, injury or death of a species.

It is preferable to have oil-affected animals that have no prospect of surviving or being successfully rehabilitated and released to the environment humanely euthanized than to allow prolonged suffering. The removal of these individuals from the environment has additional benefits in so far as they are not consumed by predators/scavengers, avoiding secondary contamination of the food-web.

Hazing and exclusion of wildlife from known congregation, resting, feeding, breeding or nesting areas may have a short- or long-term impact on the survival of that group if cannot access preferred resources. These effects may be experienced by target and non-target species. For example, shoreline booming or ditches dug to contain oil may prevent penguins from reaching their burrows after they've excited the water and low helicopter passes flown regularly over a beach to deter coastal birds from feeding in an oil-affected area may also deter penguins from leaving their burrows to feed at sea, which may impact on their health.

Due to the potential for localised short-term impacts to species/habitats of recognised conservation value but not affecting local ecosystem functioning, the potential impacts form this activity have been identified as **Level 2.**

7.10.5.4 Environmental Impact and Risk Assessment:

Table 7-32 provides the EIA / ERA for OWR activities.

Table 7-32 Oiled Wildlife Response EIA / ERA

ALARP Decision Context and Justification	**ALARP Decision Context A** The implementation of OWR activities are standard practice for marine oil spills where there is the potential for hydrocarbon exposure to wildlife. There is a good understanding of potential impacts and risks from these techniques, and the control measures required to manage these. There is little uncertainty associated with the potential environmental impacts and risks, which have been evaluated as **Level 2** due to the incidental expected impacts from this response. No objections or concerns were raised during stakeholder consultation regarding this activity or its potential impacts and risks. As such, Cooper Energy believes **ALARP Decision Context A** should apply.
Control Measure	**Source of good practice control measures**
Maintain Oiled Wildlife Response capability	Maintaining the capability is key for ensuring that the any response is implemented effectively and quickly.
Consultation	Consultation In the event of a spill will ensure that relevant government agencies support the OWR strategy thus minimising potential impacts and risks to sensitivities.

Use of Existing Tracks and Pathways	Utilising existing tracks and paths where possible will ensure the disturbance footprint associated with the implementation of this response technique is reduced to ALARP.
Wildlife is only approached or handled by State agency trained oiled wildlife responders unless formal direction is received from the Government IMT.	Cooper Energy response personnel are advised of wildlife interaction restrictions through site safety inductions.
Likelihood	The small volumes hydrocarbons ashore, and associated limited residual fractions indicate implementing this type of technique is low. Thus, the likelihood associated with causing a Minor Impact from this technique is considered to be **Remote (E)**.
Residual Risk Severity	**Low**
Demonstration of Acceptability	
Principles of ESD	The potential impact associated with this aspect is limited to a localised short-term impact, which is not considered as having the potential to affect biological diversity and ecological integrity. The activities were evaluated as having the potential to result in a **Level 2** consequence thus is not considered as having the potential to result in serious or irreversible environmental damage. Consequently, no further evaluation against the principles of ESD is required.
Legislative and other requirements	Legislation and other requirements considered as relevant control measures include: • OPGGS Act 2006 (Cth) [R13(5) Risk assessment to ALARP]. • OPGGS Act 2010 (Vic) [R15(3) Risk assessment to ALARP]. • EPBC Act 1999 and EPBC Regulations 2000 (Part 8). • Emergency Management Act 2013 (Vic). • Wildlife Act 1975 (Vic). Oil Spill Response Technical Guidelines: The adopted controls have been guided by the following technical guides: • Wildlife Response Preparedness (IPIECA/OGP, 2014). • Victorian Maritime Emergencies (Non-search and rescue) Plan (DEDJTR, 2017).
Internal context	Relevant management system processes adopted to implement and manage hazards to ALARP include: • Risk Management (MS03) • Technical Management (MS08) • Health Safety and Environment Management (MS09) • Incident and Crisis Management (MS10) • Supply Chain and Procurement Management (MS11) • External Affairs & Stakeholder Management (MS05)
External context	No stakeholder concerns have been raised to date regarding impacts and risks from OWR strategies. As such, Cooper Energy considers that there is broad acceptance of the impacts associated with the activity.

8 Environmental Performance Outcomes, Standards and Measurement Criteria

This section summarises the EPOs, standards, and measurement criteria that have been developed as part of a systematic approach to the management of environmental risks as identified in Section 6. The EPOs, standards and criteria related to the BMG Closure Project (Phase 1) activities are shown in Table 8-1. Also shown are key responsible and accountable personnel who will ensure the EP is implemented and records of implementation retained.

Table 8-1 Environmental Performance Outcomes, Standards and Measurement Criteria (BMG Closure Project (Phase 1) activities)

EPO	Control	EPS	Measurement Criteria	Responsible Person
EPO1: No serious or irreversible harm to a threatened or migratory listed species. **EPO2:** Biologically important behaviours within a BIA or outside a BIA can continue while the activity is being undertaken. **EPO3:** No substantial reduction of air quality within local airshed caused by atmospheric emissions produced during the activity. **EPO4:** No substantial and unrecoverable change in water quality which may adversely impact on biodiversity, ecological integrity, social amenity or human health. **EPO5:** No substantial and unrecoverable changes to seabed which may adversely impact on biodiversity, ecological integrity, social amenity or human health.	C10: Tethering System Plan & Install Procedure	Tethering system plan & install procedure will ensure that seabed installation and removal is undertaken as required.	Tethering system plan and install procedure	Project Manager
	C12: Planned Maintenance System	Equipment used to treat planned vessel discharges maintained in accordance with preventative maintenance system.	PMS records	Vessel Master
		Combustion equipment maintained in accordance with preventative maintenance system.	PMS records	Vessel Master
	C28: Mooring plan	Mooring related infrastructure laydown is limited to within 2 km radius of the MOU to limit the extent of disturbance to the seabed.	As-left survey undertaken to verify mooring laydown and is within predefined corridors.	Offshore Installation Manager (OIM)
	C37: Mooring analysis	Mooring analysis will be undertaken before anchoring, as required API RP 2SK.	Mooring analysis report shows mooring analysis was completed before mooring commenced.	Project Manager
		Seabed disturbance from MOU mooring limited to that required to ensure adequate MOU station holding capacity.	Records demonstrate Mooring Design Analysis implemented during anchor deployment.	Project Manager
	C38: Monitoring mooring line tensions	Mooring tension monitoring will be undertaken, for duration of Activity as required by ISO 19901-7:2013 to limit unnecessary dragging and seabed scouring.	Records confirm mooring tension was monitored for duration of MOU mooring.	OIM
	C39: Wet parking restricted to within the existing infrastructure PSZs	All infrastructure requiring wet parking is limited to identified planned wet storage areas inside existing PSZs.	Data verifies infrastructure locations are as planned within Cooper Energy infrastructure tracking system.	Project Manager
			Planned wet storage locations are within existing PSZ.	Project Manager
	C13: Positioning Technology	Infrastructure will be positioned in the planned location where impacts have been assessed.	Data verifies infrastructure locations are as planned within Cooper Energy infrastructure tracking system.	Project Manager

EPO	Control	EPS	Measurement Criteria	Responsible Person
	C7: Marine Order 30: Prevention of collision	Vessels shall meet the navigation equipment, watchkeeping, radar and lighting requirements of AMSA MO 30.	Vessel inspection	Vessel Master
	C8: Fluids Handling Package accepted under safety case regime	Flaring and venting will be undertaken in accordance with the approved procedures for the Fluids Handling Package.	Records	Project Manager
	C9: Well Returns Management Philosophy	Bullhead returns to MOU into subsurface oil reservoirs, where practicable.	Offshore execution reports	Project Manager
		Fluid will be confirmed as ≤30ppm oil in water prior to discharge to sea.	Oil in water records.	Project Manager
		Returns which do not meet criteria for either bullhead or discharge will be sent to shore for treatment.	Records	Project Manager
	C14: Selection of high efficiency burner.	High efficiency burner will be selected (>99% efficiency).	Equipment records and certification	Project Manager
	C15: Drilling Fluids Reuse Assessment	Cooper Energy will undertake an assessment on the suitability of well control fluids to be reused for other wells. Where deemed suitable, well control fluids will be reused.	Records show that an assessment was made, and suggestions adhered to.	Project Manager
	C22: AMSA Discharge Standards	• Low-sulphur (<0.5% m/m) marine-grade diesel used. • Vessels with diesel engines>130 kW must be certified to emission standards (e.g. IAPP, EIAPP). • Vessels implement their Ship Energy Efficiency Management Plan (SEEMP) to monitor and reduce air emissions (as appropriate to vessel class).	Bunker receipts SEEMP records Certification documentation	Vessel Master
		• Bilge water treated via a MARPOL (or equivalent) approved oily water separator and only discharge if oil content less than 15 ppm. • Sewage discharged at sea is treated via a MARPOL (or equivalent) approved sewage treatment system.	Oil record book Garbage record book	Vessel Master

EPO	Control	EPS	Measurement Criteria	Responsible Person
		• Food waste only discharged when: vessel is: - Vessel is en-route and >12nm from land, or - food waste is communited or ground to <25mm and vessel is en route and >3nm from land, or - food waste is communited or ground to <25mm and platform is >12nm from land.		
		• Waste handled according to vessel waste management plan. • Waste with potential to be windblown stored in covered containers. • Waste lost overboard is recorded and recovered if possible.	Garbage record book Incident report	Vessel Master
	C25: Garbage Management Plan	Vessels and MOU will have a garbage management plan in place.	Garbage record book	Vessel Master OIM
	C17: NOPSEMA accepted safety cases and safety case revision	Activities will be managed in accordance with the accepted safety case revision.	Accepted Safety Cases in place Inspection records	Project Manager
	C18: Cooper Energy Offshore Chemical Assessment Procedure (CMS-EN-PCD-0004).	• Project chemicals will meet the requirements of the Cooper Energy Offshore Chemical Assessment Procedure. • Record and Reconcile Phase 1 project chemical discharges	Completed and approved chemical assessment Activity Completion Reports	Project Manager
	C19 Phase 1 Flowline Flushing.	Plan and execute flowline flushing to remove hydrocarbons from flowlines to ≤30ppm oil in water during Phase 1. Flushing provisions include: • Flowline flushing procedures are developed and implemented. • Selection of pumps to exceed lowest rates from 2011 flushing scope.	Project Procedures Project execution reports	Project Manager

EPO	Control	EPS	Measurement Criteria	Responsible Person
		• Contingency pressure retaining cap available to support completion of flushing scope. Testing at surface to confirm oil in water content.		
	C16: Inventory Management System	Sufficient stocks of weighting material, fluids and chemicals for well control.	Daily activity records	Activity Superintendent
		Upon completion of the activity: • excess bulks will be retained onboard for future activity where acceptable by the subsequent operator, returned to shore or discharged overboard subject to practicability assessment which considers: - impact of discharge - emissions from each option - cost of each option Spare drilling fluid additives will be retained on board where acceptable by the subsequent operator or returned to shore.	Waste/Materials transfer records show excess chemicals returned to shore.	Activity Superintendent
		Detailed cementing procedures will be developed and implemented before cementing activities commence	Cementing Program / Cementing Plan of Action developed and implemented for all cementing operations	Activity Superintendent
		Actual cement use and discharge will be reconciled against planned quantities throughout the campaign.	Cementing reports will include: Cement use, including excess, for each cement job. Materials on location and used to make cement during the day.	Activity Superintendent
	C11: SIMOPS Procedure	SIMOPS Procedure will be developed and implemented for managing simultaneous operations	Records	Project Manager
	C24: Equipment deployment and recovery procedures.	Umbilicals will be removed from subsea equipment via disconnecting to minimise discharges to sea. Where disconnection is unsuccessful, umbilicals may be removed via cutting.	Project Procedures Project execution reports	Project Manager

EPO	Control	EPS	Measurement Criteria	Responsible Person
EPO1: No serious or irreversible harm to a threatened or migratory listed species. **EPO2:** Biologically important behaviours within a BIA or outside a BIA can continue while the activity is being undertaken. **EPO6**: Minimise anthropogenic threats to allow for blue whale and southern right whale conservation status to improve so that they can be removed from the EPBC Act threatened species list, consistent with the objectives and specific actions of the species recovery plans.	C26: EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans	Vessels and helicopters adhere to the distances and vessel and helicopter management practices of EPBC Regulations (Part 8) with increased caution zone of 500m between whales and project vessels.	Daily operations report details when whales, dolphins or seals sighted, and the interaction management actions were implemented, if required.	Vessel Master
	C27: Blue whale CMP Action A.2.3 and Marine Mammal Adaptive Management	Blue whale CMP Action A.2.3: Anthropogenic noise in biologically important areas will be managed such that any blue whale continues to utilise the area without injury and is not displaced from a foraging area) will be implemented where the action is needed to achieve the objectives of the blue whale CMP (EPO6). This will involve: • Exclude use of DP MOU during the defined periods (including shoulder periods) when blue whales are more likely to be foraging in the area. • Adaptive management measures will be implemented for IMR vessels operating within the defined periods (including shoulder periods) when blue whales are more likely to be foraging in the area. • Application of mitigation measures to reduce the risk of (blue whale) displacement occurring during operations.	Daily report MMO reports Risk Review Records (where required).	Project Manager
EPO7: Undertake the activity in a manner that will not interfere with other marine users to a greater extent than is necessary for the exercise of right conferred by the titles granted.	C1: Marine exclusion and caution zones	A permanent PSZ shall be maintained for the BMG subsea infrastructure until PSZ adjustment/revocation is agreed with relevant stakeholders and administrators.	PSZ gazetted notice	Operations Manager
		Subsea infrastructure is marked on navigational charts	Navigational charts	Operations Manager
	C2: Pre-start notifications	The AHS will be notified no less than four working weeks before operations commence to enable Notices to Mariners to be published	Email records	Project Manager

EPO	Control	EPS	Measurement Criteria	Responsible Person
		AMSA's JRCC will be notified 24–48 hours before operations commence to enable AMSA to distribute an AUSCOAST warning. AMSA JRCC will also be notified if the vessel moves out of the area that the broadcast is issued for.	Email records	Vessel Master
	C3: Marine Order 27: Safety of navigation and radio equipment	Vessels shall meet the safety of navigation and radio equipment requirements of AMSA MO 27.	Vessel inspection	Vessel Master
	C4: As-left seabed survey	An as-left seabed survey will be undertaken prior to completion of the activity	Survey records	Project Manager
	C5: Ongoing consultation	Notifications for any on-water activities and ongoing consultations undertaken as per Section 9 Stakeholder Consultation	Notification records	Project Manager
	C6: Fisheries Damage Protocol	Fisheries Damage Protocol in place to provide a compensation mechanism to fishers who damage fishing equipment on Gippsland assets infrastructure outside of the PSZ.	Fisheries Damages Protocol	General Manager Projects and Operations
	C39: Wet parking restricted to within the existing infrastructure PSZs	All infrastructure requiring wet parking is limited to identified planned wet storage areas within existing PSZs.	Data verifies infrastructure locations are as planned within Cooper Energy infrastructure tracking system.	Project Manager
			Planned wet storage locations are within existing PSZ.	Project Manager
EPO8: No unplanned discharge of waste to the marine environment.	C22: AMSA Vessel Discharge Standards	Waste with potential to be windblown shall be stored in covered containers.	HSE inspection records Garbage record book Incident report	Vessel Master / OIM
	C25: Garbage Management Plan	Vessels and MOU will have a garbage management plan in place.	Garbage record book	Vessel Master OIM
	C24: Equipment deployment and recovery procedures.	Equipment will be deployed and recovered in line with the Operations Program, Cooper Energy Management System (including well engineering management) and MOU operations procedures.	Daily activity report	Activity Superintendent

EPO	Control	EPS	Measurement Criteria	Responsible Person
EPO9: No introduction, establishment or spread of a known or potential invasive marine species	C20: Invasive Marine Species Procedure (CMS-EN-PCD-0006)	Completed risk assessment and management actions in accordance with the IMS Risk Management Protocol.	Compliance and Readiness Review report verifies that IMS Risk Assessment undertaken.	Project Manager
EPO10: No spills of chemicals or hydrocarbons to the marine environment.	C1: Marine exclusion and caution zones	A permanent PSZ shall be maintained for the BMG subsea infrastructure until PSZ adjustment/revocation is agreed with relevant stakeholders and administrators.	PSZ gazetted notice	Operations Manager
		Subsea infrastructure is marked on navigational charts	Navigational charts	Operations Manager
	C5: Ongoing consultation	The AHS will be notified no less than four working weeks before operations commence to enable Notices to Mariners to be published.	Email records confirm a Notice to Mariners was provided to the AHS via email hydro.ntm@defence.gov.au and that such notice was provided at least four weeks before operations commenced	Project Manager
		AMSA's JRCC will be notified 24–48 hours before operations commence to enable AMSA to distribute an AUSCOAST warning. AMSA JRCC will also be notified if the vessel moves out of the area that the broadcast is issued for.	Email records confirm that information to distribute an AUSCOAST warning was provided to the JRCC via email rccaus@amsa.gov.au	OIM / Vessel Master
		Relevant Stakeholders will be notified of activities prior to operations commencing as agreed during consultation.	Stakeholder log / records confirm that pre-start notices were sent to all relevant stakeholders	Project Manager
	C11: SIMOPS Procedure	SIMOPS Procedure will be developed and implemented for managing simultaneous operations.	Records	Project Manager
	C3: Marine Order 27: Safety of navigation and radio equipment	Vessels shall meet the safety of navigation and radio equipment requirements of AMSA MO 27.	Vessel inspection	Vessel Master
	C30: Marine Order 31: SOLAS and non-SOLAS certification	Support vessels will meet survey, maintenance and certification of regulated Australian vessels as per AMSA MO 31.	Vessel certification	Vessel Master

EPO	Control	EPS	Measurement Criteria	Responsible Person
	C29: Marine Order 21: Safety and emergency arrangements	Vessels shall meet the safety measures and emergency procedures of the AMSA MO 21.	Vessel inspection	Vessel Master
	C7: Marine Order 30: Prevention of collisions	Vessels shall meet the navigation equipment, watchkeeping, radar and lighting requirements of AMSA MO 30.	Vessel inspection	Vessel Master
	C21: NOPSEMA accepted WOMP	A NOPSEMA-accepted WOMP that describes well barriers and integrity testing will be in place before well abandonment activities start.	Records confirm a NOPSEMA-accepted WOMP was in place before operations	Well Engineering Manager
	C35: Cooper Energy Well Management System (WEMS-DC-STD-0001)	Activities will be approved under the Cooper Energy Well Management System (WEMS-DC-STD-0001) before operation.	Records confirm the well program received approval before operations	Well Engineering Manager
	C32: Source Control Emergency Response Plan	A campaign Source Control Emergency Management Plan (SCERP) will be developed which aligns with the APPEA Source Control Guideline before entry into a well.	SCERP available	Well Engineering Manager
	C34: MOU Material Transfer Procedures	MOU will have a bulk fluid transfer process in place before commencing operations. The process will include: • MOU-to-vessel communication protocols • transfer hose pressure testing • continuous visual monitoring • tank volume monitoring	Records demonstrate implementation of MOU Operator's bulk fluid transfer process	OIM
		Transfer hoses shall comprise sufficient floating devices and self-sealing weak-link couplings in the mid-section of the hose string, in accordance with GOMO 0611-1401.	Records demonstrate transfer hoses meet GOMO 0611-1401 requirements	OIM
	C31: Vessel compliant with MARPOL Annex I, as appropriate to class (i.e. SMPEP or equivalent)	Vessel has a SMPEP (or equivalent appropriate to class) which is: 1. Implemented in the event of a spill to deck or ocean. 2. Exercised as per the vessels exercise schedule.	Vessel SMPEP Vessel exercise schedule Vessel inspection	Vessel Master

EPO	Control	EPS	Measurement Criteria	Responsible Person
		Spill response kits are located in high spill risk areas and routinely checked to ensure adequate.		
	C19 Phase 1 Flowline Flushing.	Plan and execute flowline flushing to remove hydrocarbons from flowlines to ≤30ppm oil in water during Phase 1. Flushing provisions include: • Flowline flushing procedures are developed and implemented. • Selection of pumps to exceed lowest rates from 2009/11 flushing scope. • Contingency pressure retaining cap available to support completion of flushing scope. • Testing at surface to confirm oil in water content.	Project Procedures Project execution reports	Project Manager
EPO11: Impacts to values and sensitivities are minimised in the event of a loss of hydrocarbons.	C33: OPEP	Emergency spill response capability is maintained in accordance with the OPEP. Emergency response activities will be implemented in accordance with the OPEP.	Records confirm that emergency response activities have been implemented in accordance with the OPEP	Incident Management Team (IMT) Incident Controller (IC)
	C36: OSMP	Operational and scientific monitoring will be implemented in accordance with the OSMP.	Records confirm that operational and scientific monitoring have been implemented in accordance with the OSMP	IMT IC
	C5: Ongoing consultation	In the event of a LOWC event, potentially relevant stakeholders will be identified and notified.	Records confirm that relevant stakeholders identified using oil spill trajectory modelling, and that consultation efforts commenced.	IMT IC
	C41: SCERP	Source Control Response Capability is Maintained in Accordance with the SCERP. Source Control Activities are Undertaken in Accordance with the SCERP.	Records confirm that emergency response activities have been implemented in accordance with the SCERP	IMT IC

EPO	Control	EPS	Measurement Criteria	Responsible Person
EPO12: General Direction 824(3) Until such time as direction 1 and 2 are complete, maintain all property on the title to NOPSEMA's satisfaction, to ensure removal of property is not precluded.	C23 Phase 1 Flowline Integrity Provisions	Flowlines are managed during Phase 1 activities such that full removal is not precluded during Phase 2. Integrity provisions for implementation is Phase 1 include: • Flowline flushing procedures are developed and implemented. • Environmental caps are installed on flowlines if needed to limit corrosion of flowline internal materials between Phase 1 and Phase 2. Depending on corrosion studies, the flowlines may be displaced to inhibited water after flushing, if required, to maintain integrity sufficient to allow removal within the period 2024-2026 (Phase 2 campaign).	Project procedures Project execution reports	Project Manager
EPO13: Sea dumping is undertaken in accordance with the Sea Dumping Act**.**	C40 Sea Dumping Permits	Sea Dumping permits are obtained prior to sea dumping, and permit requirements are fulfilled.	Approved Sea Dumping Permits Project Execution Reports	Project Manager

9 Implementation Strategy

Cooper Energy retains full and ultimate responsibility as the Titleholder of the activity and is responsible for ensuring that the Activity is undertaken in accordance with this EP.

Regulation 14 of the OPGGS(E) Regulations details that the EP must contain an implementation strategy. The implementation strategy described in this section provides a summary of the Cooper Energy Management System (CEMS).

9.1 Cooper Energy Management System

The CEMS is Cooper Energy's integrated system which consolidates all of Cooper's business processes into one system of management, to manage every aspect of Cooper Energy's business (HSEC, Operations, Well Construction, Engineering, Finance etc) in accordance with a set of core concepts detailed in Table 9-1.

The CEMS document hierarchy is shown in Figure 9-1: with Cooper Energy's Health, Safety, Environment and Community (HSEC) Policy shown in Figure 9-2 and CEMS standards list in Table 9-2.

Table 9-1: Cooper Energy's Management System Core Concepts

Core Concepts	
People	• How we organise (line and function) • Which roles we need • Which skills we need • How we build and sustain capability
Culture	• Why we exist • What we value • How we work together • How we communicate
Process	• What we do • How we do it • How we learn • How we continuously improve
Technology	• Which tools we use • How we use them • How we support people to perform their role
Governance	• How we manage risk • How we make decisions • How we ensure safety, quality and technical integrity

Figure 9-1: CEMS Document Hierarchy

Table 9-2: CEMS Standards

CEMS Standard	Focus Area
MS00	Statement of Intent and Expectations
MS01	Accountability and Leadership
MS02	People Management
MS03	Risk Management
MS04	Strategy and Planning Management
MS05	External Affairs, Investor Relations, Community and Stakeholder Management
MS06	Information Systems
MS07	Operations Management
MS08	Technical Management
MS09	Health, Safety and Environment Management
MS10	Incident and Crisis Management
MS11	Supply Chain and Procurement Management
MS12	Technical Assurance and Compliance Management
MS13	Financial Management
MS14	Commercial Marketing and Economics Management
MS15	Asset Lifecycle Management

Health, Safety and Environment Policy

Cooper Energy | HSE | Policy

Our Commitment

Care is a core value of Cooper Energy.

Cooper Energy is committed to taking all reasonably practicable steps to protect the health and safety of our workers, contractors, partners, and communities in the areas in which we operate. In addition, we will ensure our business is conducted in an environmentally responsible manner.

Our Actions

Wherever we operate we will develop, implement, and maintain HSE protocols that are consistent with recognised standards and practices, which will enable us to:

- Proactively assess and control our health and safety risks and environmental aspects and impacts
- Provide the HSE systems and resources to adequately support organisation in meeting its objectives
- Continually improve HSE systems through periodic consultation and review with the workforce
- Ensure all employees and contractors are appropriately trained and competent and suitably supervised to ensure works are undertaken in a safe and environmentally responsible manner
- Monitor HSE performance through the identification and communication to the workforce of clear, effective HSE objectives and targets
- Encourage participation in promoting improvements in safety, health and environmental practices and supporting a positive and caring culture in all areas of Cooper Energy's business
- Identify and comply with relevant HSE legislation and regulations and other requirements to which we subscribe and incorporating any changes into our HSE systems.

Governance

The HSEC Committee has oversight of this policy. The Managing Director is accountable for communicating this Policy and for ensuring compliance with its undertakings. All Executive Leadership Team members and Managers shall ensure the effective implementation, management, and monitoring of the HSEC Management System and its subsequent outcomes. All Staff are responsible for compliance with our policy, standards, and procedures. This policy will be reviewed at appropriate intervals and revised, as necessary.

David Maxwell

Managing Director

Role	Name	Signature	Document Properties
Document Author:	Ben Edwards	Ben Edwards	Doc No. CMS-HS-POL-0001
CEMS Review:	Sean Brooks		Rev: 5
Document Owner:	Iain MacDougall	Iain MacDougall Digitally signed by Iain MacDougall Date: 2021.12.20 10:30:31 +10'30'	Rev Date: 22 Sept 2021
Document Approver:	David Maxwell		

Figure 9-2: Cooper Energy Health, Safety, Environment and Community Policy

9.2 Asset Integrity Management

The existing Gippsland Operations EP provides for the NPP of the BMG facilities, including integrity maintenance. The BMG Offshore Facilities Integrity Management Plan (BMG-IR-IMP-0001) describes how Cooper Energy manages integrity of the BMG assets whilst in NPP, utilising the Plan-Do-Act-Check cycle. The overall strategy is to maintain the assets as close to their design condition as possible. Accordingly, the integrity of the BMG assets is maintained and monitored in a number of ways, including:

- Design, Pressure Containment and Primary Protection functions:
  - Design basis and documentation
  - Pipeline cover (where required)
  - Protection and support structures
  - External corrosion protection system
  - Internal corrosion control system
  - Restriction and safety zone systems
  - Intervention procedures
  - Pipeline integrity reviews
- Monitoring and inspection:
  - Marine activity monitoring
  - Weather (exceedance) monitoring
  - ROV visual and CP inspection
  - Stakeholder engagement (facility awareness).

This approach is preferred to ‘controlled deterioration’ as it attempts to maintain enough control effectiveness to prevent ‘surprise’ deterioration threatening integrity, acknowledges that individual control effectiveness will not always be perfect and provides operational flexibility for decommissioning options.

9.3 Contractor Management System

The Supply Chain and Procurement Management Standard (MS11) details Cooper Energy's contractor management system which provides a systematic approach for the selection and management of contractors to ensure any third party has the appropriate safety and environment management system and structures in place to achieve HSEC performance in accordance with Cooper Energy's expectations.

The Standard applies to sub-contractors, Third Party Contractors (TPCs) and suppliers conducting work at Cooper Energy sites or providing services to Cooper Energy.

The Standard addresses operational HSEC performance of all contractors while working under a Cooper Energy contract or in an area of Cooper Energy responsibility or which may be covered under the HSEC Management System. The key HSEC steps in MS11 include:

- Planning - HSEC assessment of potential contractors, suppliers and/or TPCs;
- Selection - Submission and review of contractors and/or TPCs HSEC management data;
- Implementation - Onsite contractors and/or TPCs HSEC requirements including induction and training requirements; and
- Monitoring, review and closeout - Ongoing review of contractors and/or TPCs HSEC performance including evaluation at work handover.

Prior to Contractor commencement of operations, contractors must have in place a Cooper Energy approved HSE MS that meets minimal regulatory requirements and ensures compliance with this EP.

Cooper Energy will undertake an on-hire audit of the relevant vessel (or facilities) against EP requirements, using the EP Commitments Register to assess the Contractors HSE management system but also specifically cover EP commitments. This is one of a number of means to ensure Contractors are aware of, and comply with, EP requirements.

9.4 Roles and Responsibilities

As required by Regulation 14(4) of the OPGGS(E) Regulations, this section outlines the chain of command and roles and responsibilities of personnel in relation to the implementation, management and review of this EP.

The emergency response structure for the Activity is detailed in the Cooper Energy BMG Closure Project (Phase 1) Oil Pollution Emergency Plan (OPEP) (VIC-ER-EMP-0004). The chain of command for the Activity is shown in Figure 9-3 with the roles and responsibilities of personnel in relation to the implementation, management and review of this EP detailed in Table 9-3.

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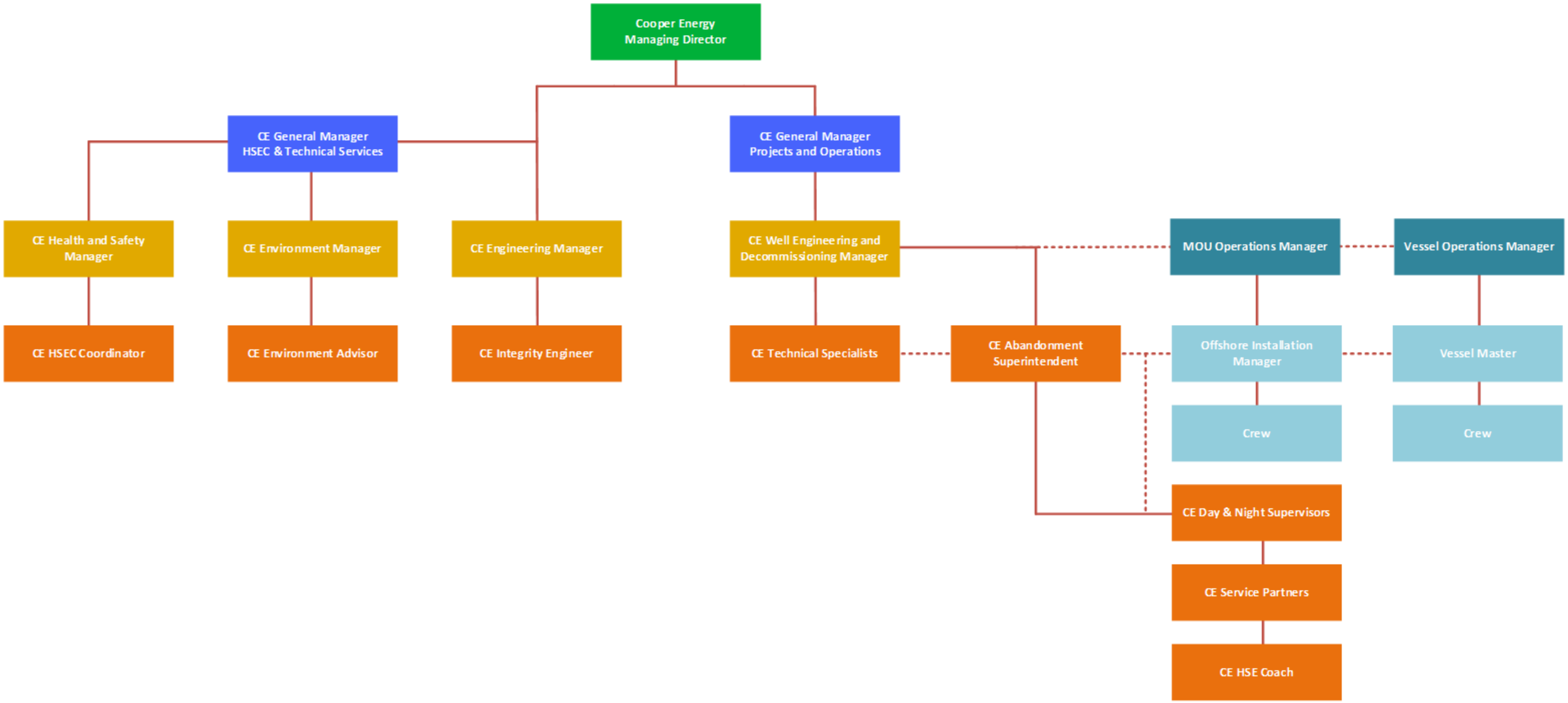


Figure 9-3:Cooper Energy Activity Organisation Structure

Table 9-3 Cooper Energy Environment Plan Roles and Responsibilities

Role	Environment Plan Responsibility
Cooper Energy	
Managing Director	• The Managing Director is accountable for ensuring a framework has been established through which the Management System requirements will be met.
General Manager Projects and Operations	Ensures: • Compliance with the Cooper Energy HSEC Policy and Management System. • Audits and inspections to verify HSEC and integrity performance are scheduled and undertaken. • Adequate resources are in place to meet the requirements within the EP and OPEP. • Adequate emergency response capability is in place. • Incidents and non-conformances are recorded, reported and investigated.
Well Engineering or Project Manager	Ensures: • Compliance with the Cooper Energy HSEC Policy. • Compliance with this EP and controls implemented. • Contractor prequalification and qualification processes are undertaken (Section 9.5.2). • Personnel are inducted into this EP requirements and are aware of their environmental responsibilities (Section 9.5.3). • Response arrangements in the OPEP are in place and tested prior to the survey commencing (Section 9.6). • Environmentally relevant changes are assessed and approved by Cooper Energy (Section 9.9). • Environmental incidents are reported internally and externally, and investigations undertaken (Section 9.11). • Inspections and audits undertaken (Section 9.12.5). • Actions from environmental audits and incidents are tracked to completion (Section 9.13). • Stakeholder engagement undertaken (Section 10). • Annual progress reporting in accordance with General Direction 824
Environment Manager	Ensures: • Systems are in place to support the implementation of Cooper Energy Management System requirements. • Personnel are adequately trained to implement Cooper Energy Management System requirements. • Specialist environment input and support is provided to the HSEC Committee, Management and Board as required. • Incidents are investigations in accordance with Cooper Energy requirements and learnings are disseminated appropriately • An in-depth and up to date knowledge of the legal and statutory Environmental obligations for is maintained. • Environmental performance is monitored, evaluated and reported as appropriate at all levels in the organisation.
Health and Safety Manager	Ensures: • Response arrangements in the OPEP are in place and tested. Coordinates: • Cooper Energy's approach to Emergency Response and Preparedness including oil spills. • Emergency Response Training and Competency.
Activity Superintendent	Ensures: • Compliance with EP commitments (EPOs/EPSs) for all well construction activities.

<table>
<tr><th>Role</th><th>Environment Plan Responsibility</th></tr>
<tr><td></td><td>Implementation of risk assessment processes and management of change for well construction activities.
Environmentally relevant changes are assessed and approved by Cooper Energy.
Appropriate well control resources are available and maintained.
Relevant plans are implemented.</td></tr>
<tr><td>HSEC Coordinator</td><td>Ensures:
The Cooper Energy Project Team and relevant service partners are inducted into Cooper HSEC requirements (inclusive of EP requirements) and are aware of their responsibilities.
Implementation of Cooper Energy HSEC requirements is supported and monitored on site.
Emergency Response
Emergency Response Room and resources are maintained in a state of readiness.
Emergency Response Team is familiar with the emergency response room and communication arrangements.
Coordinates:
HSEC pre-qualification processes / readiness reviews are reported in a timely manner.
Roster for the Emergency Response Team.</td></tr>
<tr><td>Environment Advisor</td><td>Ensures:
EP, OPEP and OSMP are developed for the project.
Relevant environmental legislative requirements, commitments, conditions and procedures are communicated to relevant Cooper Energy and Service Partner personnel.
EP compliance inspections / audits are conducted, and actions are tracked to completion.
Environmental incidents are reported internally and externally, and investigations undertaken where necessary.
Environmentally relevant changes to the work program are assessed by Cooper Energy.
Stakeholder engagement is undertaken.
EP performance reports are submitted to NOPSEMA.</td></tr>
<tr><td>Offshore Supervisor</td><td>Ensures:
Compliance with relevant environmental legislative requirements, performance outcomes, control measures, performance standards, measurement criteria and requirements in the implementation strategy in this EP.
Inductions completed, and record of attendance maintained (Section 9.5.3).
Chemicals that have the potential to be discharged to the marine environment are assessed and approved using the Cooper Energy’s Offshore Chemical Assessment Procedure (Section 0).
Environmentally relevant changes are assessed and approved by Cooper Energy (Section 9.10.2).
Incidents reported to the Cooper Energy Project Manager (Section 9.11).
Monitoring and other records (Section 9.12) are collated and provided to the Cooper Energy Project Manager on completion of the program.
Ensure HSEC inspections undertaken throughout the offshore activity to ensure ongoing compliance with the EP requirements (Section 9.12.5)
Corrective actions identified from incidents or inspections are implemented (Section 9.12.6).</td></tr>
<tr><td colspan="2">Contractors</td></tr>
<tr><td>Offshore Installation Manager
Vessel Master</td><td>Ensures:
MOU / vessel operations comply with relevant environmental legislative requirements, performance outcomes and performance standards in this EP.
The MOU / vessel carries the correct class certification.
The safe operation of the MOU / vessel.
The MOU / Vessel PMS (or equivalent) is fully implemented.</td></tr>
</table>

Role	Environment Plan Responsibility
	• All MOU / vessel-based incidents are reported in accordance with the reporting arrangements established with Cooper Energy. • Cooper Energy Training (including Environment components) is completed by all crew. • Compliance records (measurement criteria) under this EP are provided in a timely manner. • MOU / vessel in a state of preparedness for emergency response. • oil spill tracking buoy (if provided by Cooper) is ready and available for deployment.
Offshore Crews	• Completion of Cooper Energy Campaign Training (including Environment components). • Compliance with relevant environmental legislative requirements, performance outcomes and performance standards in this EP. • Records (measurement criteria) as required under the EP are maintained.

9.5 Training and Competency

Regulation 14(5) of the OPGGS(E) Regulations requires that the implementation strategy detail measures to ensure each employee or contractor working on, or in connection with, the activity is aware of their responsibilities in relation to this EP, including during emergencies or potential emergencies.

9.5.1 Cooper Energy Personnel

Cooper Energy personnel competency and training requirements are outlined in position descriptions and reviewed during the recruitment process. Competencies and training is initiated as defined in the Training and Development Procedure (CMS-HR-PCD-0004).

Personnel training records are maintained internally in accordance with MS06 Information and Systems Management.

9.5.2 Contractor personnel

Contractors engaged to work on the activity are assessed and engaged in accordance with the requirements of the MS11 Supply Chain and Procurement Management.

Competency of contractors is assessed as part of the pre-qualification and qualification process and requires contractors to define the competency and training requirements necessary to ensure that contractor personnel have the relevant knowledge and skills relevant to their role.

9.5.3 Environmental Induction

Cooper Energy and contractor personnel who work on the activity will complete an induction.

The environmental component of the induction will include information as detailed in Table 9-4. Records of personnel that complete the induction will be maintained internally in accordance with MS06 Information and Systems Management.

Table 9-4: Environmental components to be included in Environmental Inductions

Component	Onshore personnel	Offshore personnel
Description of the environmental sensitivities and conservation values of the operations area and surrounding waters.	✓	✓
Controls to be implemented to ensure impacts and risks are ALARP and of an acceptable level.	✓	✓
Requirement to follow procedures and use risk assessments/job hazard assessments (JHAs) to identify environmental impacts and risks and appropriate controls.	✓	✓
Procedures for responding to and reporting environmental hazards or incidents.	✓	✓
Megafauna sighting and vessel interaction procedures	✗	✓

Component	Onshore personnel	Offshore personnel
Overview of emergency response and spill management procedures.	✓	✓

9.6 Emergency Response

9.6.1 General Response

Cooper Energy manages emergencies from offshore Victoria activities in accordance with the Cooper Incident Management Plan (IMP) (COE-ER-ERP-0001). The purpose of the IMP is to provide the Cooper Energy Incident Management Team (IMT) with the necessary information to respond to an emergency affecting operations or business interruptions. The IMP:

- Describes the Emergency Management Process;
- Details the response process; and
- Lists the roles and responsibilities for the IMT members.

9.6.2 Oil Pollution Emergency Plan

In accordance Regulation 14(8) of the OPGGS(E) Regulations the implementation strategy must include an Oil Pollution Emergency Plan (OPEP)/Emergency Response Plan (ERP) and arrangements for testing the response arrangements within these plans.

The Cooper Energy BMG Closure Project (Phase 1) OPEP (VIC-ER-EMP-0004) and Offshore Victoria Operational and Scientific Monitoring Plan (OSMP) (VIC-ER-EMP-0002) provide for oil spill response and monitoring arrangements for this activity. These documents are submitted with this EP.

Roles and responsibilities for maintaining oil spill response capability and preparedness, testing and review arrangements and oil spill response competency and training requirements are detailed in the OPEP.

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.

9.6.3 Source Control Emergency Response Plan

A Source Control Emergency Response Plan (SCERP) has been prepared for the BMG P&A campaign and will provide for source control emergency response arrangements and preparedness for the activity. The SCERP will be written to align with industry and regulatory guidelines and will provide for each of the key source control response strategies outlined in Section 7 of this EP.

Roles and responsibilities for maintaining source control response capability and preparedness, testing and review arrangements and source control response competency and training requirements are detailed in the SCERP.

Table 9-5 SCERP Content

<table>
<tr><th>Response options</th><th>Topics addressed</th></tr>
<tr><td>Site Survey</td><td rowspan="6">Arrangements for the provision of the Source Control IMT personnel (numbers, competency, capability for the duration of the response)
Arrangements for the provision of equipment and material supplies
Arrangements for equipment and personnel monitoring and tracking
Activation and mobilisation plans, including activation and expenditure authority and regulatory approval processes
Logistics plans and providers
SIMOPS planning process</td></tr>
<tr><td>Debris Removal</td></tr>
<tr><td>Intervention Pressure Control Equipment</td></tr>
<tr><td>Capping</td></tr>
<tr><td>Dispersant Application</td></tr>
<tr><td>Relief Well Drilling</td></tr>
</table>

Response options	Topics addressed
	• Deployment and installation plans • Well kill and shut-in plans.

9.7 Chemical Assessment and Selection

Cooper Energy's Offshore Chemical Assessment Procedure (CMS-EN-PCD-0004) requires that project chemicals that will be or have the potential to be discharged to the environment are assessed and approved prior to use. This process is used to ensure the lowest toxicity, most biodegradable and least accumulative chemicals are selected which meet the technical requirements.

A summary of the evaluation process is detailed in Table 9-6.

Table 9-6 Cooper Energy Offshore Chemical Assessment Procedure Summary

Step	Evaluation	Input	Outcomes
1	Characterise proposed chemical.	Confirm the following: • Chemical name & supplier • Chemical Function/purpose • Formulation, where available • CAS number, where available • Eco toxicity, where available • Estimated use, dosage and discharge.	Proceed to **Step 2**
2	Determine whether the chemical proposed is to be discharged to the marine environment.	Refer to EP to determine proximity to priority sensitivities.	Where chemical is to be used in an entirely closed loop system no further action is required. Where chemical is to be discharged - proceed to **Step 3.**
3	Determine whether the chemical proposed is on the OSPAR PLONOR List.	Refer to OSPAR PLONOR List	Where the chemical is listed the chemical is approved at **Step 3**. Where the chemical Is not listed go to **Step 4**.
4	Use the OCNS Definitive Ranked Lists of Registered Substances to determine the risk banding.	Search the OCNS Definitive Ranked Lists of Registered Substances for the product name or equivalent branding. Always use the latest version.	Is the HQ Band "Gold" or "Silver," or OCNS Group "E" or "D"? If yes go to **Step 5**. Where the chemical is not listed go to **Step 6.**
5	Determine whether the chemical has a substitution or product warning.	OCNS Definitive Ranked Lists of Registered Substances or obtain from the current CEFAS template. Always use the latest version.	Where the chemical does not have a product or substitution warning no further action is required and chemical is approved. Where the chemical has a product or substitution warning go to **Step 7.**
6	Assess the Ecotoxicity.	LC50 or EC50 concentrations for representative species; Octanol-water partition coefficient (Log Pow); and Biodegradation information (% biodegradation in 28 days).	Requires a Hazard Assessment and ALARP justification where: • Toxicity = LC50 <100 mg/L or • EC50 <100mg/L • Bioaccumulate = Log Pow >3 • Biodegradability <20%

Step	Evaluation	Input	Outcomes
7	Consider an alternative or complete ALARP justification.	Technical justification required to proceed with selected chemical.	Where there is no technical justification for the chemical it is not accepted for use Where there is a technical justification the A Technical note on the Chemical Selection ALARP Justification must be prepared by the Environment Advisor and approved by the Project Manager.

9.8 Invasive Marine Species Risk Assessment

Cooper Energy's Invasive Marine Species Protocol (CMS-EN-PCD-0006) was developed to integrate Australian IMS prevention efforts into Cooper Energy's offshore operations. The procedure details the actions to be undertaken during the contracting phase for a vessel, MOU and submersible equipment (e.g. ROVs) for a project within a Cooper Energy Operational Area (as defined under the EP for the activity). The procedure incorporates key considerations from IMO (2011) and Australian Government (2009) biofouling guidelines; the inputs, decision points and general flow of the of IMS risk management actions are shown in Figure 9-4.

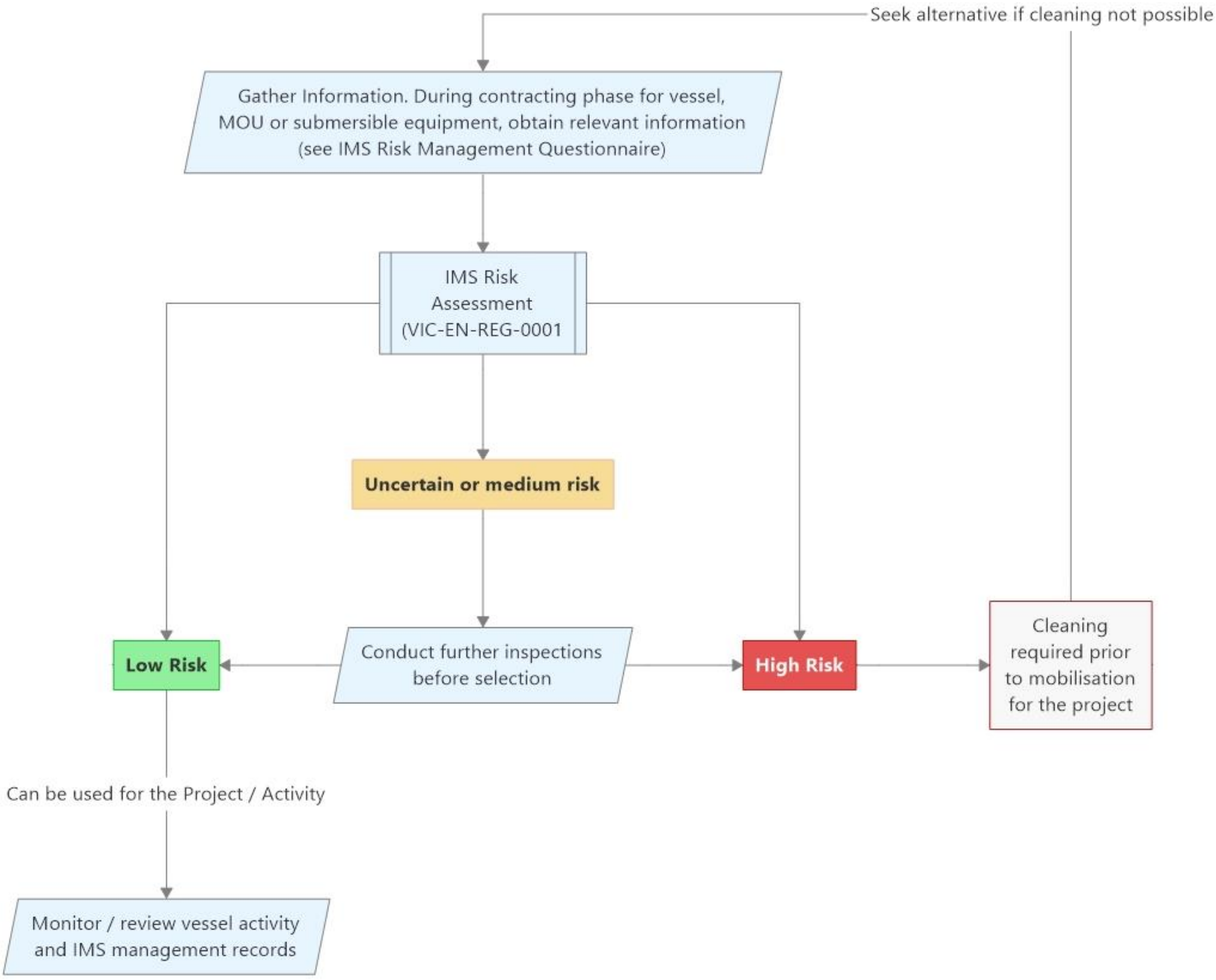


Figure 9-4: Cooper Energy IMS Risk Management Flow

9.9 Marine Mammal Adaptive Management Measures

Figure 9-5 outlines the adaptive measures adopted to manage the impacts and risks of subsea noise from vessels and MOU during the P&A program.

Activity | **Control Measure**

IMR (DP ROV Vessel)
Start: 2Q 2023

P&A reliance on IMR pre-work

P&A (DP MOU)
Start: 3Q 2023

Inside PBW possible BIA and foraging period

Monitoring
Dedicated MMO supported by trained crew (during breaks).

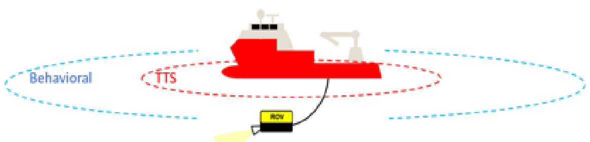
Prestart observation
MMO 30-minute pre-start watch before commencing DP. Commence if no BW seen in observation zone (A.3.1, DEWHA 2008).

Observation Zone
Inclusive of TTS contour and behavioral contour.

DP Shutdown***
DP Shutdown if foraging BW observed inside Observation Zone. Assume whale is foraging unless advised otherwise by MMO.

Nighttime Ops
No nighttime DP ops if ≥3 whale instigated shutdowns during preceding 24h period (A.3.6, DEWHA 2008).

Risk Review
Undertake if 3 consecutive days of whale instigated shut-downs. Consider:
- Aerial survey
- Increased duration pre-start observation
- Increased no nighttime ops trigger



TTS and behavioral contours are described in Section 6 of the EP

Initial pre-activity survey**
undertaken by appropriate means to cover both TTS and behavioral disturbance contour before DP start.

Process notes

*Limits of detection are expected to be 3-7km for a vessel-based MMO depending on height of observation platform (DEWHA 2008, Beach Energy 2021).

**for the initial pre-activity survey, where visibility precludes observations out to the behavioral contour the project will undertake:
- an aerial survey with coverage of the area inside the behavioral contour. The survey will occur within the 24 hours preceding DP commencement, or
- extended prestart observation from the vessel for a duration of at least 2 hours prior to DP commencement (A.3.6, DEWHA 2008).

***ROV Vessel DP shutdown can be achieved inside 1 hour.

Avoidance
Avoid PBW possible foraging period (April-June).

Monitoring
Routine monitoring and reporting by trained crew.

Risk review
If ≥ 3 whales are observed from the MOU for 3 consecutive days – review risk assessment and management measures to ensure performance outcomes are achieved.

Training levels

Trained Crew
This will include bridge watch crews and helicopter crews. Observations reported daily when in field and in transit. Crew will be inducted in whale ID, binocular use, range finding, reporting.

Dedicated MMO
A trained Marine Mammal Observer with prior experience in observing and identifying whales in field environment, whale behaviour, recording, reporting, project induction. The MMO has discretion over species and behaviour observed.

References

DEWHA 2008 EPBC Policy 2.1 Interaction between offshore seismic exploration and whales.
Beach Energy 2021. Geograph Subsea Installation & Commissioning EP (accepted November 2021).

Figure 9-5: Marine Mammal Adaptive Management Measures

9.10 Management of Change

MS08 Technical Management and Management of Change General Protocol (CMS-TS-PRO-0002) describes the requirements for dealing with change management.

The objective of the MoC process is to ensure that changes do not increase the risk of harm to people, assets or the environment. This includes:

- Deviation from established corporate processes;
- Changes to offshore operations and/or status of infrastructure;
- Deviation from specified safe working practice or work instructions/procedures;
- Implementation of new systems; and
- Significant change of HSEC-critical personnel.

Environmentally relevant changes include:

- New activities, assets, equipment, processes or procedures proposed to be undertaken or implemented that have the potential to impact on the environment and have not been:
  - Assessed for environmental impact previously, in accordance with the relevant standard; and
  - Authorised in the existing management plans, procedures, work instructions or maintenance plans.
- Proposed changes to activities, assets, equipment (including change of well or infrastructure status that may be undertaken under another EP), processes or procedures that have the potential to impact on the environment or interface with the environmental receptor;
- Changes to the existing environment including (but not limited to) fisheries, tourism and other commercial and recreational uses, and any changes to protective matter requirements;
- Changes to the requirements of an existing external approval (e.g. changes to conditions of environmental licences);
- New information or changes in information from research, stakeholders, legal and other requirements, and any other sources used to inform the EP; and
- Changes or updates identified from incident investigations, emergency response activities or emergency response exercises.

For any MoC with identified environmental impacts or risks, an impact/risk assessment will be undertaken to ensure that impacts and risks from the change can be managed to meet the nominated EPOs set out in the accepted EP as well as be ALARP and of an acceptable level.

9.10.1 Changes to Titleholders and Nominated Liaison Person

Section 1.6 details the titleholders, survey nominated liaison person and contact details for both. Any change in these details are required to be notified to NOPSEMA as soon as possible.

9.10.2 Revisions to the EP

In the event that the proposed change introduces a significant new environmental impact or risk, results in a significant increase to an existing risk, or through a cumulative effect of a series of changes there is a significant increase in environmental impact or risk, this EP will be revised for re-submission to NOPSEMA.

Where a change results in the EP being updated, the change/s are to be logged in the EP Change Register (Appendix 3).

In addition, the titleholder is obligated to ensure that all specific activities, tasks or actions required to complete the activity are provided for in the EP. Regulation 17(5) of the OPGGS(E) Regulations require that where there is a significant modification or new stage of the activity (that is, change to the spatial or temporal extent of the activity) a proposed revision of the EP will be submitted to NOPSEMA.

9.11 Incident Reporting and Recording

As per MS10 Incident and Crisis Management, Incident and Crisis Management Protocol (CMS-ER-PRO-0002) and Incident Investigation and Reporting Protocol (CMS-ER-PRO-0001), Cooper Energy has a systematic method of incident reporting and investigation and a process for monitoring close out of preventative actions.

The incident reporting and investigation procedure defines the:

- Method to record, report, investigate and analyse accidents and incidents;
- Legal reporting requirements to the regulators within mandatory reporting timeframes;
- Process for escalating reports to Cooper Energy senior management and the Cooper Energy Board;
- Methodology for determining root cause;
- Responsible persons to undertake investigation; and
- Classification and analysis of incidents.

Notification and reporting requirements for environmental incidents to external agencies are listed in Table 9-7. Notification and reporting requirements for oil spills (Level 2/3) are detailed in the OPEP.

Table 9-7 External Incident Reporting Requirements

<table>
<tr><th>Incident Type</th><th>Description</th><th>Requirement</th><th colspan="2">Timing</th><th>Contact</th></tr>
<tr><td>Recordable Incident</td><td>OPGGS(E) Regulations: An incident arising from the activity that breaches an EPO or EPS in the EP that applies to the activity that is not a reportable incident.</td><td>As a minimum, the written monthly recordable report must include a description of:
• All recordable incidents which occurred during the calendar month;
• All material facts and circumstances concerning the incidents that the operator knows or is able to reasonably find out;
• Corrective actions taken to avoid or mitigate any adverse environmental impacts of the incident; and
• Corrective actions that have been taken, or maybe taken, to prevent a repeat of similar incidents occurring.</td><td colspan="2">Before the 15th day of the following calendar month.</td><td>Written Notification:
NOPSEMA - submissions@nopsema.gov.au
DJPR -reports@ecodev.vic.gov.au</td></tr>
<tr><td rowspan="4">Reportable Incident</td><td rowspan="4">OPGGS(E) Regulations (Cwlth): An incident arising from the activity that has caused, or has the potential to cause, moderate to significant environmental damage.
OPGGS Regulations (Vic): An incident arising from the activity that has caused, or has the potential to cause:
• Moderate to catastrophic environmental consequences; and
• A breach of, or non-compliance with the Victorian OPGGS Act 2010; Victorian OPGGS Regulations 2011 (Chapter 2 – Environment); or EPOs set out in the EP.</td><td rowspan="2">Verbal Notification:
The notification must contain:
• All material fact and circumstances concerning the incident;
• Any action taken to avoid or mitigate the adverse environmental impact of the incident; and
• The corrective action that has been taken or is proposed to be taken to stop control or remedy there portable incident.
This must be followed by a written record of notification ASAP after notification.</td><td>State Waters</td><td>Within 2 hrs of becoming aware of the incident</td><td>Verbal:
DJPR - Phone 0409 858 715
Written Notification:
DJPR - marine.pollution@ecodev.vic.gov.au</td></tr>
<tr><td>Cwlth Waters</td><td>Within 2 hrs of becoming aware of the incident</td><td>Verbal:
NOPSEMA – Phone 1300 674 472
Written Notification:
NOPSEMA - submissions@nopsema.gov.au
NOPTA – reporting @nopta.gov.au</td></tr>
<tr><td rowspan="2">Written Notification:
Verbal notification of a reportable incident to the regulator must be followed by a written report. As a minimum, the written incident report will include:
• The incident and all material facts and circumstances concerning the incident;
• Actions taken to avoid or mitigate any adverse environmental impacts;</td><td>State Waters</td><td>Within 3 days of notification of incident</td><td>DJPR - marine.pollution@ecodev.vic.gov.au</td></tr>
<tr><td>Cwlth Waters</td><td>Within 3 days of notification of incident</td><td>NOPSEMA - submissions@nopsema.gov.au</td></tr>
</table>

Incident Type	Description	Requirement	Timing	Contact
	For Cooper Energy, reportable incidents include, but are not limited to, those that have been identified through the risk assessment process as having an inherent impact consequence of 'moderate', 'major' or 'critical'; or at a minimum, the following incidents: • A level 2/3 spill incident. • IMS Introduction.	• The corrective actions that have been taken, or may be taken, to prevent a recurrence of the incident; and • The action that has been taken or is proposed to be taken to prevent a similar incident occurring in the future.		
		Written reports to be submitted to National Offshore Petroleum Titles Administrator (NOPTA) and DJPR (for incidents in Commonwealth waters).	Within 7 days of written report submission to NOPSEMA	DJPR - marine.pollution@ecodev.vic.gov.au NOPTA – reporting @nopta.gov.au
Reportable incident - in the event an AMP may be exposed to hydrocarbons		Notification must be provided to the Director of National Parks and include: • Titleholder details; • Time and location of the incident (including name of marine park likely to be affected); • Proposed response arrangement; • Confirmation of providing access to relevant monitoring and evaluation reports when available; and • Contact details for the response coordinator.	ASAP	Marine Park Compliance Duty Officer – 0419 293 465
Reportable Incident - Invasive Marine Species		Suspected or confirmed Invasive Marine Species Introduction.	ASAP	DJPR on 136 186 or marine.pests@ecodev.vic.gov.au.
Reportable Incident - Injury or Death to Fauna		Incidents of injury or death to native fauna including whales and dolphins. https://www.wildlife.vic.gov.au/wildlife-emergencies/whale-and-dolphin-emergencies https://www.zoo.org.au/fighting-extinction/marine-response-unit/	ASAP	DELWP Whale & Dolphin Emergency Hotline - 1300 136 017. Seals, Penguins or Marine Turtles Zoo Victoria Marine Response Unit – 1300 245 678.
		Impacts to MNES, specifically injury to or death of EPBC Act-listed species.	Within 7 days	DAWE Phone: +61 2 6274 1111

Incident Type	Description	Requirement	Timing	Contact
		https://www.environment.gov.au/biodiversity/threatened/listed-species-and-ecological-communities-notification		Email: EPBC.Permits@environment.gov.au
		Vessel strike with cetacean.	Within 72 hours of incident.	DAWE – National Ship Strike Database https://data.marinemammals.gov.au/report/shipstrike

9.12 Environmental Performance Monitoring and Reporting

This section details the specific measures Cooper Energy will implement to ensure that, for the duration of the activity:

- the environmental impacts and risks of the activity continue to be identified and reduced to a level that is ALARP;
- control measures detailed in the EP are effective in reducing the environmental impacts and risks of the activity to ALARP and an acceptable level; and
- environmental performance outcomes and standards set out in the EP are being met.

9.12.1 Emissions and Discharges

Emissions and discharge monitoring and records required for operations and vessel-based activities are detailed in Table 9-8. Copies of emission and discharge records will be retained in accordance with the MS06 Information and Systems Management.

Table 9-8 Discharge and Emission Monitoring

Aspect	Monitoring	Frequency	Reporting
Operations			
Routine release of hydraulic fluid	• Chemical Type • Volume	Daily	Distributed Control System
Offshore Activity			
Treated bilge	• Volume • Location • Vessel Speed	As required	Oil Record Book
Food scraps	• Volume • Location	As required	Garbage Record Book
Fuel use	• Volume	Daily	Daily Report
Ballast water discharge	• Volume • Location	As required	Ballast Water Record System.
Chemical discharges to marine environment	• Chemical name • Chemical type • Chemical use • Chemical volume	Weekly	Daily Report
Drill Fluids Discharge	• Fluid type • Fluid volume • % oil on cuttings	As required	Daily Report
Cementing discharges	• Nature of discharge • Volume • Location	As required	Daily Report
Waste	• Volume sent ashore	As required	Garbage Record Book
Spill	• Volume • Chemical / Oil type	As required	Daily Report Incident Report
Accidental release or losses overboard	• Nature of the discharge material • Volume / Amount	As required	Daily Report Incident Report

9.12.2 Activity Commencement and Cessation Notifications

Activity notification requirements are detailed in Section 10.5.

9.12.3 Reporting Environmental Performance

Annual Reporting will comprise annual progress report on decommissioning program progress, and annual environment performance report of compliance with EP performance outcomes and standards.

9.12.3.1 Annual Progress Report (Direction 824)

In accordance with Direction 6 of General Direction 824, Cooper Energy will:

a) Submit to NOPSMEA on an annual basis, until all directions have been met, a progress report detailing planning towards and progress with undertaking the actions required by direction 1, 2, 3, 4 and 5.

b) The report submitted under Direction 6(a) must be to the satisfaction of NOPSEMA and submitted to NOPSEMA no later than 31 December each year.

c) Publish the report on the registered holder's website within 14 days of obtaining NOPSEMA satisfaction under Direction 6(b).

9.12.3.2 Activity Environmental Performance Report

As required by Regulation 26C of the OPGGS(E) Regulations (Cwlth), Cooper Energy will submit an EP performance report to NOPSEMA for the activities provided for under this EP. This report will provide sufficient detail to enable the Regulator to determine whether the environmental performance outcomes and standards in the EP have been met in relation to the decommissioning.

The report will be submitted to NOPSEMA no later than 31 December each year.

The report will include activities undertaken during the reporting period 01 January – 31 December.

9.12.4 Cetacean Reporting

Cetacean observation data will be submitted to DAWE via the National Marine Mammal Data Portal.

https://data.marinemammals.gov.au/report/sighting

Data will be reported within 3 months of the completion of an offshore activity.

9.12.5 Audit and Inspections

Environmental performance of offshore operations and activities will be audited and reviewed in several ways in to ensure that:

- Environmental performance standards to achieve the EPOs are being implemented and reviewed;
- Potential non-compliances and opportunities for continuous improvement are identified; and
- Environmental monitoring requirements are being met.

Non-compliance with the environmental performance standards outlined in this EP will be managed as per Section 8.

Opportunities for improvement or non-compliances noted will be communicated to relevant personnel at the time of the inspection or audit to ensure adequate time to implement corrective actions. The findings and recommendations of inspections or audits will be documented and distributed to relevant personnel for comment, and any actions tracked until completion.

9.12.5.1 EP Compliance

The following assurance arrangements will be undertaken:

- Pre-start readiness review to ensure the implementation of EP controls is provided for.
- Audit of the performance outcomes and performance standards contained in the EP and the requirements detailed in the implementation strategy. This audit will be used to inform the EP performance report submitted to NOPSEMA.
- Pre-activity review the Victoria OPEP to ensure the arrangements are up to date and can be met.
- Testing of spill response and source control arrangements in accordance with the OPEP and SCERP.

9.12.5.2 Offshore Activities

The following arrangements review the environmental performance of offshore vessel activities:

- A premobilisation inspection will be undertaken for offshore vessels and MOUs to ensure they will meet the requirements of the EP; and
- HSEC inspections will be undertaken throughout the offshore activity on a weekly basis to ensure ongoing compliance with relevant EP requirements. The scope of the inspections will include (but is not limited to):
  - Spill readiness (i.e. provision spill kits and drills in accordance with vessel SOPEP/SMPEP);
  - Waste management in accordance with EP EPO and EPSs;
  - Chemical Inventory checks to ensure campaign chemicals are accepted via the Cooper Energy Offshore Chemical Assessment Procedure;
  - Maintenance checks for equipment identified within an EP EPS (e.g. OWS).

Non-compliance and improvement opportunities will be managed as per Section 9.12.6.

9.12.6 Management of Non-conformance

In response to any EP and environmental audits and inspections non-compliances, corrective actions will be implemented and tracked to completion as per MS10 Incident and Crisis Management, Incident and Crisis Management Protocol (CMS-ER-PRO-0002) and Incident Investigation and Reporting Protocol (CMS-ER-PRO-0001).

Corrective actions will specify the remedial action required to fix the breach and prevent its reoccurrence and is delegated to the person deemed most appropriate to fulfil the action. The action is closed out only when verified by the appropriate Manager and signed off. This process is maintained through the Cooper Energy corrective action tracking system.

Where more immediacy is required, non-compliances will be communicated to relevant personnel and responded to as soon as possible. Where relevant the results of these actions will be communicated to the offshore crew during daily toolbox meetings or at daily or weekly HSEC meetings.

Cooper Energy will carry forward any non-compliance items for consideration in future operations to assist with continuous improvement in environmental management controls and performance outcomes.

9.13 Records Management

In accordance with the Regulation 27 of the OPGGS(E) Regulations, Cooper Energy will store and maintain documents or records relevant to the EP in accordance with the Document and Records Management Procedure (CMS-IM-PCD-0002).

10 Stakeholder Consultation

The OPGGS(E) Regulations (Cwlth) require that titleholders (and those with access authority):

must give each relevant person sufficient information to allow the relevant person to make an informed assessment of the possible consequences of the activity on the functions, interests or activities of the relevant person.

To meet these requirements, Cooper Energy has and will continue to undertake stakeholder consultation with persons and organisations that operate or have an interest in the area where the BMG offshore decommissioning activities are undertaken. This is done as part of the consultation cycle (Figure 10-1).

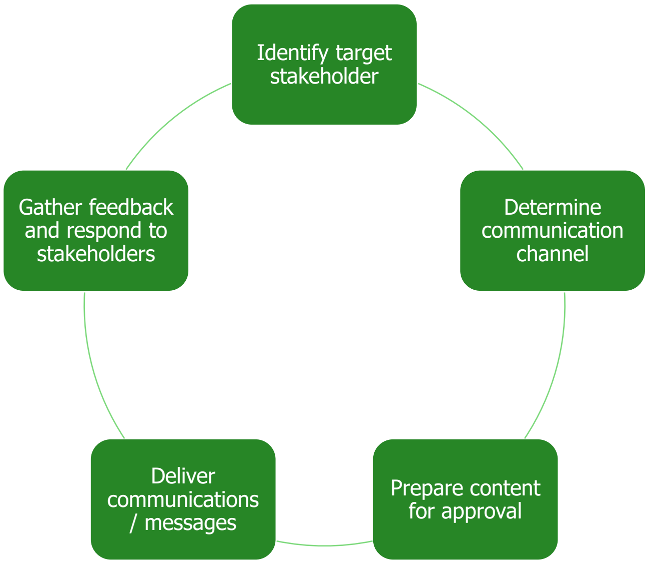


Figure 10-1: Consultation Cycle

Key learnings and consultation from previous Cooper Energy campaigns and ongoing activities offshore Victoria have been considered for the current campaign, where relevant.

Project stakeholder engagement objectives align with the consultation cycle, and include:

- Confirm relevant stakeholders for the activity;
- Prepare simple and targeted engagement materials;
- Initiate and maintain open communications between stakeholders and Cooper Energy relevant to their interests;
- Proactively work with stakeholders on recommended strategies to minimise negative impacts and maximise positive impacts of all activities; and
- Provide for ongoing consultation that reflects the requirements of stakeholders and the activity schedule.

Cooper Energy has maintained records of consultation and tracks commitments made through to closure.

10.1 Scoping – Identification of Relevant Stakeholders

Determining the relevant stakeholders for the BMG Closure project involved the following:

- Reviewing the receptors identified in the existing environment section, persons or groups linked to those receptors, and their functions interests and activities;
- Reviewing existing stakeholders identified as relevant and contained within the Cooper Energy stakeholder register (offshore Gippsland);
- Reviewing previous BMG and Gippsland asset campaign consultation records, including BMG development, cessation and non-production phases;
- Conversing with existing stakeholders to identify potential new stakeholders or changes to stakeholder contacts or consultation preferences;
- Reviewing Commonwealth and State fisheries jurisdictions and fishing effort in the region; and

- Reviewing and acting upon NOPSEMA guideline A705589 (03/07/2020) *'Consultation with Commonwealth agencies with responsibilities in the marine area'*.

Cooper Energy has undertaken consultation activities in the Gippsland region and specifically in relation to BMG since the facilities were acquired from the previous operators in 2014. The previous operators consultation records go back to the early development phases pre-2005.

Cooper Energy has consulted with stakeholders in the region and established a good working relationship with them. Consequently, Cooper Energy believe they have effectively identified relevant stakeholders and have a good understanding of issues and areas of interest.

During the scoping activity, it was identified that some stakeholders previously engaged are no longer relevant or no longer exist and they have been removed from the stakeholder register. It is also recognised that additional stakeholders may be identified through the life of the closure project; consultation with these additional stakeholders will be integrated into the project consultation cycle.

Stakeholders identified and contacted for this activity listed in Table 10-1. These stakeholders include relevant persons under the OPGGS(E) Regulations (Cwlth) Regulation 11A, where a 'relevant person' is:

A person or organisation whose functions, interests or activities may be affected by the petroleum activity

Stakeholders that may only be relevant in the event of an oil spill and these stakeholders are identified in Cooper Energy's Emergency Contacts register.

Cooper Energy also engages and collaborates with other parties including operators and research organisations; these parties are not considered 'relevant persons'.

Table 10-1 Relevant Stakeholders for the BMG Closure Project

Stakeholder	Functions, Interests, Activities	Activity relevance	Reason for inclusion
Department or agency of the Commonwealth to which the activities to be carried out under the EP may be relevant			
Australian Antarctic Division (AAD)	Marine Mammal research, protection and conservation	Australian Antarctic Division. Administrators of Australian marine mammal sightings database. Experience and specialism in marine mammal monitoring and risk mitigations.	Consultation in relation to marine mammal sightings, risk management and reporting.
Australian Border Force	National maritime security	Responsible for coordinating and advising on maritime security. Communicates with industry to advise of maritime actions that may impact on their businesses and advising of appropriate preventive security measures. Australian Border Control have a role in the enforcement of Petroleum Safety Zones. A PSZ is currently established at BMG whilst there are risks to infrastructure from other sea users.	Decommissioning options not relevant to functions or interests however changes to PSZ following decommissioning and relevance to maintaining maritime security.
Australian Fisheries Management Authority (AFMA)	Commonwealth fisheries	Activity is within a Commonwealth fishery area or will impact or potentially impact a Commonwealth fishery area or resource. Via previous consultation has recommended that engagement with CFA as the peak fishing industry body for commonwealth and that ABARES reports should be reviewed for fishery status. CFA is included in this table as a relevant stakeholder; the latest ABARES report and study by SETFIA (2021) was used to determine which Commonwealth fisheries have fishing effort within the activity area.	There has been no fishing by licence holders in Commonwealth managed fisheries in the Operational Areas since operation commenced. However future changes in PSZ, decommissioning end states and support vessel movements may be of interest.
Australian Hydrological Service (AHS)	Maritime safety	Interest in identification and charting of potential seabed features and hazard warnings to mariners. Via previous consultation have request to provide information at least three weeks prior to commencement of any oil and gas activity to allow for publication of notices to mariners.	Changes in rezoning PSZ associated with decommissioning. Interested in safe navigation of commercial shipping in Australian waters during activity and in relation to decommissioning end states.
Australian Maritime Safety Authority (AMSA)	Marine Vessel Safety	Activity focused consultation regarding shipping, emergency response preparedness and offshore activity levels.	Changes in rezoning PSZ associated with decommissioning. Interested in safe navigation of commercial shipping in Australian waters during activity and in relation to decommissioning end states.
Department of Agriculture, Water and Environment (DAWE) - Biosecurity	Biosecurity	Responsible for managing biosecurity of incoming goods and conveyances (including biosecurity) in Australia. Responsible for implementation of marine pest and biosecurity within Australian Waters (12nm), including conveyances into Australian Waters. The BMG closure project will involve activities beyond 12nm, provisioned by conveyances within 12nm. The department also provides national leadership in management of established marine pests, and in responding to incursions of exotic marine pests, and is responsible for implementing ballast water requirements under the Biosecurity Act.	Potential for biosecurity risk associated with conveyances between Australia and offshore petroleum activities.

Stakeholder	Functions, Interests, Activities	Activity relevance	Reason for inclusion
Department of Agriculture, Water and Environment (DAWE) - Fisheries	Fisheries	Activity is within a Commonwealth fishery area or will impact or potentially impact a Commonwealth fishery area or resource.	Consultation in relation to potential impacts to other marine users, including commonwealth fisheries.
DAWE - Heritage	Underwater Heritage	Administration of the Underwater Cultural Heritage Act, applicable to any wrecks identified within VIC/RL13.	Any actions involving contact with the seabed, or activities in close proximity to the seabed, have the potential to impact underwater heritage.
DAWE – Sea Dumping Section	Administration of the Sea Dumping Act.	NOPSEMA guidance N-06800-GL1887 identifies DAWE as a relevant Department or Agency with respect to Sea Dumping. Further to guidelines released in Q4 2019 (Revised specific guidelines for assessment of platforms or other man-made structures at sea, London Convention Annex 8), DAWE will now review facility decommissioning scenario's on a case by case basis (pers comm. DAWE Sea dumping section).	May be relevant if any equipment is planned to remain on the seabed, or materials are planned to be disposed of offshore (e.g. downhole) to be addressed within the BMG Closure Project (Phase 1 and 2) EPs and supporting sea dumping permits (if required).
Department of Foreign Affairs and Trade (DFAT)	Australia's shared maritime boundaries	DFAT has no direct role in the management of the Commonwealth marine area but has an interest in ensuring that consultation with foreign entities, both private and government, is effective and is aligned with Australia's interests.	The BMG worst case spill scenario extends beyond the Australian EEZ and may therefore have the potential to trigger DFAT involvement.
Department of Industry, Science, Energy and Resources (DIISER)	Commonwealth resource management and innovation	The Department's primary function is to support economic growth and job creation for all Australians. Provides public consultation hub for Australian policy and legislative frameworks.	Involved in recent review of Australia's decom policy and legislative frameworks to ensure they remain fit for purpose now and into the future. i.e. Offshore petroleum decommissioning guideline 2018 and Discussion Paper.
Department of Defence (DoD)	National security	Relevant where the proposed activity may impact DoD operational requirements, where the proposed activity encroaches on known training areas and/or restricted airspace and where there is a risk of UXO in the area where the activity is taking place.	Not directly relevant to activities within VIC/RL13. Consult in relation airspace restrictions pending definition of offshore crew transfer plans.
Director of National Parks (DoNP)	Managing Commonwealth reserves and conservation zones.	The DoNP is a relevant person for consultation for this project in relation to potential incidents in commonwealth waters which could impact on the values of a Commonwealth marine park.	Operational Area does not overlap marine parks however potential for unplanned WCD (LOWC) scenario spill EMBA to overlap and impact the values within a Commonwealth marine park. Consult in relation to spill response planning as relevant.

Stakeholder	Functions, Interests, Activities	Activity relevance	Reason for inclusion
Each Department or agency of a State or the Northern Territory to which the activities to be carried out under the EP may be relevant			
DJPR – Victorian Fishery Authority	Changes in fishery access and/or habitat	Activity is within a Victorian fishery area or will impact or potentially impact a Victorian fishery area or resource.	Activity Operational Area overlaps with Victorian fishery areas.
Department of Jobs Precincts and Regions (DJPR) – Biosecurity	Victorian biosecurity	DJPR Biosecurity and Agricultural Services manage advices on biosecurity within Victoria including vessels in state waters/calling into ports. The DJPR BAS has provided advice during the development of Cooper Energy IMS risk management processes and BMG closure project IMS risks.	Vessels traversing between offshore installations and mainland, along with potential interest in disposal of subsea infrastructure (biofouled). Consult on biosecurity concerns and specific requirements or guidance in relation moving structures with biofouling across state waters.
Department of Jobs Precincts and Regions (DJPR) – Earth Resources Regulation	Regulator of exploration, mining, quarrying, petroleum, recreational prospecting and other earth resource activities in Victoria.	In the event of a marine pollution incident, activities associated with spill response will be required to enter Victorian waters.	EMBA overlaps with Victoria waters
Department of Transport (DoT) – Victoria	Marine pollution response in Victoria	Responsible for marine pollution response arrangements in Victorian jurisdiction. DoT coordinate advice with other state agencies involved in marine pollution response including DELWP and Port Authorities.	EMBA and Support vessel routes overlaps with Victoria waters as such OPEP sets out arrangements with DoT.
Department of Environment, Land, Water and Planning (DELWP)	Wildlife and habitat protection/conservation	Responsible for State marine protected areas within Victorian jurisdiction, and oiled wildlife response.	Wildlife response control agency in the event of an oil spill. Input into OPEP wildlife response plan were there is shoreline contact in Victoria or impact on Victorian coastal waters.
Transport NSW	Marine pollution response in NSW	Responsible for marine pollution response arrangements in NSW jurisdiction. Transport NSW coordinate advice with other state agencies involved in marine pollution response including NSW EPA and Port Authorities.	Where EMBA enters NSW waters or contact land involved in response and management of pollution incidents involving hazardous materials (in collaboration with other government agencies)
Department of Primary Industries, Parks, Water and Environment (DPIPWE) –	Marine pollution response in Tasmania	Responsible for preparedness and responding to oil and chemical spills in Tasmanian waters. Spill Response 'Control Agency' for any spill that enters (or threatens to enter Tasmanian coastal waters). Tasmania EPA coordinate advice with other state agencies involved in marine pollution response including DPIPWE Fisheries branch and wildlife and conservation branch.	Petroleum activity not occurring in Tasmanian Waters. Oil spill EMBA overlap with Tasmanian coastal waters.

Stakeholder	Functions, Interests, Activities	Activity relevance	Reason for inclusion
Environment Protection Authority (EPA) Tasmania			
Maritime Safety Queensland	Marine pollution response in Tasmania	Maritime Safety Queensland is a Queensland government agency of the Department of Transport and Main Roads. The agency is responsible for the safety of all water vessels in Queensland waterways. It deals with marine pollution and provides pilotage for Queensland ports. Maritime Safety Queensland works in conjunction with the Department of Environment and Science and local government authorities to protect the marine environment and prosecute offenders	If EMBA enters QLD waters or contacts land.
NSW Department of Planning, Industry and Environment	Regulator - NSW	In the event of a marine pollution incident, activities associated with spill response may be required to enter NSW waters.	EMBA overlaps with NSW waters
Parks Victoria	Wildlife and habitat protection/conservation in Victoria	Manages Victoria's marine national parks.	EMBA overlaps with Victoria waters
Tasmania Parks and Wildlife Service	Marine pollution in Tasmania	In the event of a marine pollution incident, activities associated with spill response may be required to enter Tasmanian waters.	EMBA overlaps with Tasmanian waters
A person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the EP.			
Commonwealth Fisheries			
Abalone Council Australia	Changes in fishery access and/or habitat	Peak industry body representing the wild-harvest abalone Industry from Tasmania, Victoria, South Australia, Western Australia and New South Wales. However fishing occurs in water depths <30m.	Activity is within the Victorian Eastern Abalone Zone. Based on water depths for fishing and habitat it is unlikely overlap between this aspect of the project and stakeholder functions, interests, and activities.
Commonwealth Fisheries Association (CFA)	Changes in fishery access and/or habitat	Peak industry body representing the interests of fishers operating in Commonwealth managed fisheries. AFMA recommended that engagement with CFA be undertaken as the peak fishing industry body for Commonwealth fisheries.	Petroleum Activity and support route overlaps with Commonwealth fisheries areas and may restrict access. Future changes in PSZ of interests to fishers.
South East Fishing Trawl Industry	Changes in fishery access and/or habitat	Peak industry body representing the interests of fishers operating in the Cwth Trawl Sector. BMG closure project activities overlap with fisheries which SETFIA	Records indicate LEFCOL (represented by SIV) and SETFIA have historically represented the majority of fishing vessels impacted by the BMG development since its commencement.

Stakeholder	Functions, Interests, Activities	Activity relevance	Reason for inclusion
Association (SETFIA)**		represent (Southern Shark Industry Alliance, Eastern Rock Lobster and Small Pelagic Fishery Industry Association). SETFIA engagement covers following fisheries; Eastern Victorian Rock Lobster Industry Association and SSIA	Cooper Energy has ongoing engagement with SETFIA across all operations offshore Victoria.
Southern Rock Lobster (SRL)	Changes in fishery access and/or habitat	National peak body working to further the interests of the Australian Southern Rock Lobster Industry. Note Southern Rock Lobsters have extensive larval dispersal and can be found to depths of 150 metres, with most of the catch coming from inshore waters less than 100 metres deep. Small quantities of Eastern Rock Lobster are taken off eastern Victoria, particularly near the border of New South Wales and Victoria (VFA 2018). The fishing grounds for southern rock lobster extend through State and Commonwealth waters, however based on known rock lobster habitat and depths it is unlikely that rock lobster fishing occurs at BMG.	Activity is within the eastern zone of the Rock Lobster Fisher. No impact stakeholder functions, interests, and activities planned given depth.
Southern Shark Industry Alliance (SSIA)**	Changes in fishery access and/or habitat	Industry body representing interests of its Commonwealth-licenced shark gillnet and shark hook members in the Gillnet Hook and Trap Fishery. Activity is within the Southern and Eastern Scalefish and Shark Fishery management area where there is no fishing effort.	Within fishery area and given fisheries interest in area access. However no overlap between this aspect of the project and stakeholder functions, interests, and activities expected given no recent fishing effort. *Noting engagement is via SETFIA.
Southern Squid Jig Fishery	Changes in fishery access and/or habitat	Individual skippers managed by AFMA South East Management Advisory Committee. Activity is within the Southern Squid jig fishery management area, though the fishery is transient and operate at water depths between 60m and 120m. It is therefore unlikely the fishery operates in in the BMG area.	Within fishery area and given fisheries interest in area access. However no overlap between this aspect of the project and stakeholder functions, interests, and activities expected given depth.
Sustainable Shark Fishing Inc. (SSF)**	Changes in fishery access and/or habitat	Activity is within the Southern and Eastern Scalefish and Shark Fishery management area where there is no fishing effort.	Within fishery area and given fisheries interest in area access. However no overlap between this aspect of the project and stakeholder functions, interests, and activities expected.
Tuna Australia **Australian Southern Bluefin Tuna Industry Association (Port Lincoln)**	Changes in fishery access and/or habitat	Peak body representing statutory fishing right owners, holders, fish processors and sellers, and associate members of the Eastern and Western tuna and billfish fisheries of Australia.	Operational Area overlaps ETBF and SBTF area. No active fishing identified at in vicinity of BMG.
State Fisheries			

Stakeholder	Functions, Interests, Activities	Activity relevance	Reason for inclusion
Abalone Victoria Central Zone (AVCZ)	Changes in fishery access and/or habitat	Represents the views and interests of its members and to ensure appropriate governance of member resources. However fishing occurs in water depths <30m.	Activity is within the Victorian Eastern Abalone Zone and not the Central Zone represented by Abalone Victoria. No overlap between this aspect of the project and stakeholder functions, interests, and activities. Note indirectly engaged via representative body (SIV)
Eastern Victoria Sea Urchin Divers Association	Changes in fishery access and/or habitat	Industry body representing views and interests of its members. Activity is within the eastern zone of the Sea Urchin Fishery. Based on water depths (typically <10m) and habitat (DEPI 2014) it is unlikely that sea urchin fishing occurs at BMG.	Activity overlap fishery. However given depth no active fishing overlap between this aspect of the project and stakeholder functions, interests, and activities expected. Note indirectly engaged via representative body (SIV)
Eastern Victorian Rock Lobster Industry Association	Changes in fishery access and/or habitat	Industry body representing views and interests of its members. Note Southern Rock Lobsters have extensive larval dispersal and can be found to depths of 150 metres, with most of the catch coming from inshore waters less than 100 metres deep. Small quantities of Eastern Rock Lobster are taken off eastern Victoria, particularly near the border of New South Wales and Victoria (VFA 2018). The fishing grounds for southern rock lobster extend through State and Commonwealth waters, however based on known rock lobster habitat and depths it is unlikely that rock lobster fishing occurs at BMG.	Activity overlap fishery. However given depth no active fishing overlap between this aspect of the project and stakeholder functions, interests, and activities expected. Note indirectly engaged via representative body (SETFIA)
Eastern Zone Abalone Industry Association	Changes in fishery access and/or habitat	Industry body representing views and interests of its members. Activity is within the Victorian Eastern Abalone Zone. Based on water depths for the fishery (typically <30m) and habitat (DEDJTR 2015) it is unlikely that abalone fishing occurs in the Operational Area. Stakeholder has been sent information regarding Sole and BMG activities during 2017 and 2018 with no response.	Activity overlap fishery. However given depth no active fishing overlap between this aspect of the project and stakeholder functions, interests, and activities expected. Note indirectly engaged via representative body (SIV)
Lakes Entrance Fishermen's Society Cooperative Limited (LEFCOL)	Changes in fishery access and/or habitat	Industry body and fishing services provider. Represents views and interests of its members. Activity overlaps with State fisheries who may be members of the cooperative.	Activity overlap fishery. *Note indirectly engaged via representative body (SIV). 2017/18 consultation concerns around noise and fishing area access, as such likely to be interested in PSZ changes. Records indicate LEFCOL and SETFIA represent the majority of fishing vessels impacted by the BMG development. May have concerns in relation to decommissioning in situ. Previously influenced trenching and PSZ reductions at BMG.
Port Franklin Fishermen's Association	Changes in fishery access and/or habitat	Industry body representing views and interests of its members. Activity overlaps with State fisheries who may be members of the association. Port Franklin is in South Gippsland.	Activity overlaps with State fisheries who may be members of the association. Note indirectly engaged via representative body (SIV).
San Remo Fishing Cooperative	Changes in fishery access and/or habitat	Industry body representing views and interests of its members. Activity overlaps with State fisheries who may be members of the association.	May be overlap between BMG field and stakeholder interests and activities. Note indirectly engaged via representative body (SIV).

Stakeholder	Functions, Interests, Activities	Activity relevance	Reason for inclusion
Seafood Industry Victoria (SIV)	Changes in fishery access and/or habitat	Peak industry body representing the interests of fishers operating in State (Vic) managed fisheries. SIV primary contact for State fishers. Multiple constructive engagements over the years with SIV to discuss Cooper Energy's activities and ongoing engagement. SIV has expressed interest in overlapping activities with its members and reducing the size of PSZs. SIV engagement covers following fisheries; VRLA, AVCZ, Eastern Victoria Sea Urchin Divers Association, Eastern Zone Abalone Industry Association, LEFCOL, Port Franklin Fishermen's Association, San Remo Fishing Cooperative	Activity overlaps with a number of State fisheries. Changes in PSZ and fishing access of interest. Records indicate LEFCOL (represented by SIV) and SETFIA represent the majority of fishing vessels impacted by the BMG development.
Victorian Recreational Fishers Association (VRFish)	Changes in fishery access and/or habitat	Peak body representing recreational fishing interests in Victorian waters.	Activity is within an area where there may be only low levels of recreational fishing given the distance to shore. Support vessel activities may overlap within an area where they maybe low levels of recreational fishing as not features other than pipeline.
Victorian Rock Lobster Association (VRLA)	Changes in fishery access and/or habitat	Activity is within the eastern zone of the Rock Lobster Fishery. Support activities (vessel transits) may overlap.	Activity overlap fishery, however Based on habitat it is unlikely that rock lobster fishing occurs in the Operational Area. Note requested that consultation be undertaken via SIV as such indirectly engaged via SIV
Victorian Scallop Fisherman's Association	Changes in fishery access and/or habitat	Representative body of Victorian Scallop Fisherman. Most of our members are based in Lakes Entrance, in East Gippsland, Victoria. Activity is within the Bass Strait Scallop Fishery. BMG area does not intersect active scallop fishing grounds; commercial scallops are mainly found at depths of 2-20 m, occurring at depths of up to 120 m (Victorian Scallop Fisherman's Association, 2020). Support activities (vessel transits) may overlap.	Activity is within the Bass Strait Scallop Fishery. Via previous consultation are mainly concerned regarding seismic surveys and do not fish in water depths relevant to the BMG project.

***Actively fish within the vicinity of BMG. Although multiple fisheries can legally fish in the area, only a few actually do due to the unsuitability of the area (depth / habitat) and/or the relative lack of target species (Boag and Koopman 2021).*

10.2 Provision of Sufficient Information

The Regulations require titleholders to make sufficient information available to relevant stakeholders.

Cooper Energy integrates consultation into its planning process, ensuring stakeholders are:

- Provided with details and milestones of the Project.
- Advised, where they are or may be directly impacted (e.g. fisheries), of any potential hazards/risks and the mitigation measures to address them and provided the opportunity to raise additional concerns.
- Involved in the closure planning process where their functions, interests or activities may be directly impacted by the project.

Consultation methods and media vary with the project phase and level of engagement required (as informed by the stakeholder). Typical means of engagement are provided in Table 10-2.

Table 10-2 BMG Closure Project consultation approach

Communication method	Description
Meetings	Cooper Energy is committed to meeting with relevant stakeholders for the Project in order to enable transparent and direct feedback on the proposed Project. This will include: + Regulator briefings on a semi-regular basis + Meetings with individual stakeholders and / or community information sessions Face-to-face meetings (where possible given COVID-19 otherwise video conference or phone calls) will be conducted with relevant stakeholders. The purpose of briefings is to provide project updates, reinforce key messages, clarify any misconceptions, and build stronger stakeholder relationships.
Letters and emails	Letters and emails will be used as an initial consultation tool to introduce the Project to relevant stakeholders and establish appropriate forms of communication that will be used during the Project. Written communications may include formal correspondence, Project updates regarding developments or upcoming activities, and specific responses to issues, concerns or requests.
Information sheets	Information sheets on the Project will be developed to inform relevant stakeholders. Information sheets will be provided during personal meetings, housed on the Cooper Energy webpage and provided in hard copy upon request by any stakeholder. Note that relevant activity information which may change (such as project timing) will be re-communicated to relevant stakeholders as provided for within Table 10-3. Further information, such as detailed maps will be tailored to meet the needs of each stakeholders circumstances and will be provided as part of the consultation process.
Public display of regulatory documentation	Assessment documents (the EP) will be placed on public exhibition within the NOPSEMA website following acceptance. To protect the rights of both parties involved in the consultation process, records of all engagements between Cooper Energy and third parties during the Project development will be maintained by Cooper Energy, subject to Information Privacy requirements.
Cooper Energy Web page	The Cooper Energy website will be used to provide information regarding the Project. The website: + Contains details on Cooper Energy and the Project + Contains any fact sheets or newsletters as they are developed + Contain details of any public displays and information sessions + Allows documents produced for public display to be downloaded + Provides methods for contacting, providing feedback to, or registering complaints with Cooper Energy. https://www.cooperenergy.com.au/
Address, phone and email	Relevant stakeholders may wish to contact the Project team via the details below: Address: Level 8, 70 Franklin Street, Adelaide SA 5000 Phone: (08) 8100 4900 Email: stakeholder@cooperenergy.com.au

10.3 Summary of Stakeholder Consultation

Table 10-4 provides a summary of the stakeholder consultation undertaken as part of revising the EP and were applicable an assessment of any claims or objections.

All stakeholder consultation activities along with any actions required and commitments made, are recorded and tracked via a stakeholder engagement register.

10.4 Assessment of Claims and Feedback

Cooper Energy shall assess the merits of any new claims or objections made by a relevant stakeholder whereby they believe the activity may have adverse impacts upon their interest or activities. Cooper Energy shall finalise the assessment of the merit of any claim or objection within two weeks of receipt of all pertinent information and undertake any resulting actions as soon as practicable.

In determining if a claim or objection has merit, evidence must be presented such as literature, scientific data, historical fishing data etc. In relation to objections or claims from commercial fishers, Cooper Energy will assess the possibility of placing temporal or physical exclusions, or other control measures if evidence demonstrates that by not implementing exclusions or other control measures, there will be a significant detrimental impact to fish populations or catch rates.

Assessment will be undertaken using the methodology outlined in Section 10.5.

If the claim has merit, where appropriate, Cooper Energy shall modify management of the activity. The assessment of merit and any resulting actions shall be shared with the stakeholder.

Cooper Energy shall determine through internal risk assessment, whether a risk or impact is considered 'significant' (i.e. has resulted in an increased residual risk ranking) based on information available at that time (e.g. reviewed scientific information, stakeholder claims or concerns). If the outcome of the assessment suggests that impacts and risks are new or significantly increased, then this will trigger a revision to the EP as described in Section 9.9. Under sub regulation 8(1) it is an offence for a titleholder to continue if a new impact or risk, or significant increase in an impact or risk not provided for in the EP in force is identified.

Notification to stakeholders of significant new or increased risks will be issued prior to submission of the revised EP as part of a new consultation process for the revised EP.

10.5 Ongoing Consultation

Consultation for the BMG development and decommissioning scopes has spanned a number of decades. The activities and management described within this EP are informed by historical and present consultation, and will continue to be shaped by feedback from stakeholders.

Since the commencement of consultation on the BMG decommissioning activities the timing of the offshore scope has shifted. Cooper Energy will continue to provide annual updates to stakeholders with up to date timeframes. More detailed and more frequent updates will be provided to stakeholders as the campaign approaches in accordance with agreed communications with particular stakeholders.

Further consultation for the planning and execution phases is described in Table 10-3. Note, whilst NOPSMA are not considered a ‘relevant stakeholder’, they are included here for completeness.

Table 10-3 BMG Closure Project ongoing engagements

Ongoing Engagements	Timing	Person or Organisation
Annual progress reports to the regulator (Direction 824)	Annual by 31 December	NOPSEMA
Regular project updates with Regulator.	6-monthly, as advised by regulator	NOPSEMA
Provision of operational activity plans and Cooper Energy contact person flyer with updates on timing and activity details.	Annual (typically Q1) until this EP is closed or replaced.	Relevant stakeholders
Risk Reviews (fishery activity).	6-monthly	Fisheries
Meetings, calls, enquiries.	Ongoing. Stakeholder engagement inbox is monitored throughout the planning and execution phases.	Relevant stakeholders

Ongoing Engagements	Timing	Person or Organisation
Regulatory notification of start of an activity.	10 days prior to activity commencing	NOPSEMA
Notification of start of activity for publication of AUSCOAST warning and notice to mariners.	3 weeks prior to activity commencing	AHS
	24-48 hours prior to activity commencing	AMSA-JRCC
Notification to trawl fisheries of on-water activity. Notification to include: - Type of activity - Location of activity: coordinates and/or map - Timing of activity: start and finish date and duration	4 weeks prior to activity commencing Then 1 day prior to activity commencing	SETFIA, who will provide SMS to eastern fleet.
Notification to trawl fisheries of cessation of on-water activity	Within 10 days of activity completion	
Regulatory notification of cessation of an activity	Within 10 days of activity completion	NOPSEMA
Notification of cessation of activity to cease warnings for an activity	On vessel demobilisation from field	AHS AMSA-JRCC

Table 10-4 Stakeholder Feedback and Cooper Energy Assessment of Objections and Claims

Stakeholder	Stakeholder ID	Information provided	Summary of Stakeholder Response	Cooper Energy (COE) Assessment of Objection/ Claim	COE Response	Record ID (Stakeholder-ID-Date-Item)
Australian Antarctic Division	GA-AAD	Historical consultation summary	• Cooper Energy submission of marine mammal sightings forms following offshore activities. • Clarification whether to use cetacean sightings application or sightings spreadsheet for offshore activities. AAD confirmed use spreadsheet.			2018 BMG Well Abandonment EP BMG-EN-EMP-0002 (activity deferred)
		COE contacted AAD to enquire about the presence of blue whales on the Marine Mammal Search map. As there were limited number of blue whales present in the Otway and Gippsland regions, compared to studies conducted by the Blue Whale Study. COE emailed AAD seeking advice regarding how COE can manage potential impacts from noise (primarily from vessels) during facility decom, particularly to these more sensitive species. COE are wondering if we can learn from how vessel noise is managed in the Antarctic.	AAD responded that the database does not contain all of the States data hence some of the issues COE have noticed. AAD provided links to various other sites to obtain blue whale data. AAD provided additional information on recent examples (and ideas) of control measures including those used by the British Antarctic Survey to manage the impact of subsea noise in Antarctic waters from construction projects (rock breaking using explosives for wharf construction): • MMO monitoring • Pre-start and shut-down process • Passive Acoustic Monitoring The AAD also described relevant design features of the latest Australian Icebreaker (RSV NUYINA): • Ship design including DNV Silent R Notation for science acoustic work • Avoidance of areas where large aggregations of cetaceans are well known or predictable The AAD also noted whether bubble curtains might be worth considering.	No claims or objections raised with the proposed activity. COE assessed examples and ideas provided by AAD within the ALARP assessment for the management of noise impacts. Adopted measures have been integrated into EP performance standards.	COE assessed the additional blue whale data sources provided by AAD and integrated into the EP. No claim or objection has been raised. COE will continue to consult with AAD in line with ongoing engagements described above.	GA-AAD-20210803- Email GA-AAD-20211005-Email
Australian Border Control	GA-ABC	Historical consultation summary	• Informed of 2017 BMG EP 5-yearly revision. No response • Flyer/email updates on BMG well abandonments planned for 2018. Confirmed they would forward on any and all information on to relevant parties within Maritime Border Command.			2018 BMG Well Abandonment EP BMG-EN-EMP-0002 (activity deferred)
		COE provided Cooper Energy Activity Update Statement 2021 factsheet and key points in relation to BMG activity.	No response received	No claims or objections raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-ABC-20201120-email
Australian Fisheries Management Authority	GA-AFMA	COE provided Cooper Energy Activity Update Statement 2021 factsheet and key points in relation to revised BMG EP. Specific highlight included project activities overlap with fisheries areas and PSZ. Provided a list of all Commonwealth- and Victorian- managed fisheries with spatial boundaries that overlap with the BMG area, and whether fishing operations occur in the area.	AFMA confirmed due to limited resources, they are unable to comment on individual proposals, however, it is important to consult with all fishers who have entitlements to fish within the proposed area. This can be done through the relevant fishing industry associations or directly with fishers who hold entitlements in the area. AFMA provided links to relevant information to identify relevant fishers and noted individual fisher contact details can be requested through licensing@afma.gov.au and that there is a cost associated with this service and the total price will depend on the complexity of the request.	COE have updated their stakeholder mail list with the contact details AFMA provided. COE continues to identify and consult with relevant fishers via established contacts within fishing industry associations.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-AFMA-20201120-email
Australian Hydrographic Service	GA-AHS	Historical consultation summary	• General and specific activity updates. • Confirming and cancelling NTM for various offshore campaigns.			2018 BMG Well Abandonment EP BMG-EN-EMP-0002 (activity deferred)

Stakeholder	Stakeholder ID	Information provided	Summary of Stakeholder Response	Cooper Energy (COE) Assessment of Objection/ Claim	COE Response	Record ID (Stakeholder-ID-Date-Item)
		COE provided Cooper Energy Activity Update Statement 2021 factsheet and provided key points in relation BMG closure project	AHS confirmed receipt of email and that data provided will be used to update AHO Navigational Charting products.	No objections or claims raised with the proposed activity.	COE replied to AHS confirming receipt of email. COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-AHS-20201120-email
		COE seeking data on "hook up" marine incidents in Australia over the past 10-20 years involving fishing vessels snagging on seabed obstructions.	AHS confirmed: the statistics only have domestic commercial vessel (DCV) data going back until July 1, 2018, which is not even close to the 10 to 20 years COE were hoping for and the data AHS have won't get a good picture of how commonly this occurs.	No objections or claims raised with the proposed activity.	COE thanked AHS for their help. Having looked through the 2018 -2020 monthly incident summaries there aren't any mentions of vessel hook up. No further action required.	GA-AHS-20201123-email
Australian Maritime Safety Authority (AMSA)	GA-AMSA	Historical consultation summary	• Informed of 2017 BMG EP 5-yearly revision. Advice on marine traffic and notification requirements. • Flyer updates for BMG well abandonments planned for 2018 followed by standard pre-start notifications (and subsequent cancellation of those notifications). Subsequent consultation regarding other offshore projects through 2019 and 2020 including inspections at BMG in Q1 2020.			2018 BMG Well Abandonment EP BMG-EN-EMP-0002 (activity deferred)
		Contacted AMSA about initiative that COE and SETFIA are working on together to increase knowledge within the fishing industry about PSZs. Provided AMSA with information pack being provided to fisheries in the south east and google map with PSZs marked. Requested feedback on the initiative. Asked if it was ok to use excerpt of AMSAs video on hook-up response in COE/SETFIA PSZ video.	Email forwarded to alternate email within AMSA requesting to provide help to COE. Following email stated that they were happy for COE to use park of the hook-up video for PSZ video.	No objections or claims raised with the proposed activity.	COE replied to AMSA acknowledging their reply. COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-AMSA-20200903-Emails
		COE provided their Activity Update Statement 2021 factsheet and provided key points in relation BMG closure project	AMSA confirmed they received the email.	No objections or claims raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-AMSA-20201120-email
	GA-AMSA-SR	COE provided their Activity Update Statement 2021 factsheet and provided key points in relation BMG closure project	No response received	No objections or claims raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-AMSA-SR-20201120-email
Department of Agriculture, Water and the Environment - Biosecurity	GA-DAWE-B	Historical consultation summary	• Previously the DAWR. Flyer updates on BMG well abandonments planned for 2018. Auto Response only. • Subsequent consultation for 2019 Otway offshore drilling campaign which is considered relevant to BMG decommissioning: advice provided by DAWE on topsides biosecurity, MARS, and waste transfers. • COE agreed to continue dialogue regarding vessel activities, particularly when utilising international vessels.			2018 BMG Well Abandonment EP BMG-EN-EMP-0002 (activity deferred)
		COE provided Cooper Energy Activity Update Statement 2021 factsheet and provided key points in relation BMG closure project	No response received	No objections or claims raised with the proposed activity.	COE sent follow up email with additional consultation attachments relevant to BMG closure project prepared in line with the Departments consultation guidance for petroleum industry Environment Plans. COE Provided an offer to discuss further. COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-DAWE - B- 20201120-email GA-DAWE - B- 20210225-email GA-DAWE - B- 20210225-Email Attachment 1 GA-DAWE - B- 20210225-Email Attachment 2 GA-DAWE - B- 20210225-Email Attachment 3

Stakeholder	Stakeholder ID	Information provided	Summary of Stakeholder Response	Cooper Energy (COE) Assessment of Objection/ Claim	COE Response	Record ID (Stakeholder-ID-Date-Item)
		COE sent follow up email with additional consultation attachments x3 relevant to BMG closure project prepared in line with the Departments consultation guidance for petroleum industry Environment Plans. COE Provided an offer to discuss further.	DAWE confirmed receipt of information from COE.	No objections or claims raised with the proposed activity.	COE confirmed it is appropriate to share DAWE contact details with the vessel contractor Helix Energy who are planning to bring semisubmersible vessel the Q7000 into country in 2022. COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-DAWE -B- 20210226-email
Department of Agriculture, Water and Environment (DAWE) - Fisheries	GA-DAWEF	COE provide Cooper Energy Activity Update Statement 2021 factsheet and key points in relation to BMG activity. Specific highlight included project activities overlap with fisheries areas and PSZ. Provided a list of all Commonwealth- and Victorian- managed fisheries with spatial boundaries that overlap with the BMG area, and whether fishing operations occur in the area.	No response received	No objections or claims raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-DAWEF-20201120-Email
		COE sent a follow up email with additional consultation attachments relevant to BMG closure project prepared in line with the Departments consultation guidance for petroleum industry Environment Plans. COE Provided an offer to discuss further.	No response received	No objections or claims raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-DAWE -F- 20210225-email GA-DAWE -F- 20210225-Email Attachment 1 GA-DAWE - F- 20210225-Email Attachment 2 GA-DAWE - F- 20210225-Email Attachment 3
DJPR – Earth Resources Regulation (ERR)	GA-DJPR-ERR	Historical consultation summary	• Provided updates for BMG well abandonments planned for 2018 followed by standard pre-start notifications (and subsequent cancellation of those notifications). • Subsequent consultation regarding other offshore projects through 2019 and 2020 including inspections at BMG in Q1 2020.			2018 BMG Well Abandonment EP BMG-EN-EMP-0002 (activity deferred)
		COE provided Cooper Energy Activity Update Statement 2021 factsheet and key points in relation to BMG activity. Confirmed appropriate time frame for Vic Government to review OPEP in late January 2021.	DJPR- Earth Resources Regulation confirmed email receipt. Clarified that as per Regulation 31A of the OPGGS(R) 2011 (Vic) only requires a titleholder to submit a report to the Minister in relation to the titleholder's environmental performance for the activity as specified in EP.	No objections or claims raised with the proposed activity. COE noted that BMG OPEP government review is planned given spill EMBA overlap with state waters.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-DJPR-ERR-20201120 -email
Department of Transport (DoT)	GA-DJPR-EMB Now DoT	Historical consultation summary	• Project updates and OPEP review for BMG 2018 well abandonment scope. • BMG well abandonment campaign updates through 2018 including activity delay notification. • Consultation for revision of Vic Offshore OPEP for exploration drilling in the Otway (2019) including relevant advice on state response resources and OPEP review requirements.			2018 BMG Well Abandonment EP BMG-EN-EMP-0002 (activity deferred)
		COE provided Cooper Energy Activity Update Statement 2021 factsheet and key points in relation to BMG activity. Confirmed appropriate time frame for Vic Government to review OPEP in late January 2021.	Communications linked to GA-DJPR-ERR-20201120 -email.	No objections or claims raised with the proposed activity.	COE replied and sent a follow-up email to arrange government review of BMG OPEPs early next year.	GA-DJPR-EMB-20201127 -email

Stakeholder	Stakeholder ID	Information provided	Summary of Stakeholder Response	Cooper Energy (COE) Assessment of Objection/ Claim	COE Response	Record ID (Stakeholder-ID-Date-Item)
		COE following up on previous communications requesting a meeting to run through BMG project spill risks, and key elements ahead of providing draft OPEP to Victorian Government for review. COE requesting a Victorian Government review in June.	No response received	No objections or claims raised with the proposed activity.	N/A Continued Consultation.	GA-DJPR-EMB-20210603-email
		COE following up previous communications requesting a meeting to run through BMG project spill risks, and key elements ahead of providing draft OPEP to Victorian Government for review. COE requesting a Victorian Government review in June.	DJPR-EMB agreed to discuss the OPEP.	No objections or claims raised with the proposed activity.	A meeting was held- see email correspondence GA-DJPR-EMB-20210621 COE thanked DJPR-EMB for their time to discuss the OPEP. In line with discussions, COE provided a copy of the Victorian Oil Pollution Response Guidance Note along with the JRCC discussion / diagram within the Guidance note and adapted it to try and depict how things would work if multiple states were involved. Continued Consultation.	GA-DJPR-EMB-20210607-email GA-DJPR-EMB-20210621-email GA-DJPR-EMB-20210621-attachment 1 GA-DJPR-EMB-20210621-attachment 2
		COE followed up on their correspondence in June – as to whether DoT have any comments on our draft OPEP, or advice on potential locations for forward operating bases	DJPR provided comments back to COE from both DELWP and DoT. Suggestions for update: • Additional emergency response liaison officers may be required if the response extended to NSW and Tasmania. • Note in the document that provided safe to do so all accessible wildlife with welfare needs should be addressed • In Victoria, process outlined in GUI-025 will be used to determine when to terminate shoreline response • Update of oil thickness considerations for booming • Suggest including performance standard to engage with Traditional Owners during a response to identify areas of importance to be aware of / demarcated. • Suggest including performance standard to undertake site survey for critical fauna during a response to identify areas of importance to be aware of / demarcated.	COE updated the OPEP and included DELWP and DoT suggestions	N/A COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-DJPR-EMB-20210804-email GA-DJPR-EMB-20210804-email 2 GA-DJPR-EMB-20210804-Attachment 1
		COE asked DoT for the link to the shoreline segments.	DoT provided original report with the shoreline segments, also pointing to CoastKit as the most up to date source of information, related to suggestion to include updated shoreline segment information during OPEP review.	No claims or objections raised with the proposed activity. COE have adopted CoastKit as a reference source within the OPEP.	N/A COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-DJPR-EMB-20210827-Email GA-DJPR-EMB-20210827-Attachment 1
Department of Agriculture, Water and Environment (DAWE) - Heritage	GA-DAWE-H	COE provided Cooper Energy Activity Update Statement 2021 factsheet along with map and details of 'Barque' Shipwreck location for confirmation given not previously identified within BMG field.	DAWE- Heritage confirmed email had been forwarded to relevant department and will reply to the correspondence within 20 working days of receipt. DAWE- Heritage confirmed the exact location of wreck Result (ID 6550) remains unknown at this time. Stated that remains of this wreck is protected regardless and should discovery of a wreck or any other protected UCH site during COE activity must be notified in accordance with Underwater Cultural Heritage Act 2018 and attached relevant fact sheet "Underwater Cultural Heritage Guidance for Offshore Developments" and Result (id 6550) wreck data on file.	No objections or claims raised with the proposed activity.	COE will notify DAWE in the event of shipwreck discovery in line with requirements of the Underwater Cultural Heritage Act 2018. COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-DAWE-H- 20201120-email GA-DAWE-H- 20210111-email GA-DAWE-H- 20210111-email attachment 1 GA-DAWE-H-20210111-email attachment 2

Stakeholder	Stakeholder ID	Information provided	Summary of Stakeholder Response	Cooper Energy (COE) Assessment of Objection/ Claim	COE Response	Record ID (Stakeholder-ID-Date-Item)
Department of Agriculture, Water and the Environment - Sea Dumping Section	GA-DAWE-SD	COE provided Cooper Energy Activity Update Statement 2021 factsheet and key points in relation to revised BMG EP.	No response received DAWE called and emailed COE on 22 January 2022 indicating they had viewed COE BMG Phase 1 EP (available on NOPSEMA website 'EPs under assessment') and that there were likely some activities that may require a sea dumping permit including: • in-situ abandonment of the Basker-A manifold pile. • disposal downhole of flushing and cleaning waste. • Re-running equipment into the well for the purposes of disposal DAWE suggested COE include a performance standard in the EP to provide for sea dumping permits where necessary.	No objections or claims raised with the proposed activity.	COE notes the Department's response and will submit sea dumping permit applications in line with DAWE advice following further consultation with the department. New EPO and EPS added to Section 8: EPO13: Sea dumping is undertaken in accordance with the Sea Dumping Act. C40: Sea Dumping Permits. EPS: Sea Dumping permits are obtained prior to sea dumping, and permit requirements are fulfilled.	GA-DAWE- SD-20201120-Email GA-DAWE-SD-20220122-Email
Department of Foreign Affairs and Trade	GA-VDFAT	COE provided Cooper Energy Activity Update Statement 2021 factsheet and key points in relation to revised BMG EP.	No response received	No objections or claims raised with the proposed activity.	N/A Consultation continued	GA-VDFAT-20201120-email
		Informed DFAT of potential for worst case spill scenario to enter international EEZ.	No response received	No objections or claims raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-VDFAT-20210201-Email GA-VDFAT-20210201-Email Attachment
Department of Industry, Innovation, Science, Energy and Resources (DIISER)	GA-DIISER	COE provided Cooper Energy Activity Update Statement 2021 factsheet and key points in relation to BMG activity. Specific highlight included details of CA workshop process.	No response received	No objections or claims raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-DIISER-20201120-Email
		COE provided Cooper Energy Activity Update Statement 2021 factsheet and key points in relation to revised BMG activities. Noted that currently there is no overlap between offshore facilities and subsea cables.	No response received	No objections or claims raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-DIISER-20201208-email
Department of Defence	GA-DoD	Historical consultation summary	• General activity updates and notices provided in 2017 and 2018. DoD confirmed review of material and had no objections.			2018 BMG Well Abandonment EP BMG-EN-EMP-0002 (activity deferred)
		COE provided Cooper Energy Activity Update Statement 2021 factsheet and provided key points in relation BMG closure project	No response received	No objections or claims raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-DoD-20201120-email
Director of National Parks (DNP) / Parks Australia (DAWE)	GA-DoNP	Historical consultation summary	• Flyer/email updates on BMG well abandonments planned for 2018. • Subsequent consultation for 2019 Otway drilling campaign which is considered relevant to BMG decommissioning. Key points: a) Oil pollution response is allowable in Multiple Use and Special Purpose Zones (IUCN Category VI) when undertaken in accordance with an accepted EP. b) DNP should be made aware of oil/gas pollution incidences which occur within a marine park or are likely to impact on a marine park.			2018 BMG Well Abandonment EP BMG-EN-EMP-0002 (activity deferred)
		COE provided Cooper Energy Activity Update Statement 2021 factsheet and key points in relation to COE activities including potential for worst case spill scenario to enter MPA	No response received	No objections or claims raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-DoNP-20201120 -email
Victorian Fishery Authority	GA-VFA	COE provided Cooper Energy Activity Update Statement 2021 factsheet and key points in relation to BMG activity. Specific highlight	AFMA acknowledged they received the email.	No objections or claims raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will	GA-VFA-20201120-Email

Stakeholder	Stakeholder ID	Information provided	Summary of Stakeholder Response	Cooper Energy (COE) Assessment of Objection/ Claim	COE Response	Record ID (Stakeholder-ID-Date-Item)
		included project activities overlap with fisheries areas and PSZ. Provided a list of all Commonwealth- and Victorian- managed fisheries with spatial boundaries that overlap with the BMG area, and whether fishing operations occur in the area.			continue in line with ongoing engagements described above.	
Vic Department of Jobs, Precincts and Regions - Biosecurity & Agriculture Services	GA-DJPR-BAS	Historical consultation summary	• Flyers, emails in relation to the development of the COE IMS Management Plan. COE agreed to continue dialogue regarding vessel activities off of the Victoria coast.			2018 BMG Well Abandonment EP BMG-EN-EMP-0002 (activity deferred)
		COE emailed DJPR- Biosecurity & Agriculture Services regarding Victorian biofouling management specific to Contractor vessel use of "vessel check" system and decommissioning of subsea structure to shore guidelines.	DJPR- Biosecurity & Agriculture Services confirmed use of "Vessel Check" and process if insufficient information provided. Confirmed decommissioning of subsea infrastructure if transported to shore on deck is unlikely to present a biosecurity risk.	No claims or objections raised with the proposed activity. Based on the feedback from DJPR, COE assesses that sufficient mitigations are in place to manage biosecurity risk.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-DJPR-BAS-20201106 - Emails
		COE emailed DJPR- Biosecurity & Agriculture following on from previous email dated 06/11/2020. COE provided Cooper Energy Activity Update Statement 2021 factsheet and provided key points in relation BMG closure project and Comparative analysis underway	No response received	No claims or objections raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-DJPR-BAS-20201120-email
Transport Safety Victoria (Maritime Safety)	GA-TSVMS	Historical consultation summary	• Provided updates for BMG well abandonments planned for 2018 followed by standard pre-start notifications (and subsequent cancellation of those notifications). • Subsequent consultation regarding other offshore projects through 2019 and 2020 including inspections at BMG in Q1 2020. • Note BMG Decom pre-start and cessation notifications will be carried out.			2018 BMG Well Abandonment EP BMG-EN-EMP-0002 (activity deferred)
		COE provided Cooper Energy Activity Update Statement 2021 factsheet and key points in relation to BMG activity.	Transport Victoria informed COE of the new contact details to be using for any information regarding activity for Victorian coastal waters (within 3NM) and for Notices to Mariners.	No claims or objections raised with the proposed activity. COE have updated their Stakeholder mail out list with the new contact details.	COE replied to confirm contact details have been received and COE's system will be updated. COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-TSVMS-20201120-email
Department of Environment, Land, Water and Planning (DELWP) - Marine National Parks and Marine Parks	GA-DELWP-NPMP	Historical consultation summary	• Flyer/email updates on BMG well abandonments planned for 2018. • BMG well abandonment campaign updates through 2018 including activity delay notification.			2018 BMG Well Abandonment EP BMG-EN-EMP-0002 (activity deferred)
		COE seeking appropriate point of contact in relation to Marne National Parks and spill response within DELWP. COE provided Cooper Energy Activity Update Statement 2021 factsheet and overview of BMG closure project in relation to planned activity and emergency response.	DWELP replied confirming Parks Victoria statutory planning contact for Gippsland region and confirmed Planning approvals Gippsland would appreciate future updates. Note: DELWP were also engaged via DoT for whole of State Government review of OPEP and have provided advice.	Stakeholder interests in relation to potential hydrocarbon release were coordinated through DoT and this process has addressed DELWP feedback. No further claims or objections	COE replied to DELWP confirming Gippsland Planning will remain a relevant Stakeholder and provided Cooper Energy Activity Update Statement 2021 factsheet. COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above. Planning approvals Gippsland has been included within COEs Stakeholder Engagement Mail out list and	GA-DELWP-NPMP-20201120 - email

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				raised with the proposed activity	COE will ensure Planning approvals Gippsland are kept up to date on the project activities.	
Transport for NSW, NSW Maritime	GA-NSWRMS	Historical consultation summary	• Email with outline of BMG activity, spill scenario and offer to provide OPEP for review. Spill map and Campaign Brochure also supplied. RMS would like to receive copy of the OPEP. • RMS recommendation to confirm Control Agency roles and responsibilities in Commonwealth Waters as there are some complexities (i.e. AMSA role), Provided contact for NSW Port Authority. • RMS Advised that RMS would undertake necessary consultation and advice with EPA and Port Authority. • COE recognise the RMS and their input as a response agency and requirements to review OPEP and TRPs. • COE updated OPEP to reflect RMS comments/ feedback (refer to BMG Well Abandonment EP for further details).			2018 BMG Well Abandonment EP BMG-EN-EMP-0002 (activity deferred)
		Confirm correspondence contact. COE provided Cooper Energy Activity Update Statement 2021 factsheet and key points in relation BMG activity. Confirmed COE's understanding of NSW spill response consultation is correct. Confirmed appropriate timeframe for Government to review OPEP in late January 2021.	Transport NSW confirmed to send through the OPEP and TRPs for review. Noted that RMS is no longer an agency within NSW as such any reference to RMS should now read: Transport for NSW, NSW Maritime.	No claims or objections raised with the proposed activity. COE have updated their stakeholder amil out list contact details from RMS to Transport for NSW, NSW Maritime.	COE confirmed update from RMS to Transport for NSW, NSW Maritime. Confirmed OPEP and NSW TRPs will be provided once ready. Consultation ongoing.	GA-NSWRMS-20201120-email
		COE following up previous communications requesting a meeting to run through BMG project spill risks, and key elements ahead of providing draft OPEP for review.	Transport NSW confirmed they will review and revert back with any comment.	No claims or objections raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-NSWRMS-20210723-email GA-NSWRMS-20210723-attachment 1 GA-NSWRMS-20210723-attachment 2 GA-NSWRMS-20210723-attachment 3
Tasmania EPA	GA-EPATAS	Historical consultation summary	• emails and calls in 2017 and 2018 in relation to spill response planning • EPA have historically provided advice regarding response coordination. • Agreed previously to send EPA a copy of the BMG OPEP.			2018 BMG Well Abandonment EP BMG-EN-EMP-0002 (activity deferred)
		COE confirmed EPA point of contact is still appropriate and provided Cooper Energy Activity Update Statement 2021 factsheet. COE also provided key points in relation to revised BMG EP/OPEP. COE also seeking confirmation around EPAs expected level of engagement regarding OPEP and emergency response in event of a spill entering State waters. COE sent their draft OPEP for any comments the EPA may have.	EPA Tasmania's concern from the review of the draft OPEP was around the focus on Tasmania is not always represented in terms of wording in the report. For example, it would be good to see that commitment a little more concrete in terms of resource allocation calculations in the OPEP document.	No claims or objections raised with the proposed activity. COE agreed and updated the OPEP accordingly.	COE followed up previous communications requesting a meeting to run through BMG project draft OPEP spill risks, and key elements. Offered EPA opportunity to review draft OPEP. COE agreed with EPA in relation to their main comment in the draft OPEP and COE will address it. COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements.	GA-EPATAS- 20210831-email GA-EPATAS- 20210831-attachment 1 GA-EPATAS- 20210831-attachment 2 GA-EPATAS- 20210831-attachment 3
Maritime Safety Queensland	GA-MSQ	COE provided Cooper Energy Activity Update Statement 2021 factsheet. COE confirmed appropriate level of involvement in OPEP development expected by QLD Maritime Safety given potential for worst case spill to enter QLD state waters.	No response received	No claims or objections raised with the proposed activity.	COE following up previous communications offering a meeting to run through BMG project draft OPEP spill risks, and key elements if MSQ interested. COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-MSQ-20201120-email

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NSW Department of Planning, Industry and Environment	GA-DPIE	COE informed department of Offshore Operations in the Bass Strait including an offshore oil field which will be decommissioned from 2022. COE emailed seeking point of contact in relation to Oil Spill Response in NSW.	Receipt of confirmation that the NSW Department of Planning, Industry and Environment had received the email. Confirmed with Transport NSW that point of contact for oil spill preparedness was Transport NSW.	No claims or objections raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-DPIE-20201208-email
Parks Victoria	GA-PV	Historical consultation summary	• General activity updates			2018 BMG Well Abandonment EP BMG-EN-EMP-0002 (activity deferred)
		COE seeking appropriate point of contact in relation to State marine parks and spill response in Parks Victoria. COE provided Cooper Energy Activity Update Statement 2021 factsheet and overview of BMG closure project in relation to planned activity and emergency response.	Response received from Parks Victoria, indicating that information received will be shared with regional and state-wide staff with management responsibilities in both marine protected areas, conservation reserves along this coast, as well as for emergency response. Also indicated that Parks Victoria will seek advice to any additional preparation that may be required in response to COE's program. Indicated interest in additional information as it arises.	No claims or objections raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-PV-20201120 - email
Tasmania Parks and Wildlife Service	GA-PaWS	COE provided Cooper Energy Activity Update Statement 2021 factsheet. COE informed department of Offshore Operations in the Bass Strait including an offshore oil field which will be decommissioned from 2022.	No response received. Confirmed with Tasmania EPA that point of contact for oil spill preparedness was Tasmania EPA.	No claims or objections raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-PaWS-20201208-email
Abalone Council Australia	CF-ACA	Historical consultation summary	• Flyer/email updates on BMG well abandonments planned for 2018. No response.			2018 BMG Well Abandonment EP BMG-EN-EMP-0002 (activity deferred)
		Confirm correspondence contact. COE provided Cooper Energy Activity Update Statement 2021 factsheet and key points in relation BMG project. Provided list of all Commonwealth- and Victorian-managed fisheries with spatial boundaries that overlap with the BMG area	No response received	No claims or objections raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	CF-ACA-20201120 -email
Australian Southern Bluefin Tuna Industry Association (Port Lincoln)	CF-ASBTIA-PL	Historical consultation summary	• Provided updates for BMG well abandonments planned for 2018 followed by standard pre-start notifications (and subsequent cancellation of those notifications). • Thanked COE for info and confirmed that activities were unlikely to impact SBT migration or fishing and ranching operations that mainly occur in central and eastern GAB Confirmed that they would like to stay on the list in case fishing activities changed.			2018 BMG Well Abandonment EP BMG-EN-EMP-0002 (activity deferred)
		COE provided Cooper Energy Activity Update Statement 2021 factsheet and key points in relation to revised BMG activities.	No response received	No claims or objections raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	CF-ASBTIA-PL-20201208-email
Commonwealth Fisheries Association	CF-CFA	Historical consultation summary	• Informed of 2017 BMG EP 5-yearly revision. No response. • Flyer/email updates on BMG well abandonments planned for 2018. • COE also provided what Cwth Fisheries had been identified and how COE were consulting them. No response.			2018 BMG Well Abandonment EP BMG-EN-EMP-0002 (activity deferred)
		COE provided Cooper Energy Activity Update Statement 2021 factsheet and key points in relation to BMG activity. Specific highlight included project activities overlap with fisheries areas and PSZ. Provided a list of all Commonwealth- and Victorian- managed fisheries with spatial	No direct response received to date. However, engagement has also taken place with companion license holders and associations to maximise potential feedback on activity. For example, feedback has also been sought from Tuna Australia (reference CF-TA-20201120-email) and SETFIA.	No claims or objections raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	CF-CFA-20201120-email

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		boundaries that overlap with the BMG area, and whether fishing operations occur in the area.				
South East Trawl Fishing Association (SETFIA)	CF-SETFIA	Historical Consultation Summary	• Consultation records from previous operators at BMG show SETFIA have been part of discussions on the BMG development and PSZ during BMG production and cessation phases. Consultation with LEFCOL and SETFIA in 2010 ultimately led to the trenching of the B6 flowline and umbilical in 2012 and reductions in the PSZ extent at BMG. • Consultation records indicate LEFCOL and SETFIA represent the majority of fishing vessels impacted by the BMG development. • Informed of 2017 BMG EP 5-yearly revision. • Flyer/email updates on BMG well abandonments planned for 2018. No outstanding issues. • Regular contact and feedback on activities in the Gippsland region. • Discussions in 2020 around decommissioning options. Engaged to undertake fishing study for BMG area in 2020.			2018 BMG Well Abandonment EP BMG-EN-EMP-0002 (activity deferred)
		Risk Review meeting N/A	SETFIA provided feedback on the marking of PSZs on Australian hydrographic charts. Noted that some fishers may be confused by the differing terminology used on Charts vs PSZ Gazettals.	COE assessed the feedback from SETFIA was relevant and valid and undertook to improve the quality of, and access to information for license holders. COE worked with SETFIA to develop and distribute materials to support improved understanding of the activity with license holders.	COE suggested development and roll-out of education materials to fishers around what a PSZ is and the hazards associated with entering. Discussed best method to do this due to COVID restrictions. Consultation ongoing	CF-SETFIA-20200821-Emails
			SETFIA noted that one of the issues is that fishing vessels are allowed to steam through marine parks, fishery closures and the "are to be avoided" areas but are not ever allowed to enter PSZ's. This can lead to confusion. Requested COE to send SETFIA the NOPSEMA link to the coordinates. Also noted that it would be nice to get Esso and APPEA on board noting that it may end up complicating things. Keen to get the message out.	(as above)	(as above)	(as above)
		COE updated comments and re-worked the PSZ video and fact sheet. Asked for feedback. Provided link to list of PSZ on the NOPSEMA website. Provided link to BMG PSZ. COE goes on to discuss information available on the NOPSEMA website noting it's difficult to use if you're not in the industry and that it might be a good idea to create a google map with pins for facilities with PSZs. Agreed that involvement of Esso and APPEA would be a good idea. Queried whether video/fact sheet should be run past other fishing bodies.	SETFIA provided feedback and queries including: 1. Crew and vessel (not vessel and crew). 2. What infrastructure are we looking at (fishers will want to know). 3. Would consider co-branding with SETFIA? 4. Can we put a map of the SE in that shows PSZs?	(as above)	COE thanked for feedback and responded to queries. Noted that FishSafe and AMSA need to be contacted to check if it is ok to use their animations and asked SETFIA if they wish to be included in the correspondence. Consultation ongoing	(as above)
		N/A	Requested to be cc'd into email to FishSafe and AMSA. Noted they might be able to find some footage from a real trawler to include in the video.	(as above)	Agreed some real footage would be a good idea. Consultation ongoing	(as above)
		Provided SETFIA with updated PSZ video noting changes content.	Had trouble viewing video. Suggested adding some words in Filipino as large cohort of fishers are from Philipines.	(as above)	Consultation ongoing	(as above)
		Provided SETFIA with smaller size video. Provided interactive google map with PSZs and requested feedback.	No response received	(as above)	Consultation ongoing	(as above)

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		Also noted that another video with Pilipino script could be made with a translator.				
		COE provided SETFIA with PSZ videos, info sheets and PSZ map. Asked is SETFIA could provide a link when hosted on website / Facebook page. Noted changes to videos since last checked.	SETFIA posted PSZ education video and PSZ map on SEFTIA Facebook page. PSZ Awareness video: https://www.facebook.com/southeasttrawl/videos/434966874187770/ PSZ Locator Map	No claims or objections raised with the proposed activity	Consultation ongoing	CF-SETFIA-20200917-Email CF-SETFIA-20200917-Offshore Zones
		Outcomes of the meeting were that there has been no increase in general fishery risks. Follow up meeting planned for subsequent week to catch up on actions from this meeting and February 2020 session. Notable discussion includes: • Completion of the CGG survey which has allowed fisheries back into usual fishing grounds off Lakes Entrance, as such expect fishers to return to usual fishing grounds closer to shore. • Some impacts on whiting and flathead fisheries from CGG Seismic Survey Impacts have been observed - 10 months or longer recovery noted and will affect seine vessel fishing locations. • Possible future opening of a small exploratory quota for orange roughy. This may attract the four larger board trawlers between Aug 21 and May 22 – however expected locations are away from O&G infrastructure and it is years away from re-establishing the fishery. • New Beach Artisan-1 well PSZ in Otway region gazetted in April with drilling scheduled early 2021. • PSZ safety video to be distributed via SETFIA Facebook • Seasonal increase in winter fishing activity expected for Orange Roughy and Grenadier fisheries, while trawl fisheries activities largely driven by market prices (i.e. fish when the prices are good) Refer to email attachment CF-SETFIA-20201117-meeting attachment 1- MoM CF-SETFIA-20201117-meeting attachment 2- Nov 2020 Risk Review Cooper Esso Feb 2020 Draft for full details of risk assessment and resulting meeting actions.	Follow up meeting held. Meeting recapped previous meeting half on 17th November. SETFIA confirmed PSZ educational video has received good engagement. Noted good feedback received from WAFIC in a Facebook post. SETFIA noted that PSZ map developed by COE is useful, but COE may need to consider whether to keep it up to date or take it down after a period. COE seeking advice from SETFIA regarding effectiveness of AFMA stakeholder engagement advise to consult with all fishers or peak industry bodies. SETFIA suggests contacting all fishers offers little value and does not necessarily reach the right people and potentially disengages fishers. SETFIA suggests it is reasonable to expect Peak Industry Bodies would provide individual fishers it believed should consult directly.	No claims or objections raised with the proposed activity	COE re-sent project information pack for use on SETFIA Facebook page as per MoM action list. SETFIA provided Facebook link to Cooper activity update shared on SETFIA Facebook page. Consultation ongoing	CF-SETFIA-20201117-email CF-SETFIA-20201117-meeting attachment 1- MoM CF-SETFIA-20201117-meeting attachment 2- Nov 2020 Risk Review Cooper Esso Feb 2020 Draft CF-SETFIA-20201204- email 1 CF-SETFIA-20201204- email 1 attachment MoM

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		COE provided Cooper Energy Activity Update Statement 2021 factsheet and key points in relation COE project.	SETFIA response received.	No claims or objections raised with the proposed activity. COE provided a link to COE Activity Update page and attached a single image with activity outline and COE contact details as per SETFIA's request.	COE provided factsheet "COE Activity update for 2021", link to https://www.cooperenergy.com.au/Upload/Cooper-Energy-Activites-Update-November-2020.pdf for use on SETFIA Facebook page	CF-SETFIA-20201204-Emails 2 CF-SETFIA-20201204- email 2 attachment
		No information provided. SETFIA contacted COE	SETFIA asked COE whether they would consider having Melbourne University wave buoy relocated to just inside either then Patricia or Baleen PSZs given current location is very exposed to trawlers. SETFIA confirmed Seine shots occur in all directions (dependant on current) and that steaming also presents a risk. As such wave buoy would only be protected if it is inside the PSZ is it protected.	No claims or objections raised with the proposed activity.	COE responded seeking further information about the buoy, re deployment method and whether it would be safe from fishers if it is placed just outside of PSZ. NB: Cooper Energy collaborated with both Melbourne University to investigate the use of a PSZ for mooring a wave buoy. This included meetings and risk assessments which concluded with the University deciding to keep the buoys stationed in their current positions.	CF-SETFIA-20201208-email
		SETFIA sent teams meeting invite to discuss Risk mitigation de-commissioning. COE provided discussion points relevant to decommissioning options considered ahead of meeting.	Ahead of meeting, SETFIA provided additional information relevant to discussion points provided. Key points being if equipment remains then there will continue to be a snag hazard, the area is lost to fishing and offsets would be expected.	No claims or objections raised with the proposed activity. COE considered all discussion points outlined by SETFIA within the meeting.	Meeting with COE and SETFIA to discuss BMG Closure (decommissioning) Project fisheries risk mitigation. COE described current decommissioning scenarios. COE considered SETFIA's concerns in relation to snag hazards from infrastructure remaining in situ. COE confirmed with SETFIA that it was planned to remove all structures (i.e. trees, manifolds, UTA's) from the field and that the decommissioning of flowlines and umbilicals was the subject of a comparative assessment which will factor in concerns from fisheries and management of snag risks.	CF-SETFIA-20201209-Email CF-SETFIA-20201216-MoM
		COE contacted SETFIA to confirm whether 2019 SSJF fishing activity overlapped BMG as Patterson et al. 2020 suggests it did, however not identified within SEFIA AFMA report produced for COE.	No response received. However data is captured in SETFIA Final report.	COE used the SETFIA Final report to update Section 4.4.1.2	N/A	CF-SETFIA-20210108-Email
		N/A	SETFIA shared WAFIC consultation with NOPSEMA and DISER dated June 2020 and January 2021 respectively, relevant to WAFIC perspectives on decommissioning methods and fisheries impacts.	No claims or objections raised with the proposed activity.	COE phoned SETFIA to further discuss WAFIC vs SETFIA perspectives on decommissioning risks to fisheries.	CF-SETFIA-20210201-email CF-SETFIA-20210201-email attachment 1 NOPSEMA CF-SETFIA-20210201-email attachment 2 DISER
		N/A	SETFIA shared the final report of the 'Commercial fishing catch and value in the area of the Basker-Manta-Gummy oil and gas field'	No claims or objections raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	CF-SETFIA-20210621-Attachment CF-SETFIA-20210624-Email

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		N/A	Risk review meeting for December 2020.	No claims or objections raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	CF-SETFIA-20201207- Email CF-SETFIA-20201207- Attachment 1
		N/A	Risk review for June 2021.	No claims or objections raised with the proposed activity.	COE provided a review of the risk spreadsheet for SETFIA.	CF-SETFIA-20210624- Email
Southern Rock Lobster Ltd	CF-SRL	Historical consultation summary	• Stakeholder has been sent information regarding Sole and BMG activities during 2017 and 2018 with no response.			Archive
		Confirm correspondence contact. COE provide Cooper Energy Activity Update Statement 2021 factsheet and key points in relation to BMG activity. Specific highlight included vessel transits and interactions with fisheries and PSZ.	No response received	No claims or objections raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	CF-SRL-20201120-email
Southern Squid Jig Fishery	CF-SSJF	Historical consultation summary	• Consultation commenced in 2019 for COE Otway exploration activities. General discussion between fishery contact (DW) and COE in relation to both parties' activities. Geographical overlap between activities possible although fishery only has a small number of operators, and they do not have any specific fishing ground; they transient - following the squid. Skippers are not expected to be interested given the nature of planned activities (e.g. no seismic). Agreed to continue providing updates on COE activities.			Archive
		COE provided Cooper Energy Activity Update Statement 2021 factsheet and provided key points in relation BMG closure project	No response received	No claims or objections raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	CF-SSJF-20201120 -email
Sustainable Shark Fishing Inc	CF-SSFI	Historical consultation summary	• Informed of 2017 BMG EP 5-yearly revision. No response. • Stakeholder has been sent information regarding Sole and BMG activities during 2017 and 2018. No response. • Flyer/email updates on BMG well abandonments planned for 2018. No response.			Archive
		Confirm correspondence contact. COE provide Cooper Energy Activity Update Statement 2021 factsheet and key points in relation to BMG activity. Specific highlight included vessel transits and interactions with fisheries and PSZ.	No response received	No claims or objections raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	CF-SSFI-20201120-email
Tuna Australia	CF-TA	Submitted message via Tuna Australia website 20/11/2020 to see if Tuna Australia are interested in receiving updates on COE Activities given Tuna Fishery overlap with activities. COE provided COE contact details for further activity updates	Tuna Australia asked to be kept updated on project activities and provided the contact details.	No claims or objections raised with the proposed activity. Tuna Australia has been included within COEs Stakeholder Engagement Mail out list and COE will ensure Tuna Australia are kept up to date on the project activities.	COE provided Cooper Energy Activity Update Statement 2021 factsheet. Queried whether there were any particular aspects of the project stakeholders were most interested in and confirmed whether there are any fishery boats operating in and around Otway and Gippsland area. No response received. COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	CF-TA-20201120-email
Victorian Rock Lobster Association	CF-VRLA	Historical consultation summary	• General Activity updates • Active in Otway • Overlap between Portland fishing grounds and vessel transit routes in/out of Portland has been raised and managed between COE and VRLA • COE consults with VRLA members on vessel transit routes in/out of Portland to avoid interaction			Archive

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		COE provided Cooper Energy Activity Update Statement 2021 factsheet and provided key points in relation BMG closure project	No response received	No claims or objections raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	CF-VRLA-20210122-email CF-VRLA-20210122-email attachment
Seafood Industry Victoria	CF-SIV	Historical consultation summary	• Informed of 2017 BMG EP 5-yearly revision. • Flyer/email updates on BMG well abandonments planned for 2018. • Meetings in 2017 and 2018 confirming member representation, consultation approach and identification of concerns in relation to COE activities in the Otway and Gippsland.\ • Annual COE activity flyers included in Profish Magazine distributed to SIV members. • One of SIVs concerns historically has been exclusion zones that reduced a fisher's useable area. • Consultation records indicate LEFCOL and SETFIA represent the majority of fishing vessels impacted by the BMG development. Note – LEFCOL are represented by SIV, though Cooper Energy have typically engaged LEFCOL directly.			Archive
		Confirm correspondence contact. COE provide Cooper Energy Activity Update Statement 2021 factsheet and key points in relation to BMG activity. Specific highlight included vessel transits and interactions with fisheries and PSZ.	No response received	No claims or objections raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	CF-SIV-20201120-email
		COE contacted SIV to confirm when next issue of Profish Magazine is due. Relevant to Cooper Energy's annual project update article in Profish magazine.	SIV confirmed ProFishing magazine is currently on hold however suggested information could be provided via SIV webpage	No concerns raised.	COE replied confirming interest in including project information on SIV webpage. Consultation will continue in line with ongoing engagements described above.	CF-SIV-20210316-email
Victorian Recreational Fishers Association	RI-VRFA	Historical consultation summary	• Informed of 2017 BMG EP 5-yearly revision. No response. • Stakeholder has been sent information regarding Sole and BMG activities during 2017 and 2018. No response.			Archive
		COE provided Cooper Energy Activity Update Statement 2021 factsheet and key points in relation to BMG activity.	No response received	No claims or objections raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	RI-VRFA-20201120-email
Victorian Scallop Fisherman's Association	CF-VSFA	Historical consultation summary	• Stakeholder has been sent information regarding Sole and BMG activities during 2017 and 2018 with no response.			Archive
		Confirm correspondence contact. COE provide Cooper Energy Activity Update Statement 2021 factsheet and key points in relation to BMG activity. Specific highlight included vessel transits and interactions with fisheries and PSZ.	No response received	No claims or objections raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	CF-VSFA-20201120-email
Department of Agriculture, Water and the Environment - Vessels	GA-DAWE-V	COE provided Cooper Energy Activity Update Statement 2021 factsheet and key points in relation to BMG activity. COE sent a follow up email with additional consultation attachments relevant to BMG closure project prepared in line with the Departments consultation guidance for petroleum industry Environment Plans. COE Provided an offer to discuss further.	No response received	No claims or objections raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-DAWE -V- 20210225-email GA-DAWE -V- 20210225-Email Attachment 1 GA-DAWE - V- 20210225-Email Attachment 2 GA-DAWE - V- 20210225-Email Attachment 3
Australian Communications and Media Authority (ACMA)	GA-ACMA	COE provided Cooper Energy Activity Update Statement 2021 factsheet and key points in relation to revised BMG activities. Noted that	ACMA acknowledged they received the email.	No claims or objections raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-ACMA-20201208-email 1 GA-ACMA-20201208-email 2

Stakeholder	Stakeholder ID	Information provided	Summary of Stakeholder Response	Cooper Energy (COE) Assessment of Objection/ Claim	COE Response	Record ID (Stakeholder-ID-Date-Item)
		currently there is no overlap between offshore facilities and subsea cables.				
Marine and Safety Tasmania	GA-MAST	COE provided Cooper Energy Activity Update Statement 2021 factsheet and sought advice on offshore oil pollution plan (OPEP) and response planning in Tasmanian waters	No response received	No claims or objections raised with the proposed activity.	COE considers that the stakeholder's interests have been adequately addressed; consultation will continue in line with ongoing engagements described above.	GA-MAST-20201208-Email

11 References

11.1 Cooper Energy Documents

Document Number	Document Name
Cooper Energy Documents	
17-033-RP-001	BMG Technical Considerations for Decommissioning of Subsea Infrastructure
17-033-RP-002	BMG Technical Considerations for Decommissioning of the B6 Flowline and Umbilical
BMG-IR-IMP-0001	BMG Facilities Integrity Management Plan
09/HSEQ/ENV/PL08	BMG Deconstruction and Well Intervention (DCWI) Environment Plan (concluded)
COE-HSEC-PLN-005	BMG Well Operations Management Plan for NPP Operations
COE-HSEC-PLN-005	BMG Field Safety Case
COE-ER-ERP-0001	Cooper Incident Management Plan (IMP)
COE-EN-EMP-0001	Cooper Energy Description of the Environment
BMG-EN-EMP-0001	BMG Non-Production Phase EP
BMG-EN-TFN-0003	BMG Well Abandonments: Spill Modelling Approach
BMG-EN-EMP-0002	2018 BMG Well Abandonment EP (concluded)
BMG-DC-PEP-0002	BMG Project Execution Plan
BMG-RE-TFN-0002	Basker-Manta 2020 WCD Calculations Technical Memorandum
BMG-EN-TFN-0003	Cooper Energy. 2020. BMG Spill Modelling Approach (P&A)
BMG-RE-TFN-0002	Basker-Manta 2020 WCD Calculations Technical Memorandum
VIC-EN-EMP-0002	Gippsland Operations EP
VIC-SS-REP-4900-0001	Basker Manta Gummy Results Final Report- Volume 2 (Multifield IRM)

11.2 Guidance

Document Number	Document Name
NOPSEMA Guidance	
A494246	Guidance Note: Petroleum Safety Zones and the Area to be Avoided. August 2020.
N-04300-GN0166	ALARP Guidance Note, June 2020
N04750-GN1344	Guidance Notes for EP Content Requirement September 2020
N-04750-GL1721	Guideline - Environment plan decision making June 2021
N-04750-IP1899	Reducing marine pest biosecurity risks through good practice management Information paper, October 2021
N-00500-PL1903	Section 572 Maintenance and removal of property Policy, November 2020.
N-04750-IP1979	Source Control Planning and Procedures Information Paper, June 2021.
N-04750-GN1488	Oil Pollution Risk Management, Guidance Note, February 2021
A652993	Environment Bulletin – Oil Spill, April 2019
N-09000-GN1661	Vessels Subject to the Australian Offshore Petroleum Safety Legislation, Guidance Note, October, 2020

Document Number	Document Name
A705589	Consultation with Commonwealth agencies with responsibilities in the marine area, July 2020
Other Guidance	
API Standard 53	Well Control Equipment Systems for Drilling Wells
APPEA	Australian Offshore Titleholders Source Control Guideline
Department of Agriculture, Water and the Environment	National Light Pollution Guidelines for Wildlife Including marine turtles, seabirds and migratory shorebirds
Department of Agriculture, Water and the Environment	EPBC Act Policy Statement 3.21—Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species
Department of Agriculture, Water and the Environment	National biofouling management guidelines for the petroleum production and exploration industry
Department of Agriculture, Water and the Environment	Anti-fouling and In-water Cleaning Guidelines
GOMO 0611-1401	Guidelines for Offshore Marine Operations GOMO 0611-1401 (2013)
IMO MEPC/Res.207(62)	Guidelines for the control and management of a ships' biofouling to minimise the transfer of invasive aquatic species
IOGP 464	Capping and Containment Global Industry Response Group Recommendations
IOGP 485	Standards and Guidelines for Well Integrity and Well Control
IOGP 533	Dispersants: Subsea Application
IOGP 592	Subsea Capping Response Time Model Toolkit User Guide
IOGP 594	Source Control Emergency Response Planning Guide for Subsea Wells
IOGP 595	Subsea Capping Stack Design and Operability Assessment
ISO 14001	Environmental Management Systems
ISO 19901	API Recommended Practice 2SK: Design and Analysis of Stationkeeping Systems for Floating Structures
ISO 31000	Risk management - Guidelines

11.3 Literature

AMSA 2021. Vessel Tracking Data for 2020. Australian Maritime Safety Authority. Accessed at: <https://www.operations.amsa.gov.au/Spatial/DataServices/DigitalData>

Amstrup, S.A., C. Gardner, K.C. Myers, and F.W. Oehme, Ethylene glycol (antifreeze) poisoning of a free-ranging polar bear, Vet. Human Toxi., 31, 317, 1989.

Andrews-Goff, V., Bestley, S., Gales, N.J. et al. Humpback whale migrations to Antarctic summer foraging grounds through the southwest Pacific Ocean. *Sci Rep 8*, 12333 (2018).

Atlas of living Australia. Occurrence records *Balaenoptera musculus*. Available at: https://www.ala.org.au/. Accessed August 2021.

Austin, M., A. McCrodan, and J. Wladichuk. 2013. Underwater Sound Measurements. In Reider, H.J., L.N. Bisson, M. Austin, A. McCrodan, J. Wladichuk, C.M. Reiser, K.B. Matthews, J.R. Brandon, K. Leonard, et al. (eds.). Marine mammal monitoring and mitigation during Shell's activities in the Chukchi Sea, July–September 2013: 90-Day Report. Report Number P1272D–2. Technical report by LGL Alaska Research Associates Inc., Anchorage, AK, USA and JASCO Applied Sciences, Victoria, BC, Canada for Shell Gulf of Mexico, Houston, TX, USA, National Marine Fisheries Service, and US Fish and Wildlife Services. 198 pp, plus appendices. http://www.nmfs.noaa.gov/pr/pdfs/permits/shell_chukchi_openwater_90dayreport.pdf.

Austin, M.E., G.A. Warner, and A. McCrodan. 2012. Underwater Sound Propagation Acoustics Technical Report: Maersk Oil Kalaallit Nunaat A/S 2012 3D Seismic Program Block 9 (Tooq). Version 2.0. Technical report by JASCO Applied Sciences for Golder Associates A/S and Golder Associates Ltd. http://naalakkersuisut.gl/~/media/Nanoq/Files/Hearings/2012/Offentliggorelse%202011%2015/Answers/Bilag/M%C3%A6rsk%20EIA%20ENG%20Appendix%20D%201.pdf.

Australian Government. 2009 National biofouling management guidelines for the petroleum production and exploration industry.

Balcazar et al. 2015. Calls reveal population structure of blue whales across the southeast Indian Ocean and the southwest Pacific Ocean. Journal of Mammalogy, 96(6):1184–1193, 2015.

Baines, PG & Fandry, CB. 1983. ‘Annual Cycle of the Density Field in Bass Strait’, Australian Journal of Marine and Freshwater Research vol. 34, no. 1, pp 143–153.

Bartol, S.M. 2008. A review of auditory funcion of sea turtles. Bioacoustics 17: 57-59. https://doi.org/10.1080/09524622.2008.9753763.

Bartol, S.M. and D.R. Ketten. 2006. Turtle and tuna hearing. In: Swimmer, Y. and R. Brill. 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.

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

Bax NJ, Williams A. 2001. Seabed habitat on the south-eastern Australian continental shelf: context, vulnerability and monitoring. Marine and Freshwater Research 52:491-512

Beaman, R.J., Daniell, J., Harris, P.T. 2005. Geology-benthos relationships on a temperate rocky bank, eastern Bass Strait, Australia. Marine and Freshwater Research 56, 943- 958.

Black, K.P., Brand, G.W., Grynberg, H., Gwyther, D., Hammond, L.S., Mourtikas, S., Richardson, B.J. and Wardrop, J.A. 1994. Production facilities. In: Environmental implications of offshore oil and gas development in Australia – the findings of an independent scientific review. Swan, J.M., Neff, J.M. and Young, P.C. (eds) Australian Petroleum Exploration Association. Sydney. pp 209–407

Boon, P., Allen, T., Brook, J., Carr, G., Frood, D., Harty, C., Hoye, J., McMahon, A., Mathews, S., Rosengren, N., Sinclair, S., White, M., and Yugovic, J. 2011. Mangroves and Coastal Saltmarsh of Victoria, Distribution, Condition, Threats and Management. Institute for Sustainability and Innovation, Victoria University.

Branch, T. A., Stafford, K. M., Palacios, D. M., Allison, C., Bannister, J. L., Burton, C. L. K., Cabrera, E., Carlson, C. A., Galletti vernazzani, B., Gill, P. C., Hucke-gaete, R., Jenner, K. C. S., Jenner, M.-N.- M., Matsuoka, K., Mikhalev, Y. A., Miyashita, T., Morrice, M. G., Nishiwaki, S., Sturrock, V. J., Warneke, R. M. (2007). Past and present distribution, densities and movements of blue whales Balaenoptera musculus in the Southern Hemisphere and northern Indian Ocean. Mammal Review, 37(2), 116– 175. https://doi.org/10.1111/j.1365-2907.2007.00106.x

CEE Consultants. 2003. Sole Development (Patricia Baleen Extension) Technical Report, Marine Biological Issues, August 2003, CEE Consultants Pty Ltd.

Chorney, N.E., G.A. Warner, J.T. MacDonnell, A. McCrodan, T.J. Deveau, C.R. McPherson, C. O'Neill, D.E. Hannay, and B. Rideout. 2011. Underwater Sound Measurements. In: Reiser, C.M., D.W. Funk, R. Rodrigues, and D.E. Hannay (eds.). Marine mammal monitoring and mitigation during marine geophysical surveys by Shell Offshore Inc. in the Alaskan Chukchi and Beaufort Seas, July-October 2010: 90-day report. LGL Report P1171E–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. 240 pp plus appendices. http://www.nmfs.noaa.gov/pr/pdfs/permits/shell_90day_report2010.pdf.

Cooper Energy 2018. *Sole Development Project Pipeline and Subsea Infrastructure Installation Environment Plan Summary*. Cooper Energy, Adelaide.

Commonwealth of Australia (2017b) National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna 2017.

Commonwealth of Australia (2018). Threat Abatement Plan for the impacts of marine debris on the vertebrate wildlife of Australia’s coasts and oceans. Available at https://www.environment.gov.au/system/files/resources/e3318495-2389-4ffc-b734-164cdd67fe19/files/tap-marine-debris-2018.pdf

Commonwealth of Australia (2019). 'Draft Wildlife Conservation Plan for Seabirds. Available at https://www.environment.gov.au/system/files/consultations/73458222-6905-4100-ac94-d2f90656c05d/files/draft-wildlife-conservation-plan-seabirds.pdf

Commonwealth of Australia (2020b) Australian Ballast Water Management Requirements. Rev 8.

Commonwealth of Australia. (2020a). National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds. Available at https://www.environment.gov.au/system/files/resources/2eb379de-931b-4547-8bcc-f96c73065f54/files/national-light-pollution-guidelines-wildlife.pdf

Commonwealth of Australia. 2009. National Biofouling Management Guidance for the Petroleum Production and Exploration Industry 2009. Available at: https://www.marinepests.gov.au/sites/default/files/Documents/petroleum-exploration-biofouling-guidelines.pdf [Accessed 23 September 2020]

Commonwealth of Australia. 2012. Conservation Management Plan for the Southern Right Whale 2011 – 2021. Department of Sustainability, Environment, Water, Population and Communities. Available from https://www.environment.gov.au/system/files/resources/4b8c7f35-e132-401c-85be-6a34c61471dc/files/e-australis-2011-2021.pdf

Commonwealth of Australia. 2015. Conservation Management Plan for the Blue Whale - A Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999. Canberra, ACT: Commonwealth of Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/recovery/blue-whale-conservation-management-plan.

Commonwealth of Australia. 2017. Recovery Plan for Marine Turtles in Australia 2017-2027. Department of the Environment and Energy.

Connell, S.C., M.W. Koessler, and C.R. McPherson. 2021. BMG Wells Plug and Abandonment Activities: Acoustic Modelling for Assessing Marine Fauna Sound Exposures. Document 02381, Version 1.0 DRAFT. Technical report by JASCO Applied Sciences for Cooper Energy Limited.

Crocker, S.E. and F.D. Fratantonio. 2016. Characteristics of Sounds Emitted During High-Resolution Marine Geophysical Surveys. Report by Naval Undersea Warfare Center Division. NUWC-NPT Technical Report 12,203, Newport, RI, USA. 266 p. https://apps.dtic.mil/dtic/tr/fulltext/u2/1007504.pdf.

CTC Consulting. 2011. Basker-Manta Gummy Project: Geotechnical Analysis and Trenching Assessment (PROJ/J10-262/ENG/001). Produced by CTC Consulting for ROC Oil AGR.

Dasic. 2021. Oil Spill Dispersants. Accessed: http://oil.dasicinter.com/oil-dispersants

DAWE. 2021a. National Conservation Values Atlas, Department of Agriculture, Water and the Environment, Canberra. Available from: http://www.environment.gov.au/webgis-framework/apps/ncva/ncva.jsf

DAWE 2021b. Guidance on key terms within the Blue Whale Conservation Management Plan. September 2021.

DAWR. 2017. Australian Ballast Water Management Requirements. Available at: https://www.agriculture.gov.au/sites/default/files/documents/australian-ballast-water-management-requirements.pdf [Accessed 23 September 2020]

Department of Defence. 2021. RAAF Base East Sale information webpage. Department of Defence, Canberra. Accessed at: < https://aircraftnoisemap.airforce.gov.au/assets/site.html?805#base/2/point/2/about> [Accessed 04 Jan 2021]

Department of Sustainability, Environment, Water, Population and Communities. 2012. Conservation Management Plan for the Southern Right Whale. A Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999 2011-2021. Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Accessed at: http://www.environment.gov.au/resource/conservation-management-plan-southern-right-whale-recovery-plan-under-environment. In effect under the EPBC Act from 26-Feb-2013 [Accessed 04 Jan 2021].

Department of the Environment and Energy, NSW Government, and Queensland Government. 2017. Recovery Plan for Marine Turtles in Australia. https://www.environment.gov.au/marine/publications/recovery-plan-marine-turtles-australia-2017.

Department of the Environment. 2021. Balaenoptera musculus in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: https://www.environment.gov.au/sprat. Accessed Mon, 8 Feb 2021 19:40:37 +1100.

Department of the Environment. 2021. Dugong dugon in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: https://www.environment.gov.au/sprat. Accessed Wed, 10 Feb 2021 19:07:12 +1100.

Department of the Environment. 2021a. Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl#:~:text=The%20database%20is%20designed%20to,and%20Biodiversity%20Conservation%20Act%201999.&text=The%20information%20has%20been%20compiled,range%20of%20sources%20and%20contributors.

DISER. 2020. Offshore renewable energy: Exploration Licences. https://www.industry.gov.au/policies-and-initiatives/australias-climate-change-strategies/offshore-renewable-energy [Accessed 04 Jan 2021].

DoPI 2021. *Commercial Fishing, Our Fisheries*. NSW Department of Primary Industries. Accessed at: < https://www.dpi.nsw.gov.au/fishing/commercial/fisheries> [Accessed 04 Jan 2021]

DSEWPaC Department of Sustainability, Environment, Water, Population and Communities. 2013. Recovery plan for the White Shark (*Carcharodon carcharias*). Commonwealth of Australia.

EMSA, 2016. The Management of Ship-Generated Waste On-board Ships EMSA/OP/02/2016 http://www.emsa.europa.eu/news-a-press-centre/external-news/item/2925-the-management-of-ship-generated-waste-on-board-ships.html. Accessed October 2020.

Energy Quest. 2020. Energy Quarterly June 2020 Report. Unpublished report.

Finneran, J.J., 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.

Fugro. 2020. Basker Manta Gummy (BMG) Results - Final Report - Volume 2 (IC-SS-REP-4900-0001.02)

GA. 2020. Regional Geology of the Gippsland Basin. Accessed at: https://www.ga.gov.au/scientific-topics/energy/province-sedimentary-basin-geology/petroleum/acreagerelease/gippsland [Accessed 04 Jan 2021]

Galvin, R, Hanley, C, Ruane, K, Murphy, J, Jaksic, V. Environmental Impact of Corrosion Rates of Steel Piles Employed in Marine Environment. Civil Engineering Research in Ireland 2020: Conference Proceedings. p284-290.

Geraci, J.R. and D.J. St. Aubin (eds.), Sea Mammals and Oil: Confronting the Risks, Academic Press, San Diego, 1990.

Glud, R. Oxygen dynamics of marine sediments. Marine Biology Research. 4:4, 243-289, DOI: 10.1080/17451000801888726

Gros J, Socolofsky SA, Dissanayake AL, Jun I, Zhao L. 2017. Petroleum dynamics in the sea and influence of subsea dispersant injection during Deepwater Horizon. PNAS September 19, 2017 114 (38) 10065-10070; first published August 28, 2017.

Hewitt, C.L., Martin, R.B., Sliwa, C., McEnnulty, F.R., Murphy, N.E., Jones, T. and Cooper, S. (eds). 2002. National introduced marine pest information system. Available online http://www.marinepests.gov.au/Pages/default.aspx Accessed 04 May 2017

Huanga Z, Hua Wang X. 2019. Mapping the spatial and temporal variability of the upwelling systems of the Australian south-eastern coast using 14-year of MODIS data. Remote Sensing of Environment 227 (2019) 90–109

Ierodiaconou D, McLean D, Whitmarsh S, Birt M, Wines S, Bond T. 2020. Marine Communities of Cooper Energy Offshore Facilities. Final Report submitted to Cooper Energy 18/12/2020.

IMAS 2021. *Tasmanian Fisheries and Aquaculture Reports & Resources*. Institute for Marine and Antarctic Studies, University of Tasmania. Accessed at: https://www.imas.utas.edu.au/research/fisheries-and-aquaculture/publications-and-resources [Accessed 04 Jan 2021].

IMCRA Technical Group. 1998. Interim Marine and Coastal Regionalisation for Australia: an ecosystem-based classification for marine and coastal environments. Version 3.3. Interim Marine and Coastal Regionalisation for Australia Technical Group. Environment Australia, Commonwealth Department of the Environment. Australia.

IMO. 2011 Guidelines for the control and management of a ships' biofouling to minimise the transfer of invasive aquatic species.

IMOS 2022. OceanCurrent. Online data open access. Available at: http://oceancurrent.imos.org.au/ [Accessed February 2022].

Infrapidia 2020. Subsea cable interactive map. Accessed at: http://www.fiberatlantic.com/ [Accessed August 2020]

ISO (2013) Petroleum and natural gas industries — Specific requirements for offshore structures — Part 7: Station keeping systems for floating offshore structures and mobile offshore. Accessed via units https://webstore.ansi.org/preview-pages/ISO/preview_ISO+19901-7-2013.pdf.

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.

Ketten, D.R. and S.M. Bartol. 2005. Functional measures of sea turtle hearing. ONR project final report. Document Number ONR Award Number N00014-02-1-0510. Office of Naval Research (US).

Kirkman, H. 1997. Seagrasses of Australia, Australia: State of the Environment, Technical Paper Series (Estuaries and the Sea). Environment Australia, Commonwealth of Australia.

Ladich, F. and R.R. Fay. 2013. Auditory evoked potential audiometry in fish. Reviews in Fish Biology and Fisheries 23(3): 317-364. https://doi.org/10.1007/s11160-012-9297-z.

Laist, D.W., Knowlton, A.R., Mead, J.G., Collet, A.S., & Podesta, M. 2001. Collisions between Ships and Whales. Marine Mammal Science, Vol. 17, Issue 1, pp 35-75.

Langford, T.E.L. 1990. Ecological effects of thermal discharges, xi, 468p. Elsevier.

Lavender, A.L., S.M. Bartol, and I.K. Bartol. 2012. Hearing capabilities of loggerhead sea turtles (Caretta caretta) throughout ontogeny. In Popper, A.N. and A.D. Hawkins (eds.). The Effects of Noise on Aquatic Life. Volume 730. Springer. pp. 89-92. https://doi.org/10.1007/978-1-4419-7311-5_19.

Lavender, A.L., S.M. Bartol, and I.K. Bartol. 2014. Ontogenetic investigation of underwater hearing capabilities in loggerhead sea turtles (Caretta caretta) using a dual testing approach. Journal of Experimental Biology 217(14): 2580-2589. https://jeb.biologists.org/content/217/14/2580.

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. <1, pp. WDS229–WDS234.

Martin, B., J.T. MacDonnell, N.E. Chorney, and D.G. Zeddies. 2012. Appendix A: Sound Source Verification of Fugro Geotechnical Sources. In ESS Group, Inc. Renewal Application for Incidental Harassment Authorization for the Non-Lethal Taking of Marine Mammals Resulting from Pre-Construction High Resolution Geophysical Survey. For Cape Wind Associates, LLC. http://www.nmfs.noaa.gov/pr/pdfs/permits/capewind_iha_application_renewal.pdf.

McCauley RD, Day RD, Swadling KM, Fitzgibbon QP, Watson RA and Semmens JM. 2017. Widely used marine seismic survey air gun operations negatively impact zooplankton. Nature Ecology & Evolution 1: 1-8. http://dx.doi.org/10.1038/s41559-017-0195.

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.

McCauley, R.D., Gavrilov, A.N., Jolliffe, C.D, Ward, R, and Gill, P.C. (2018) Pygmy blue and Antarctic blue whale presence, distribution and population parameters in southern Australia based on passive acoustics. Deep-Sea Research Part II 157– 58 (2018) 154-168.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, et al. 2000a. Marine seismic surveys: A study of environmental implications. Australian Petroleum Production Exploration Association (APPEA) Journal 40(1): 692-708. 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, J. Murdoch, et al. 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. Report Number R99-15. Prepared for Australian Petroleum Production Exploration Association by Centre for Maine Science and Technology, Western Australia. 198 p. https://cmst.curtin.edu.au/wp-content/uploads/sites/4/2016/05/McCauley-et-al-Seismic-effects-2000.pdf.

McIntyre, A.D. and Johnson, R. 1975. Effects of nutrient enrichment from sewage in the sea. In: ALH Gameson, ed. Discharge of sewage from sea outfalls. New York, Pergamon Press. pp. 131–141

McPherson C. and Wood M. 2017. Otway Basin Geophysical Operations Acoustic Modelling - Acoustic Modelling for Assessing Marine Fauna Sound Exposures. Prepared for Lattice Energy on 2 November 2017. Document 01473

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

Middleton, JF. & Black, KP. 1994. The low frequency circulation in and around Bass Strait: a numerical study. Continental Shelf Research 14, pp 1495–1521.

National Marine Fisheries Service (US) [NMFS]. 2018. 2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. US Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59. 167 p. https://www.fisheries.noaa.gov/webdam/download/75962998.

National Oceanic and Atmospheric Administration (US) [NOAA]. 2019. ESA Section 7 Consultation Tools for Marine Mammals on the West Coast (webpage), 27 Sep 2019. https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/esa-section-7-consultation-tools-marine-mammals-west. (Accessed 10 Mar 2020).

National Science Foundation (US), Geological Survey (US) [NSF], and National Oceanic and Atmospheric Administration (US) [NOAA]. 2011. Final Programmatic Environmental Impact Statement/Overseas. Environmental Impact Statement for Marine Seismic Research Funded by the National Science Foundation or Conducted by the US Geological Survey. National Science Foundation, Arlington, VA, USA. https://www.nsf.gov/geo/oce/envcomp/usgs-nsf-marine-seismic-research/nsf-usgs-final-eis-oeis_3june2011.pdf.

Neff, J.M. 2005. Composition, Environmental Fates, and Biological Effect of Water Based Drilling Muds and Cuttings Discharged to the Marine Environment: A Synthesis and Annotated Bibliography. Prepared for Petroleum Environmental Research Forum (PERF) and American Petroleum Institute. Battelle. USA.

Neuparth, T., Costa, F. O., & Costa, M. H. (2002). Effects of temperature and salinity on life history of the marine amphipod Gammarus locusta. Implications for ecotoxicological testing. Ecotoxicology, 11, 61–73.

NGER. 2021. Clean Energy Regulator. Global Warming Potentials. Web Page accessed January 2021: www.cleanenergyregulator.gov./NGER/The-safeguard-mechanism/Baselines/Reported-baseline/global-warming-potential.

Noad, Michael & Kniest, Eric & Dunlop, Rebecca. (2019). Boom to bust? Implications for the continued rapid growth of the eastern Australian humpback whale population despite recovery. Population Ecology. 61.

NOPSEMA. 2016. Guidance Notes for Environment Plan Content Requirements N04750-GN1344 Revision No 3, April 2016. Accessed at https://www.nopsema.gov.au/assets/Guidancenotes/A339814.pdf. [Jan 2021]

NOPSEMA. 2020a. ALARP Guidance Note N-04300-GN0166 A138249 June 2020. Available at: https://www.nopsema.gov.au/assets/Guidance-notes/A138249.pdf [Accessed 23 September 2020]

O'Hara, T.M. and T.J. O'Shea, Toxicology, CRC Handbook of Marine Mammal Medicine, 2nd Edition, L.A. Dierauf and F.M.D. Gulland (eds.), CRC Press, Boca Raton, FL, 471, 2001.

OGUK, 2014. OGUK. 2014. The UK offshore oil and gas industry guidance on risk-related decision making. Oil and Gas UK.

Owen, K., Jenner, C.S., Jenner, MN.M. et al. A week in the life of a pygmy blue whale: migratory dive depth overlaps with large vessel drafts. *Animal Biotelemetry 4, 17 (2016).*

OzCoasts. 2015. Map search – spatial query for estuary and beach information http://www.ozcoasts.gov.au/search_data/map_search.jsp#7 [Accessed 04 Jan 2021]

Parks Victoria. 2003. Victoria's System of Marine National Parks and Marine Sanctuaries 2003-2010. Available at: http://www.parkweb.vic.gov.au/1process_content.cfm?section=85&page=28 [Accessed 04 Jan 2021]

Patterson, H, Larcombe, J, Woodhams, J and Curtotti, R. 2020, Fishery status reports 2020, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0. Available at: https://doi.org/10.25814/5f447487e6749 [Accessed 04 Jan 2021]

Paulay, G. Kirkendale, L. Lambert, G. and Meyer, C. 2002. Anthropogenic biotic interchange in a coral reef ecosystem: A case study from Guam. Pacific Science 56(4): 403–422

Piniak, W.E., D.A. Mann, S.A. Eckert, and C.A. Harms. 2011. Amphibious hearing in sea turtles. In: Hawkins, T. and A.N. Popper (eds.). 2nd International Conference on the Effects of Noise on Aquatic Life. 15-20 Aug 2010. Springer-Verlag, Cork, Ireland.

Popper AN, Hawkins AD, Fay RR, Mann D, Bartol S, Carlson T, Coombs S, Ellison WT, Gentry R, Halvorsen MB, Løkkeborg S, Rogers P, Southall BL., Zeddies D and Tavolga WN. 2014. Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report. ASA S3/SC1.4 TR-201.4. Prepared by ANSI Accredited Standards Committee Rationale and Background Information (Chapter 8).

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.

QFish 2021. *QFish commercial fishing catch and effort data* website. The State of Queensland (Department of Agriculture and Fisheries) 2021, Queensland Government. Available at: https://qfish.fisheries.qld.gov.au/ [Accessed 04 Jan 2021]

Richardson AJ, Matear RJ and Lenton A. 2017. Potential impacts on zooplankton of seismic surveys. CSIRO, Australia. 34 pp.

Richardson W.J., Greene Jnr. C.R., Malme C.I. and Thomson D.H. 1995. Marine Mammals and Noise. Academic Press, California.

Ridgway, S.H., E.G. Wever, J.G. McCormick, J. Palin, and J.H. Anderson. 1969. Hearing in the giant sea turtle, Chelonia mydas. Proceedings of the National Academy of Sciences 64(3): 884-890. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC223317/pdf/pnas00113-0080.pdf.

ROC 2010. Basker-6ST1 Flowline Status & Future Testing Recommendation V1. 28 October 2010. Roc Oil Company Ltd. Memorandum. BMG-IR-MEM-0001.

ROC 2012. BMG Deconstruction and Well Intervention: Environment Plan Closeout Report. Roc Oil Company Ltd. Oceaneering Services Australia Controlled Document No. 1509-HS-H0027. Revision 0. Issue date: 14/06/2012. Cooper Energy Document No. BMG-EN-REP-00003.

RPS. 2020. Basker Manta Gummy Well Abandonment Oil Spill Modelling MAQ0951J Rev 0 (15 December 2020). Prepared for Cooper Energy Ltd.

RPS. 2021. Basker Manta Gummy Well Abandonment – Subsea Dispersant Injection Analysis on Basker B6ST1 crude oil. 06 July 2021.

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.

Samuel, G 2020, Independent Review of the EPBC Act – Final Report, Department of Agriculture, Water and the Environment, Canberra, October. CC BY 4.0.

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.

Santos. 2015. Patricia-Baleen Pipeline VIC/PL31 and VIC/PL31(V) Pipeline Safety Case – Non-Operational Phase (Doc No: PB-STO-8200-002).

SETFIA. 2020. Commercial fishing catch and value in the area of the Basker-Manta-Gummy oil and gas field. Final Report Prepared by South East Trawl Fishing Industry Association and Fishwell Consulting, 3 December 2020.

Shaughnessy, P.D. 1999. The Action Plan for Australian Seals. Canberra: Environment Australia. Available from: http://www.deh.gov.au/coasts/publications/seals-action-plan.html. [Accessed 04 Jan 2021]

Simmonds, M.P., Dolman, S.J. and Weilgart, L. (eds). (2004). Oceans of Noise [Online]. http://www.wdcs.org/submissions_bin/OceansofNoise.pdf . AWDCS Science Report Published by the Whale and Dolphin Conservation Society.

SPE. 2016. SPE Technical Report, Calculation of Worst Case Discharge, Rev 1 2016.

Threatened Species Scientific Committee [TSSC] (2015b). Conservation Advice *Rhincodon typus* whale shark. Canberra: Department of the Environment.

Threatened Species Scientific Committee [TSSC] (2015c). Conservation Advice *Balaenoptera borealis* sei whale. Canberra: Department of the Environment.

Threatened Species Scientific Committee [TSSC] (2015d). Conservation Advice *Balaenoptera physalus* fin whale. Canberra: Department of the Environment.

TSSC. 2013. Commonwealth Conservation Advice for Subtropical and Temperate Coastal Saltmarsh. Threatened Species Scientific Committee. Department of Sustainability, Environment, Water, Population and Communities.

Available at: http://www.environment.gov.au/biodiversity/threatened/communities/pubs/118-conservation-advice.pdf. [Accessed 04 Jan 2021]

TSSC. 2015e. Conservation Advice *Megaptera novaeangliae* humpback whale. Canberra: Department of the Environment. Available at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/38-conservation-advice-10102015.pdf [Accessed 04 Jan 2021].

Threatened Species Scientific Committee [TSSC] (2022). Listing Advice *Megaptera novaeangliae* Humpback Whale. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=38 [Accessed March 2022].

United Nations Environment Programme (UNEP). 1985. GESAMP: Thermal discharges in the marine environment. UNEP Regional Seas Reports and Studies No. 45. Victoria, Rev 2 (Project No: Q0036)

VEAC 2019. Assessment of the Values of Victoria's Marine Environment Report. Victorian Environmental Assessment Council

Walker, D.I. and McComb, A.J. 1990. Salinity response of the seagrass Amphibolis antarctica (Labill.) Sonder et Aschers: an experimental validation of field results. Aquat Bot. 36:359–366.

Warner, G.A. and A. McCrodan. 2011. Underwater Sound Measurements. (Chapter 3) In Hartin, K.G., L.N. Bisson, S.A. Case, D.S. Ireland, and D.E. Hannay (eds.). Marine mammal monitoring and mitigation during site clearance and geotechnical surveys by Statoil USA E&P Inc. in the Chukchi Sea, August-October 2011: 90-day report. LGL Rep. P1193. Report from LGL Alaska Research Associates Inc, LGL Ltd. and JASCO Research Ltd. for Statoil USA E&P Inc., NMFS, and USFWS. 202 pp + appendices.

Whale and Dolphin Conservation Society (WDCS), 2003 - Oceans of Noise. [Online]. Available from: http://ww.wdcs.org/stop/pollution/index.php

Woodside Energy Ltd. 2014. Browse FLNG Development, Draft Environmental Impact Statement. EPBC 2013/7079. November 2014. Woodside Energy, Perth WA.

Woodside. 2020. Echo Yodel and Capella Plugging and Echo Yodel Decommissioning Environment Plan. Available online at: https://info.nopsema.gov.au/environment_plans/503/show_public [Accessed 15 October 2020].

Xodus 2021. BMG Flowline and Umbilical Polymer Degradation Study – Report. BMG-EN-REP-0021. BMG Decommissioning Project.

Yudhana, A., J.D. Sunardi, S. Abdullah, and R.B.R. Hassan. 2010. Turtle hearing capability based on ABR signal assessment. Telkomnika 8: 187-194.

Zykov, M.M. 2013. Underwater Sound Modelling of Low Energy Geophysical Equipment Operations. Document Number 00600, Version 2.0. Technical report by JASCO Applied Sciences for CSA Ocean Sciences. https://www.slc.ca.gov/wp-content/uploads/2018/09/AppG.pdf.

12 Glossary

Subject	Description
AAD	Australian Antarctic Division
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ABC	Australian Border Control
ABR	Auditory brainstem response
ACA	Abalone Council Australia
ACI	Annulus chemical injection
ACMA	Australian Communications and Media Authority
ACT	Australian Capital Territory
ADIOS	Automated Data Inquiry for Oil Spills
AFMA	Australian Fisheries Management Authority
AHO	Australian Hydrographic office
AHS	Australian Hydrological Service
AHTS	Anchor handling and tow support vessels
AIMS	Australian Institute of Marine Science
ALARP	As low as reasonably practicable
AMOSC	Australian Marine Oil Spill Centre
AMPs	Australian Marine Parks
AMSA	Australian Maritime Safety Authority
ANSI	American National Standards Institute
ANZECC	Australian and New Zealand Environment and Conservation Council
API	American Petroleum Institute
APPEA	Australian Petroleum Production and Exploration association
ASAP	As Soon as Practicable
ASBTIA	Australian Southern Bluefin Tuna Industry association
ASTM	American Society for Testing and Materials
ATBA	Area to be avoided
AUSCOAST	Coastal Navigational Warnings
AVCZ	Abalone Victoria Central Zone
AZTECH	Aztech Well Construction Services
B6	Basker-6 ST-1 Well
BAM	Basker Manifold
BIAs	Biologically Important Areas
BMG	Basker Manta Gummy
BOD	Biological Oxygen Demand
BOP	Blowout preventor
BRS	Bureau of Rural Sciences
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
BWS	Blue Whale Study

Subject	Description
CAMBA	Agreement Between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment
CAS	Chemical Abstracts Service
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CEMS	Cooper Energy Management System
CFA	Commonwealth Fisheries association
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora 1973
CIV	Completion isolation valves
CMA	Commonwealth Marine Area
CO2	Carbon Dioxide
CO_2e	Carbon dioxide equivalent
CoA	Commonwealth of Australia
COE	Cooper Energy
COLREGs	International Regulations for Preventing Collisions at Sea 1972
Cooper Energy	Cooper Energy Limited
CP	Cathodic potential
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSV	Construction support vessels
DAFF	Department of Agriculture, Fisheries and Forestry (Cwth)
DAWE	Department of Agriculture, Water and Environment (Cwlth)
DAWEF	Department of Agriculture, Water and Environment (DAWE) - Fisheries
DAWR	Department of Agriculture and Water Resources (Cwth)
DCV	Domestic Commercial Vessel
DCWI	Deconstruction and Well Intervention
DELWP	Department of Environment, Land, Water and Planning (Vic)
DEPI	Department of Environment and Primary Industries
DES	Department of Environment and Science
DEWHA	Department of the Environment, Heritage, Water and the Arts
DFAT	Department of foreign Affairs and Trade
DIISER	Department of Industry, Science, Energy and Resources
DISER	Department of Industry, Science, Energy and Resources
DJPR	Department of Jobs, Precincts and Regions (Vic)
DNA	Deoxyribonucleic Acid
DNP	Commonwealth Director of National Parks
DoA	Department of Agriculture
DoD	Department of Defence
DoE	Department of the Environment
DoEE	Department of the Environment and Energy
DoNP	Director of National Parks
DoPI	Department of Primary Industries

Subject	Description
DOSITS	Discovery of Sound in the Sea
DOT	Department of Transport
DP	Dynamic positioning
DPIE	NSW Department of Planning, Industry and Environment
DPIPWE	Tasmanian Department of Primary Industries, Parks, Water and Environment
DSE	Department of Sustainability and Environment
DSEWPC	Department of Sustainability, Environment, Water, Population and Communities
DSV	Dive support and survey vessels
DTM	Disconnectable Turret-Mooring
EEZ	Exclusive Economic Zone
EFL	Electrical Flying Lead
EIA	Environmental Impact assessment
EIAPP	Engine international air pollution prevention
EMBA	Environment that May Be Affected
EMP	Emergency Management Plan
EMSA	European Maritime Safety Agency
EMT	Cooper Energy Emergency Management Team
ENIVD	Environmental Workshop
EP	Environment Plan
EPA	Environment Protection Authority (State Agency)
EPBC	*Environment Protection and Biodiversity Conservation Act 1999 (Cwth)*
EPBC	*Environment Protection and Biodiversity Conservation Act 1999 (Cwth)*
EPO	Environmental Performance Objective
EQD	Emergency Quick Disconnect
ER	Emergency Response
ERP	Emergency Response Plan
ERR	Earth Resources Regulation
ESD	Ecologically Sustainable Development
ETBF	Eastern Tuna and Billfish Fishery
FFD	Full Field Development
FFG	Flora and Fauna Guarantee *Flora and Fauna Guarantee Act 1988 (FFG Act)* (Vic)
FHA	Fish Habitat Areas
FPSO	Floating Production, Storage and Offloading
GED	General Environmental Duty
GHG	Greenhouse Gases
GOMO	Guidelines for Offshore Marine Operations
HCFC	Hydrochlorofluorocarbons
HF	High Frequency

Subject	Description
HFL	Hydraulic Flying Leads
HR	Human Resources
HSE	Health, Safety and Environment
HSEC	Health, Safety, Environmental and Community
HWIV	Heavy Well Intervention Vessel
IAPP	International Air Pollution Prevention
ID	Internal Diameter
ID	Internal Diameter
IMCRA	Integrated Marine and Coastal Regionalisation of Australia
IMO	International Maritime Organization
IMOS	Integrated Marine Observing System
IMP	Cooper Energy Incident Management Plan
IMS	Invasive Marine Species
IMT	Cooper Energy Incident Management Team
IOGP	International association of Oil and Gas Producers
IRS	Intervention Riser System
IUCN	International Union for Conservation of Nature
JAMBA	Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment 1974
JRCC	Joint Rescue Coordination Centre
JVP	Joint venture partner
KEF	Key Ecological Features
LCM	Lost circulation materials
L_E	Equivalent Sound Level
LEFCOL	Lakes Entrance Fishermen's Society Cooperative Limited
LF	Low Frequency
LOC	Loss of Containment
LOWC	Loss of Well Control
LRP	Lower Riser Package
M2A	Manta-2A Well
MAE	Major Accident Events
MARPOL	International Convention for the Prevention of Pollution from Ships
MARPOL 73/78	International Convention for the Prevention of Pollution from Ships 1973/78
MARS	Maritime Arrivals Reporting System
MAST	Marine and Safety Tasmania
MBES	Multi-Beam Echo Sounder
MDO	Marine diesel oil
MEG	Monoethylene Glycol
MEPC	Marine Environment Protection Committee
MEPC	Marine Environment Protection Committee

Subject	Description
MES	Monitoring, Evaluation and Surveillance
MF	Medium Frequency
MGO	Marine gas oil
MMO	Marine Mammal Observer
MNES	Matters of national environmental significance
MO	Marine Orders
MoC	Management of Change
MODIS	Moderate Resolution Imaging Spectroradiometer
MODU	Mobile offshore Drilling Unit
MODUs	Mobile Offshore Drilling Units
MOU	Mobile Offshore Unit
MPA	Maritime Protection Atlas
MPT	Multi Purpose Tower
MSQ	Maritime Safety Queensland
MT	Metric Tonne
NEBA	Net Environmental Benefit Analysis
NERA	National Energy Resources Australia
NES	National Environmental Significance
NISB	National Intertidal/Subtidal Benthic
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NOPTA	National Offshore Petroleum Titles Administrator
NO_X	Nitrogen Oxides
NPMP	National Parks and Marine Parks
NPP	Non-production phase
NSW	New South Wales
NSWRMS	Transport for NSW, NSW Maritime
NTM	Notice to Mariners
NWS	North-west Shelf
O&G	Oil and Gas
OCNS	Offshore Chemical Notifications Scheme
OD	Outer Diameter
OIM	Offshore Installation Manager
OIW	Oil in water
OPEP	Oil Pollution Emergency Plan
OPGGS Act	Offshore Petroleum and Greenhouse Gas Act (Cwth)
OPGGS(E)R	*Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cwth)*
OPRC	International Convention on Oil Pollution Preparedness, Response and Cooperation 1990

Subject	Description
OSCA	Oil Spill Control Agents
OSMP	Operational and Scientific Monitoring Program
OSPAR	Oslo/Paris convention (for the Protection of the Marine Environment of the North-East Atlantic)
OWR	Oiled Wildlife Response
OWS	Oily Water Separator
P&A	Plug and Abandon
PAH	Polycyclic Aromatic Hydrocarbons
PAM	Passive Acoustic Monitoring
PaWS	Tasmania Parks and Wildlife Service
PB	Lead
PFC	Perfluorocarbons
PK	Peak Sound Level
PLEM	Pipeline End Manifold
PLONOR List	Pose Little or No Risk to the Environment
PMS	Planned Maintenance System
PMST	Protected matters search tool
PMV	Production Master Valve
PPD	Pour Point Depressant
PPE	Personal Protective Equipment
PSV	Production Supply Vessel
PSZ	Petroleum safety zone
PTS	Permanent Threshold Shift
PTW	Permit to Work
RAMSAR	Importance especially as Waterfowl Habitat 1971
RMS	Root Mean Square
ROAM	Riserless Open Water Abandonment Module
ROV	Remotely Operated Vehicle
SBES	Single beam echo sounders
SBT	Southern Bluefin Tuna
SBTF	Southern Bluefin Tuna Fishery
SCAT	Shoreline Clean-up and Assessment Technique
SCERP	Source Control Emergency Response Plan
SCM	Subsea Control Module
SEEMP	Ship Energy Efficiency Management Plan
SEFIA	Socio-economic Indexes for Areas
SEFTIA	South-east Trawl Fishing Industry association
SEL	Sound Exposure Level
SEMPS	Smart Environmental Management Practices
SEPP	State Environmental Planning Policy (New South Wales)

Subject	Description
SESSF	Southern and Eastern Scalefish and Shark Fishery
SETFIA	South-east Trawl Fishing Industry association
SIMAP	Spill Impact Mapping Analysis Program
SIMOPS	Simultaneous Operations
SIT	System integrity testing
SIV	Seafood Industry Victoria
SLES	Deakin University - School of Life and Environmental Sciences
SMPEP	Shipboard Marine Pollution Emergency Plan
SMS	Short Message Service
SOLAS	Safety of Life At Sea
SOPEP	Shipboard Oil Pollution Emergency Plan
SO_X	Sulphur Oxides
SPL	Sound Pressure Level
SPM	Single Point Mooring
SPM	Single Point Mooring
SPRAT	Species profile and threats database
SRL	Southern Rock Lobster
SSD	Subsea Dispersant
SSF	Sustainable Shark Fishing
SSFI	Sustainable Shark Fishing Inc
SSIA	Southern Shark Industry Alliance
SSJF	Southern Squid Jig Fishery
SSS	Side-Scan Sonar
SSSV	Sub-surface Safety Valve
SST	Subsea tree
TEC	Threatened ecological communities
TPCs	Third Party Contractors
TRP	Tactical Response Plan
TSSC	Threatened Species Scientific Committee
TTS	Temporary Hearing Threshold Shift
UAV	Unmanned Aerial Vehicles
UCH	Underwater Cultural Heritage
UN	United Nations
UNSECO	United Nations Educational, Scientific and Cultural Organization
USBL	Ultra-short Baseline
UTA	Umbilical Termination Assembly
VFA	Victorian Fisheries Authority
WBM	Water based mud
WCD	Worst case discharge

Subject	Description
WEMS	Well Management System
WOMP	Well Operations Management Plan
XOV	Crossover Valve

Appendix 1 - Legislative Requirements Relevant to the Activity

Commonwealth Legislation / Requirements

Legalisation / Requirement	Scope	Applicability to the Activity (*under the OPGGS(E)R*)	Related International Conventions	Administering Authority
Australian Ballast Water Management Requirements (Commonwealth of Australia, 2020b)	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.	Provides requirements on how vessel operators should manage ballast water when operating within Australian seas. Section 6 details these requirements in relation to the management of ballast water.	• International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Management Convention).	Department of Agriculture and Water the Environment (DAWE)
Australian Maritime Safety Authority Act 1990	The Act's aims to: • promote maritime safety; • protect the marine environment from: pollution from ships; and other environmental damage caused by shipping; • provide for a national search and rescue service. Australian Maritime Safety Authority (AMSA) is the authority responsible for the application of the Act.	The Act is applicable to offshore petroleum activities where these have the potential to affect maritime safety and/or result in pollution and other environmental damage associated with the operation of ships. This is in particular relevant to the potential risk of oil spill associated with offshore petroleum activities. Impacts and risks associated with vessel movements as part of the proposed activities are discussed in Section 6 of this EP.	• International Convention on Oil Pollution Preparedness, Response and Cooperation 1990 (OPRC). • Protocol on Preparedness, Response and Co-operation to Pollution Incidents by Hazardous and Noxious Substances, 2000 • International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties 1969 • Articles 198 and 221 of the United Nations Convention on the Law of the Sea 1982	AMSA
Biosecurity Act 2015 Biosecurity Regulations 2016	The *Biosecurity Act 2015* replaced the *Quarantine Act 1908* in June 2016. 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. The objects of this Act are: • to provide for managing the following: biosecurity risks; the risk of contagion of a listed human disease; the risk of listed human diseases entering Australian territory or a part of Australian	For the petroleum industry, it regulates the condition of vessels and drill rigs entering Australian waters with regard to ballast water and hull fouling. The regulations stipulate that all information regarding the voyage of the vessel and the ballast water and hull fouling is declared correctly to the quarantine officers. Noting that the operational area is outside of 12 nm from the coastline, the activity does not fall under the Biosecurity Act 2015. However, vessels and the MOU travelling to and from the operational area will cross	• International Convention on the Control and Management of Ship's Ballast Water and Sediment (Ballast Water Management Convention) (adopted in principle in 2004 and in force on 8 September 2017)	DAWE

Legalisation / Requirement	Scope	Applicability to the Activity (*under the OPGGS(E)R*)	Related International Conventions	Administering Authority
	territory, or emerging, establishing themselves or spreading in Australian territory or a part of Australian territory; risks related to ballast water; biosecurity emergencies and human biosecurity emergencies; • to give effect to Australia's international rights and obligations, including under the International Health Regulations, the SPS Agreement and the Biodiversity Convention. Provides a definition of 'quarantine' and establishes the DAWR.	into the 12 nm territory limit, and therefore must adhere to relevant requirements. Management measures related to risk associated with the program are presented in Section 6.		
Environment Protection (Sea Dumping) Act 1981 and associated permit requirements	Aims to prevent the inappropriate disposal of wastes (loading, dumping, and incineration) at sea from vessels, aircraft, and platforms. As such this Act regulates the loading and dumping of wastes at sea, as well as the creation of artificial reefs.	A sea dumping permit is required for any disposal of waste required to be made at sea from vessels, aircraft and platforms involved in the conduct of petroleum exploration and production activities in Australian waters, excluding operational discharges from ships (e.g. sewage and galley wastes). Thus if a titleholder proposes to leave infrastructure partially or wholly in-situ, or dispose of infrastructure at a different site, a permit under the Sea Dumping Act may be required. Disposal of wastes required during the proposed activities is discussed in Section 6 of this EP.	• Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter 1972 and 1996 Protocol Thereto (London Convention).	DAWE
***Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)**	The Act aims to: • Protect MNES; • Provides for Commonwealth environmental assessment and approval processes; and • Provides an integrated system for biodiversity conservation and management of protected areas. MNES include: • World heritage properties;	EPBC Protected Matters are described in Section 4. Where offshore petroleum activities have the potential to impact on MNES, an assessment of these impacts is required to be presented in the EP. Potential impacts to MNES due to the proposed activities are assessed in Section 6 of this EP. The OPGGS Regulations preclude undertaking a petroleum activity within a world heritage area; the BMG P&A activity is not within a world heritage area.	• Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment 1974 (JAMBA). • Agreement between the Government of Australia and the Government of the People's Republic of China for the	DAWE

Legalisation / Requirement	Scope	Applicability to the Activity (*under the OPGGS(E)R*)	Related International Conventions	Administering Authority
	• RAMSAR wetlands; • Listed threatened species and communities; • Migratory species under international agreements; • Nuclear actions, • Commonwealth marine environment; • Great Barrier Reef Marine Park; and • Water trigger for coal seam gas and coal mining developments. The assessment process is overseen by NOPSEMA as the delegated authority under the EPBC Act.		Protection of Migratory Birds and their Environment 1986 (CAMBA). • Convention on Biological Diversity and Agenda 21 1992. • Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979. • Convention on International Trade in Endangered Species of Wild Fauna and Flora 1973 (CITES). • Convention on Wetlands of International • Importance especially as Waterfowl Habitat 1971 (RAMSAR). • International Convention for the Regulation of Whaling 1946. •	
Environment Protection and Biodiversity Conservation Regulations 2000	Part 8 of the regulations provide distances and actions to be taken when interacting with cetaceans.	The interaction requirements are applicable to the activity in the event that a cetacean is sighted. Potential impacts to cetaceans due to the proposed activities are assessed in Section 6 of this EP.	None applicable	DAWE
Hazardous Waste (Regulation of Exports and Imports) Act 1989	Controls the import and export of hazardous waste in Australia.	This Act applies to offshore petroleum activities when an Operator is required to move hazardous waste generated during the Activity in or out of Australia. The Act requires that a permit is required to transport controlled wastes. Hazardous wastes to be produced during the program are described in Section 3.	• Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal 1992.	DAWE

Legalisation / Requirement	Scope	Applicability to the Activity (*under the OPGGS(E)R*)	Related International Conventions	Administering Authority
		Management measures applicable to hazardous wastes are presented in Section 6 of this EP.		
National Biofouling Management Guidance for the Petroleum Production and Exploration Industry 2009	The guidance document provides recommendations for the management of biofouling hazards by the petroleum industry.	Applying the recommendations within this document and implementing effective biofouling controls can reduce the risk of the introduction of an introduced marine species. The requirements applicable to the activities are presented in Section 6.	• Convention on Biological Diversity • UN Convention on the Law of the Sea • International Convention on the Control of Harmful Anti-Fouling Systems on Ships • IMO Resolution MEPC.207(62). 2011 Guidelines for the Control And Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species.	DAWE
National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (Commonwealth of Australia, 2017b)	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.	Applying the recommendations within this document and implementing effective controls can reduce the risk of the vessel collisions with megafauna. The requirements applicable to the activities are presented in Section 6.	• Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979.	DAWE
Navigation Act 2012	The Act regulates international ship and seafarer safety as well as the protection of the marine environment from shipping and the actions of seafarers in Australian waters. The Act regulates: • Vessel survey and certification • Vessel construction standards • Vessel crew • Personnel qualifications and welfare • Occupational health and safety • Handling of cargoes	All ships involved in petroleum activities in Australian waters are required to abide to the requirements under this Act. Several Marine Orders (MO) are enacted under this Act which relate to offshore petroleum activities, including: • MO Part 21: Safety of navigation and emergency procedures • MO Part 30: Prevention of collisions • MO 31: SOLAS and non-SOLAS certification. • MO 47: Offshore industry units • MO Part 57: Helicopter operations	• International Convention for the Prevention of Pollution from Ships 1973/78 (MARPOL 73/78) • International Regulations for Preventing Collisions at Sea 1972 (COLREGs)	AMSA

Legalisation / Requirement	Scope	Applicability to the Activity (*under the OPGGS(E)R*)	Related International Conventions	Administering Authority
	• Passengers • Marine pollution prevention • Monitoring and enforcement activities. The Act also has subordinate legislation contained in Regulations and Marine Orders.	• MO Part 59: Offshore industry vessel operations Management measures related to shipping safety during the program are presented in Section 6 of this EP.		
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. Part 2 of the OPGGS(E) 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.	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 Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). • So that environmental impacts and risks of the Activity are reduced to ALARP. • So that environmental impacts and risks of the Activity are of an acceptable level. Demonstration that the proposed activities will be undertaken in line with the principles of ecologically sustainable development, and that impacts and risks resulting from these activities are ALARP and acceptable is provided in Section 6 of this EP. Refer to Table 2-1 which provides specific requirements relevant to the Activity.	None applicable	NOPSEMA
Ozone Protection and Synthetic Greenhouse Gas Management Act 1989	Ozone Protection and Synthetic Greenhouse Gas Management Act 1989	This Act applies to offshore petroleum activities when an Operator is required to use listed substances under the Act (HCFC, PFC and/or sulphur hexafluoride), e.g. for the operation of machinery such as refrigeration and air condition systems. Relevant management measures are presented in Section 6 of this EP.	• Montreal Protocol on Substances that Deplete the Ozone Layer 1987. • United Nations Framework Convention on Climate Change 1992.	DAWE
Protection of the Sea (Harmful Antifouling Systems) Act 2006	The Act aims to protect the marine environment from the effects of harmful anti-fouling systems.	All ships involved in offshore petroleum activities in Australian waters are required to abide to the requirements under this Act.	• International Convention on the Control of Harmful Anti-fouling Systems on Ships 2001.	AMSA

Legalisation / Requirement	Scope	Applicability to the Activity (*under the OPGGS(E)R*)	Related International Conventions	Administering Authority
	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 a ship. This Act also requires that Australian ships must hold 'anti-fouling certificates', provided they meet certain criteria.	The Marine Order MO 98: Marine Pollution Prevention – Anti-fouling Systems is enacted under this Act. The management of risk is discussed in Section 6.		
Protection of the Sea (Prevention of Pollution from Ships) Act 1983	The Act aims to protect the marine environment from pollution by oil and other harmful substances discharged from ships in Australian waters. It also invokes certain requirements of the MARPOL Convention such as those relating to discharge of noxious liquid substances, sewage, garbage and air pollution. This Act requires ships greater than 400 gross tonnes to have pollution emergency plans in place, and also provides for emergency discharges from ships.	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 Part 91: Marine Pollution Prevention – Oil • MO Part 93: Marine Pollution Prevention – Noxious Liquid Substances • MO Part 94: Marine Pollution Prevention – Harmful Substances in Packaged Forms • MO Part 95: Marine Pollution Prevention – Garbage • MO Part 96: Marine Pollution Prevention – Sewage • MO Part 97: Marine Pollution Prevention – Air Pollution • MO Part 98: Marine Pollution Prevention – Anti-fouling Systems. Management measures related to pollution from oil or other hazardous substances are presented in Section 6 of this EP.	• Various parts of MARPOL.	AMSA
Underwater Cultural Heritage Act 2018	The Act replaces the Historic Shipwrecks Act 1976. Protects the heritage values of shipwrecks sunken aircraft and other underwater cultural heritage (older than 75 years) below the low water mark. The Act designates protection zones around identified heritage values, where circumstances place a particular site at risk of interference. The Act	The Act is applicable to any activities that has the potential to result in damage, interference, removal or destruction of an historic value, including offshore petroleum activities that have the potential to interact with known wreck sites and relics. Shipwreck database identifies a historical shipwreck site within the operational area, however consultation	• Agreement between the Netherlands and Australia concerning old Dutch Shipwrecks 1972.	DAWE

Legalisation / Requirement	Scope	Applicability to the Activity (*under the OPGGS(E)R*)	Related International Conventions	Administering Authority
	prohibits any activities within this zone unless a permit has been obtained.	with DAWE has confirmed the listing is for the suspected Barque shipwreck, the location of which is unknown. Heritage values of the area of the proposed activities are described in Section 4 of this EP. Anyone who finds the remains of a ship, sunken aircraft or other underwater cultural heritage article needs to notify the relevant authorities, as soon as possible but ideally no later than after one week, and to give them information about what has been found and its location. 500m protected zones to be observed around historic ship/aircraft wrecks under Section 20(1). No relevant management measures have been identified given absence of heritage sites within Operational Area.	• UNSECO Convention on Protection of the Underwater Cultural Heritage 2001.	

Victorian Legislation / Requirements

Legalisation / Requirement	Scope	Applicability to the Activity	Administering Authority
Emergency Management Act 2013 & Regulations 2003	Provides for the establishment of governance arrangements for emergency management in Victoria, including the Office of the Emergency Management Commissioner and an Inspector-General for Emergency Management. Provides for integrated and comprehensive prevention, response and recovery planning, involving preparedness, operational co-ordination and community participation, in relation to all hazards. These arrangements are outlined in the Emergency Management Manual Victoria.	Emergency response structure for managing emergency incidents within Victorian waters. Emergency management structure will be triggered in the event of a spill threatening State waters. Emergency response arrangements are detailed in 7 and the OPEP.	Department of Justice and Regulation (Inspector General for Emergency Management)
Environment Protection Act 1970 and amendments & Regulations	This is the key Victorian legislation that 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,	No vessels involved in petroleum activities for the activity will be located in Victorian waters. Requirements of this act are triggered if an oil spill event threatens state waters.	Environment Protection Authority (EPA)

Legalisation / Requirement	Scope	Applicability to the Activity	Administering Authority
	restoration of appropriate environmental quality. This legislation provides the regulatory framework by imposing restrictions and controls on waste related activities of individuals and corporate bodies, as well as setting out the responsibilities of certain government agencies involved in regulating waste. The State Environment Protection Policy (Waters of Victoria) designates: • Spill response responsibilities by Victorian Authorities to be undertaken in the event of spills (DoT) with EPA enforcement consistent with the Environment Protection Act 1970 and the Pollution of Waters by Oil & Noxious Substances Act 1986. • Requires vessels not to discharge to surface waters sewage, oil, garbage, sediment, litter or other wastes which pose an environmental risk to surface water beneficial uses. • The SEPP (Air Quality Management) implements MARPOL Annex VI requirements by the following: Clause 33 – Management of Greenhouse Gases; Clause 35 – Management of Ozone Depleting Substances; and Clause 36 – Management of other mobile sources.		
Environment Protection Act 2017	From July 2021, the EPA will enforce new laws aimed at preventing harm to public health and the environment from pollution and waste. Following the recommendations of a public enquiry, this new Act gives the EPA enhanced powers to prevent risks to the environment and human health. Central to the new Act is the general environmental duty (GED), which shifts the expectation to businesses to: • Reduce the risks of harm to the environment • Manage activities to avoid the risk of environmental damage • Respond to a pollution event if it occurs.	The Operational area is outside of state waters, so this legislation is only applicable in the event of an oil spill threatening state waters. Management measures in the event of an oil spill are described in Sections 6 and 7.	EPA
Flora and Fauna Guarantee Act 1988 (FFG Act) & 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	The EP must assess any actual or potential impacts or risks to FFG Act-listed species (e.g., from an accidental hydrocarbon release	Department of Environment, Land,

Legalisation / Requirement	Scope	Applicability to the Activity	Administering Authority
	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.	affecting state waters). and apply controls in line with any Action Statements. Operational Area does not overlap with State waters, as such only applicable in the event of oil spill which threatens state waters. Any rare or threatened species within the EMBA have been identified in Section 4.4.1.1. The management of risk applicable Action Statement controls is discussed in Section 6.	Water and Planning (DELWP)
Heritage Act 1995 (& Heritage (Historical Shipwrecks) Regulations 2007)	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 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.	Identification of historic places, objects, shipwrecks and archaeological sites in State waters that may be impacted by the Activity and reporting of any identified historic places, objects, shipwrecks and archaeological sites or impacts to them. Operational Area does not overlap with State waters, as such only applicable in the event of oil spill which threatens state waters. Applicable heritage values of the area of the proposed activities are described in Section 4.4.1.2 of this EP. Where relevant, management measures are presented in Section 6 of this EP.	Heritage Victoria (DELWP)
Marine Safety Act 2010 & Regulations 2012	Act provides for safe marine operations in Victoria of including imposing safety duties on owners, managers and designers of vessels, marine infrastructure and marine safety equipment; marine safety workers, masters and passengers on vessels; regulation and management of vessel use and navigation in State waters; and enforcement provisions of Police Officers and the Victorian Director of Transport Safety. This Act reflects the requirements of international conventions - Convention on the International Regulations for Preventing Collisions at Sea & International Convention for the Safety of Life at Sea. The Act also defines marine incidents and the reporting of such incidents to the Victorian Director of Transport Safety.	Applies to vessel masters, owners, crew operating vessels in Victorian State waters. Operational Area does not overlap with State waters, as such only applicable in the event of oil spill which threatens state waters. No relevant management measures have been identified given Operational Area is outside of state waters.	Maritime Safety Victoria
National Parks Act 1975	Established a number of different types of reserve areas onshore and offshore, including Marine National Parks and Marine Sanctuaries. A lease, licence or permit under the OPGGS Act 2010 that is either wholly or partly over land in a marine national park or marine sanctuary is subject to the National Parks Act 1975 and	Applies where there are activities within reserve areas. Operational area does not overlap with State waters, and no planned activities will occur within a reserve area. As such, this legislation is only applicable in the event of an oil spill which threatens reserve area.	DELWP

Legalisation / Requirement	Scope	Applicability to the Activity	Administering Authority
	activities within these areas require Ministerial consent before activities are carried out.	Victorian National Park and other protected terrestrial areas within the EMBA have been identified in Section 4 Stakeholder consultation undertaken is detailed in Section 10.	
Port Management Act 1995	This Act sets out particular provisions for the operation and management of the port of Melbourne and provides Victorian Ports Corporation (Melbourne) (VPCM) with certain powers and functions in the areas of towage, hazardous activities and pollution. Under this Act all managers of local and commercial ports must prepare a Port Safety Management Plan and Environmental Management Plan (together known as SEMPs)	Applicable in the event of an oil spill entering Victorian Ports. Awareness and engagement with ports around SEMPS will facilitate integration of the different safety and environmental regimes that already apply and address any potential overlaps or gaps in emergency response planning. Stakeholder consultation undertaken is detailed in Section 10. Emergency response arrangements are detailed in Section 7 and the OPEP.	Jointly administered by Environment Protection Authority of Victoria; the Director, Transport Safety; and the Health and Safety Organisation
Wildlife Act 1975 & Regulations 2013	The purpose of this Act is to promote the protection and conservation of wildlife, prevent wildlife from becoming extinct and prohibit and regulate persons authorised to engage in activities relating to wildlife (including incidents). The Wildlife (Marine Mammal) Regulations 2009 prescribe minimum distances to whales and seals/seal colonies, restrictions on feeding/touching and restriction of noise within a caution zone of a marine mammal (dolphins (150 m), whales (300 m) and seals (50 m)).	Applicable in the event of an oil spill entering state waters. Prescribed minimum proximity distances to whales, dolphins and seals by vessels are included in this Plan. Reporting requirements are triggered if an incident results in the injury or death of whales, dolphins or seals. Applicable requirements of the proposed activities are described in Section 6 of this EP. Reporting requirements provided in Section 9 of this EP.	DELWP

Tasmanian Legislation / Requirements

Legalisation / Requirement	Scope	Applicability to the Activity	Administering Authority
Biosecurity Act 2019	Consolidates Tasmania's biosecurity laws into a single modern statute. It establishes a Biosecurity Advisory Committee, which provides advice to the Tasmanian Government and Minister for Primary Industries and Water on biosecurity in Tasmania.	Applies where project activities may pose biosecurity risk to Tasmanian waters and coastlines. Operational Area does not overlap with State waters, as such only applicable in emergency events. Applicable Tasmanian values are described in Section 4 of this EP. Management measures are presented in Section 8 of this EP.	Department of Primary Industries, Parks, Water and Environment
Emergency Management Act 2006	This Act establishes the Tasmanian emergency management framework which operates at state, regional and municipal levels,	Emergency response structure for managing emergency incidents within Tasmanian waters. Emergency management structure will be	Department of Police and

Legalisation / Requirement	Scope	Applicability to the Activity	Administering Authority
	and provides for the protection of life, property and the environment in the event of an emergency in Tasmania.	triggered in the event of a spill originating from or entering State water. Emergency response arrangements are detailed in Section 7 and the OPEP.	Emergency Management
Environmental Management and Pollution Control Act 1994	This is the primary environment protection and pollution control legislation in Tasmania, with focus on prevention, reduction and remediation of environmental harm.	Applicable in the event of oil spill entering State water. Operational Area does not overlap with State waters, as such only applicable in emergency events. Applicable Tasmanian values are described in Section 4 of this EP. Emergency response arrangements are detailed in Section 7 and the OPEP.	Environment Protection Authority Tasmania
Historic Cultural Heritage Act 1995	This Act provides for the identification, assessment, protection and conservation of places having historic cultural heritage significance (including shipwrecks within state waters) in Tasmania.	Identification of historic places, objects, shipwrecks and archaeological sites in State waters that may be impacted by the Activity and reporting of any identified historic places, objects, shipwrecks and archaeological sites or impacts to them. Operational Area does not overlap with State waters, as such only Applicable heritage values of the area of the proposed activities are described in Section 4 of this EP. Relevant management measures are presented in Section 8 of this EP.	Jointly administered by Tasmanian Heritage Council and Historic Heritage Section of Parks and Wildlife Service Tasmania (shipwrecks)
Marine and Safety Authority Act 1997	This Act establishes Marine and Safety Tasmania as the authority responsible for the safe operation of vessels in Tasmanian waters and managing its marine facilities.	Applies to vessel masters, owners, crew operating vessels in Tasmanian State waters. Operational Area does not overlap with State waters, as such only applicable in emergency events. Applicable Tasmanian values are described in Section 4 of this EP. Relevant management measures are presented in Section 8 of this EP.	Marine and Safety Tasmania
National Parks and Reserves Management Act 2002	This Act provides for the management of national parks and other reserved land.	Applies where oil spill poses a risk to Tasmanian National and other Parks protected under the Act. Tasmanian National Park and other protected terrestrial areas that maybe impacted by the Activity have been identified in Section 4 of this EP. Stakeholder consultation undertaken is detailed in Section 10.	Parks and Wildlife Service Tasmania

Legalisation / Requirement	Scope	Applicability to the Activity	Administering Authority
Pollution of Waters by Oil and Noxious Substances Act 1998	This Act is the Tasmanian state legislation giving effect to the requirements of MARPOL 73/78 within state waters, and is responsible for ensuring preparedness for and response to oil and chemical spills in Tasmania.	All ships involved in petroleum activities in Tasmanian waters are required to abide to the requirements under this Act. As the operational area is located outside of state waters, these requirements will be triggered in the event of a diesel spill originating from or entering Tasmanian state waters. Applicable MARPOL requirements of the proposed activities are described in Section 6 of this EP.	Environment Protection Authority Tasmania

New South Wales Legislation / Requirements

Legalisation / Requirement	Scope	Applicability to the Activity	Administering Authority
Biosecurity Act 2015 and Biosecurity Regulation 2017	Provides a framework to support risk-based management and efficient response to biosecurity risks.	Applies where project activities may pose biosecurity risk to NSW. Operational Area does not overlap with State waters, as such only applicable in emergency events. Applicable NSW values are described in Section 4 of this EP. Relevant management measures are presented in Section 8 of this EP.	Department of Primary Industries
Heritage Act 1977	This Act provides for the identification, registration and interim protection of items of State heritage significance (including shipwrecks within state waters) in NSW.	Identification of historic places, objects, shipwrecks and archaeological sites in State waters that may be impacted by the Activity and reporting of any identified historic places, objects, shipwrecks and archaeological sites or impacts to them. Operational Area does not overlap with State waters, as such only applicable in the event of oil spill. Applicable heritage values of the area of the proposed activities are described in Section 4 of this EP.	Heritage Council of NSW.
Marine Parks Act 1997	This Act provides for the protection and management of marine areas.	Applies where oil spill poses a risk to NSW marine parks. NSW marine parks that maybe impacted by the Activity have been identified in Section 4 of this EP. Stakeholder consultation undertaken is detailed in Section 9.	NSW Marine Parks Authority
Marine Pollution Act 2012	This Act is the NSW state legislation giving effect to the requirements of MARPOL 73/78 within state waters.	All ships involved in petroleum activities in NSW waters are required to abide to the requirements under this Act. Triggered in the event of a diesel spill originating from or entering NSW state waters. Applicable requirements of the proposed activities are described in Section 6 of this EP.	Transport for NSW.

Legalisation / Requirement	Scope	Applicability to the Activity	Administering Authority
National Parks and Wildlife Act 1974	This Act provides for the care, control and management of all national parks, historic sites, nature reserves, conservation reserves, Aboriginal areas and game reserves, and the protection and care of native flora and fauna, and Aboriginal places and objects.	Applies where oil spill poses a risk to NSW National parks, historic sites, nature reserves, conservation reserves, Aboriginal areas and game reserves, and the protection and care of native flora and fauna protected under the Act. Relevant NSW environmental and social receptors that maybe impacted by the Activity have been identified in Section 4 of this EP. Stakeholder consultation undertaken is detailed in Section 10.	NSW National Parks and Wildlife Service.
Ports and Maritime Administration Act 1995	This Act provides for the provision of marine safety services and emergency environment protection services for dealing with pollution incidents in NSW waters.	Applicable in the event of an oil spill entering NSW Ports. Awareness and engagement with ports will facilitate integration of the different safety and environmental regimes that already apply and address any potential overlaps or gaps in emergency response planning. Stakeholder consultation undertaken is detailed in Section 10. Emergency response arrangements are detailed in Section 7 and the OPEP.	Port Authority of New South Wales
Protection of the Environment Operations Act 1997	This is the main piece of NSW environmental legislation covering water, land, air and noise pollution and waste management.	Applies where oil spill poses a risk to NSW state waters and coastline. Stakeholder consultation undertaken is detailed in Section 10. Emergency response arrangements are detailed in Section 7 and the OPEP.	NSW Environment Protection Authority
Wilderness Act 1987	This Act affords declared wilderness the most secure level of protection, requiring it to be managed in a way that will maintain its wilderness values and pristine condition by limiting activities likely to damage flora, fauna and cultural heritage.	Applies where oil spill poses a risk to NSW state waters and coastline. Relevant NSW environmental and social receptors that maybe impacted by the Activity have been identified in Section 4. Reporting requirements provided in Section 9 of this EP.	NSW National Parks and Wildlife Service.

Queensland Legislation / Requirements

Legalisation / Requirement	Scope	Applicability to the Activity	Administering Authority
Aboriginal Cultural Heritage Act 2003	The main purpose of the Acts is to provide effective recognition, protection and conservation of Aboriginal cultural heritage, and	Identification of Aboriginal historic places, objects and archaeological sites in State waters or shorelines that may be impacted by the Activity and reporting of any identified historic	Department of Aboriginal and Torres Strait

Legalisation / Requirement	Scope	Applicability to the Activity	Administering Authority
	includes significance areas, objects or historic evidence of occupation. The Act: • provide blanket protection of areas and objects of traditional, customary, and archaeological significance • recognise the key role of Traditional Owners in cultural heritage matters • establish practical and flexible processes for dealing with cultural heritage in a timely manner.	places, objects, shipwrecks and archaeological sites or impacts to them. Operational Area does not overlap with State waters, as such only applicable in the event of oil spill. Applicable heritage values of the area of the proposed activities are described in Cooper Energy Description of the Environment (COE-EN-EMP-0001).	Islander Partnerships
Biosecurity Act 2014 and Biosecurity Regulation 2016	Sets out general biosecurity obligation for individual and organisations whose activities pose a biosecurity risk to Queensland. The Act provides comprehensive, consistent and risk-based approach to the management of biosecurity risks to safeguard Queensland economy, agricultural and tourism industries, environment and way of life, from pests, diseases and contaminants. The regulations prescribe ways in which a person's general biosecurity obligation can be met to prevent or minimise a biosecurity risk, and includes measures to prevent or control the spread of biosecurity matter, sets maximum acceptable levels of contaminants in carriers, and sets fees.	Applies where project activities may pose biosecurity risk to Queensland. Operational Area does not overlap with State waters, as such only applicable in emergency events. Applicable Queensland values are described in Section 4 of this EP.	Department of Agriculture and Fisheries
Coastal Protection and management Act of 1995	This Act regulates activities in coastal environments. The objects of the Act are to: • provide for the protection, conservation, rehabilitation and management of the coastal zone, including its resources and biological diversity, and • encourage the enhancement of knowledge of coastal resources and the effect of human activities on the coastal zone	Applies where oil spill poses a risk to Queensland coastal waters and shorelines. Queensland areas and values that may be impacted by the Activity have been identified in Section 4. Emergency response arrangements are detailed in Section 7 and the OPEP.	Department of Environment and Heritage Protection
Disaster Management Act 2003	Where necessary, the Act provides for the declaration of a disaster situation. It provides a framework in which all levels of government, government owned corporation, non-government organisation, partners and stakeholders can work collaboratively to ensure effective disaster management across the State.	Applies where oil spill poses a risk to Queensland coastal waters and shorelines and has been declared State disaster situation. Emergency response arrangements are detailed in Section 7 and the OPEP.	Queensland Fire and Emergency Services
Environmental Protection Act of 1994 and	This Act lists obligations and duties to prevent environmental harm, nuisances and contamination and sets out enforcement tools that can be used when offences or acts of non-compliance are identified.	Applies where an oil spill or such poses risk of serious environmental harm or material environmental harm to Queensland waters or coastlines.	Department of Environment and Science

Legalisation / Requirement	Scope	Applicability to the Activity	Administering Authority
Environmental Protection Regulation 2019	Sections 320 to 320G of the Act outline the requirements for the duty to notify of environmental harm.	Queensland areas and values that may be impacted by the Activity have been identified in Section 4. Emergency response arrangements are detailed in Section 7 and the OPEP.	
Environmental Protection (Water and Wetland Biodiversity) Policy 2019	This policy achieves the object of the Environmental Protection Act in relation to waters and wetlands. The Policy establishes environmental values (EVs) and water quality objectives (WQOs) to protect Queensland's waters, and wetlands while allowing for development that is ecologically sustainable. Queensland waters include water in rivers, streams, wetlands, lakes, groundwater aquifers, estuaries and coastal areas.	Applies where an oil spill or such poses risk of serious environmental harm or material environmental harm to Queensland waters or coastlines. Queensland areas and values that may be impacted by the Activity have been identified in Section 4. Emergency response arrangements are detailed in Section 7 and the OPEP.	Department of Environment and Science
Fisheries Act 1994 and the Fisheries (General) Regulation 2019	Provides for the use, conservation and enhancement of the community's fisheries resources and fish habitats. The Act outlines the State's interests in relation to declared fish habitat areas (FHA). The Regulation (Schedule 3) provides details on the area included within the declared FHA boundaries.	Applies where an oil spill or such poses risk to declared fish habitat areas (FHA). Queensland areas and values that may be impacted by the Activity have been identified in Section 4.	Department of Agriculture and Fisheries
Marine Parks Act 2004 and Marine Parks Regulation 2017	Provide for conservation of the marine environment through the declaration and management of marine parks. Zoning plans state the entry and use provisions for each State marine park. To protect or give effect to the State's interests, matters relating to activities within a marine park are addressed in marine park zoning plans.	Applies where oil spill poses a risk to Queensland marine parks. Queensland marine parks that maybe impacted by the Activity have been identified in Section 4.	Department of Environment and Science
Nature Conservation Act 1992	Objective is to conserve nature while allowing for the involvement of indigenous people in the management of protected areas in which they have an interest under Aboriginal tradition or Island custom. The Act outlines the State's interests for protected area management and identified threatened species and species habitats. To protect or give effect to the State's interests, matters relating to protected area management are addressed through protected area management planning.	Applies where oil spill poses a risk to Queensland state waters and coastline. Relevant Queensland environmental receptors that maybe impacted by the Activity have been identified in Section 4.	Department of Environment and Science
Transport Operations (Marine Pollution) Act 1995 and Transport Operations	This Act is the Queensland state legislation giving effect to the requirements of MARPOL 73/78 within state waters and stipulates additional documentation requirements for some ships operating in Queensland's coastal waters.	All ships involved in petroleum activities in Queensland waters are required to abide to the requirements under this Act. Triggered in the event of a diesel spill originating from or entering Queensland	Jointly managed by Maritime Safety Queensland and Department of

Legalisation / Requirement	Scope	Applicability to the Activity	Administering Authority
(Marine Pollution) Regulation 2018		state waters. Applies where oil spill poses a risk to Queensland state waters and coastline.	Transport and Main Roads
Torres Strait Islander Cultural Heritage Act 2003	The main purpose of the Acts is to provide effective recognition, protection and conservation of Torres Strait Islander cultural heritage, and includes significance areas, objects or historic evidence of occupation. The Act: • provide blanket protection of areas and objects of traditional, customary, and archaeological significance • recognise the key role of Traditional Owners in cultural heritage matters • establish practical and flexible processes for dealing with cultural heritage in a timely manner.	Identification of Torres Strait Islander historic places, objects and archaeological sites in State waters or shorelines that may be impacted by the Activity and reporting of any identified historic places, objects, shipwrecks and archaeological sites or impacts to them. Operational Area does not overlap with State waters, as such only applicable in the event of oil spill. Applicable heritage values of the area of the proposed activities are described in Cooper Energy Description of the Environment (COE-EN-EMP-0001).	Department of Aboriginal and Torres Strait Islander Partnerships
Queensland Heritage Act 1992	Provides for the conservation of Queensland's cultural heritage for the benefit of the community and future generations. Noting Queensland's Indigenous cultural heritage is protected under specific, separate legislation.	Identification of Queensland historic places, objects, shipwrecks and archaeological sites in State waters or shorelines that may be impacted by the Activity and reporting of any identified historic places, objects, shipwrecks and archaeological sites or impacts to them. Operational Area does not overlap with State waters, as such only applicable in the event of oil spill. Applicable heritage values of the area of the proposed activities are described in Section 4 of this EP.	Department of Environment and Science (DES)

Appendix 2 - Protected Matters Search

Appendix 2.1- Protected Matters Search (Operational Area)

Australian Government

Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

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

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

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

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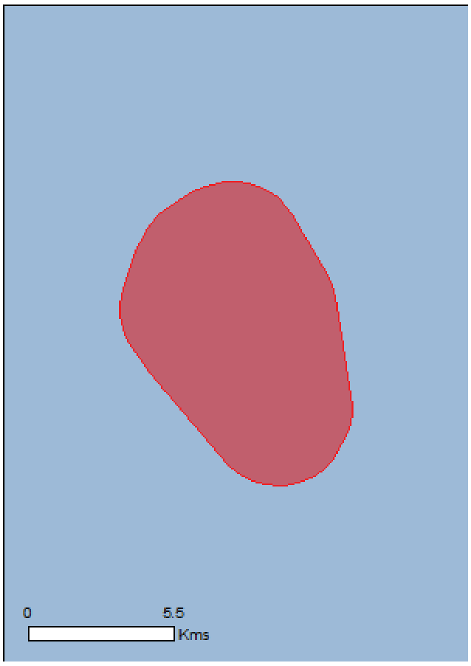

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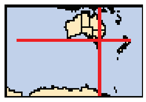


Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	35
Listed Migratory Species:	41

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	57
Whales and Other Cetaceans:	27
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

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

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

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

Name
South-east

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	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
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

Name	Status	Type of Presence
		area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	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 cauta Shy Albatross [89224]	Endangered	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 eremita Chatham Albatross [64457]	Endangered	Species or species habitat likely to 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 may 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
Mammals		
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

Name	Status	Type of Presence
		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
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

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

Name	Threatened	Type of Presence
Migratory Marine Birds		
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	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 may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Phoebetria fusca Sooty Albatross [1075]	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 cauta Shy Albatross [89224]	Endangered	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 eremita Chatham Albatross [64457]	Endangered	Species or species habitat likely to 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 may 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		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may 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 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	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	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 gibsoni Gibson's Albatross [64466]	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 may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	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 eremita Chatham Albatross [64457]	Endangered	Species or species habitat likely to 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 may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche sp. nov. Pacific Albatross [66511]	Vulnerable*	Species or species habitat may 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 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

Name	Threatened	Type of Presence
		area
Hypselognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Kimblaeus bassensis Trawl Pipefish, Bass Strait Pipefish [66247]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys semistriatus Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
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
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

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

Whales and other Cetaceans

[Resource Information]

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

Name	Status	Type of Presence
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon hectori Hector's Beaked Whale [76]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Extra Information

Key Ecological Features (Marine) [Resource Information]

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

Name	Region
Upwelling East of Eden	South-east

Caveat

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

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

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

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

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

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-38.340478 148.731682,-38.340139 148.727047,-38.339117 148.72267,-38.338311 148.720474,-38.337352 148.718431,-38.336288 148.716598,-38.3349 148.714661,-38.310174 148.687625,-38.302515 148.680784,-38.299951 148.679219,-38.297127 148.678136,-38.294811 148.677684,-38.292498 148.6776,-38.290183 148.677879,-38.288112 148.678447,-38.278262 148.682817,-38.275486 148.684413,-38.271878 148.687102,-38.269172 148.689694,-38.266897 148.692883,-38.266152 148.694207,-38.262791 148.700749,-38.261519 148.703675,-38.260648 148.706478,-38.26011 148.709148,-38.259584 148.712822,-38.259427 148.715331,-38.259498 148.718117,-38.259858 148.721068,-38.26025 148.722967,-38.261211 148.726099,-38.262523 148.729019,-38.264158 148.731663,-38.266081 148.733975,-38.268251 148.735905,-38.284095 148.747894,-38.286816 148.749578,-38.290071 148.75083,-38.316352 148.756232,-38.318854 148.756517,-38.321363 148.756357,-38.32383 148.755757,-38.326207 148.754726,-38.329353 148.753042,-38.331728 148.7515,-38.333898 148.749529,-38.335814 148.747172,-38.337827 148.743688,-38.339317 148.739748,-38.34017 148.735817,-38.340478 148.731682

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 2.2 - Protected Matters Search (Light Exposure Area)

Australian Government
Department of Agriculture, Water and the Environment

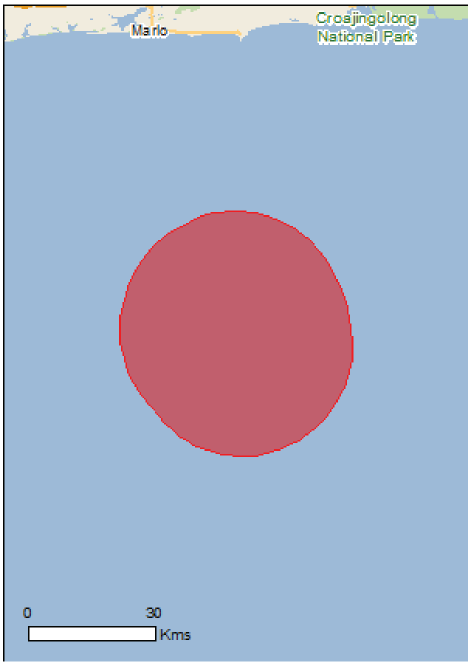
EPBC Act Protected Matters Report

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

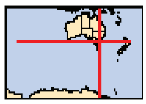
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

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

Report created: 04/11/21 21:41:47



Coordinates
Buffer: 0.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	35
Listed Migratory Species:	42

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	59
Whales and Other Cetaceans:	28
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

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

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

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

Name
South-east

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea 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
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

Name	Status	Type of Presence
		area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	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 cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur

Name	Status	Type of Presence
		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
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

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

Name	Threatened	Type of Presence
Migratory Marine Birds		
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Phoebetria fusca Sooty Albatross [1075]	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 cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat known to occur within area
Balaenoptera 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	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 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	Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea gibsoni Gibson's Albatross [64466]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche sp. nov. Pacific Albatross [66511]	Vulnerable*	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Fish		
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
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

Name	Threatened	Type of Presence
		area
Hypselognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Kimblaeus bassensis Trawl Pipefish, Bass Strait Pipefish [66247]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys semistriatus Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
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
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

Name	Threatened	Type of Presence
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area

Whales and other Cetaceans

[Resource Information]

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

Name	Status	Type of Presence
		within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon hectori Hector's Beaked Whale [76]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Extra Information

Key Ecological Features (Marine) [Resource Information]

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

Name	Region
Upwelling East of Eden	South-east

Caveat

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

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

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

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

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

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-38.502649 148.733034,-38.502524 148.722863,-38.502046 148.712721,-38.501219 148.702644,-38.499339 148.687738,-38.497671 148.677964,-38.495684 148.66835,-38.493396 148.658953,-38.489437 148.6453,-38.486459 148.636489,-38.481555 148.623824,-38.478002 148.615719,-38.472325 148.604165,-38.468311 148.596826,-38.46203 148.586442,-38.457665 148.57989,-38.450933 148.570683,-38.446321 148.564923,-38.441631 148.559466,-38.417283 148.532814,-38.404668 148.520224,-38.395927 148.512322,-38.391042 148.508192,-38.386121 148.504316,-38.378712 148.498987,-38.371272 148.494203,-38.361325 148.48863,-38.351378 148.483934,-38.341426 148.480055,-38.33396 148.477657,-38.324034 148.475123,-38.314134 148.473317,-38.304237 148.472212,-38.294347 148.471799,-38.284449 148.472073,-38.274558 148.473035,-38.264658 148.474696,-38.254746 148.477074,-38.244829 148.480192,-38.234892 148.48409,-38.22387 148.489056,-38.196132 148.505078,-38.188041 148.511078,-38.186612 148.512199,-38.159588 148.538148,-38.136703 148.570319,-38.130963 148.580666,-38.126806 148.588752,-38.114114 148.617969,-38.106181 148.643848,-38.100822 148.670497,-38.098844 148.685475,-38.097656 148.700353,-38.097292 148.710337,-38.097242 148.71739,-38.097673 148.731815,-38.098813 148.746131,-38.100647 148.760242,-38.102245 148.769512,-38.105168 148.783084,-38.114751 148.814352,-38.127847 148.843512,-38.144172 148.869937,-38.163377 148.893057,-38.185047 148.912373,-38.200873 148.924385,-38.227522 148.941011,-38.232602 148.943437,-38.24009 148.946628,-38.24763 148.949393,-38.255166 148.951723,-38.262696 148.953633,-38.290464 148.959395,-38.315477 148.962313,-38.340567 148.960788,-38.365246 148.954846,-38.389034 148.944598,-38.392183 148.942921,-38.415954 148.92754,-38.437675 148.907855,-38.456867 148.884298,-38.473108 148.857383,-38.476914 148.849671,-38.480515 148.841684,-38.485526 148.829132,-38.490003 148.815958,-38.492664 148.806842,-38.49611 148.792778,-38.498035 148.783126,-38.500312 148.768381,-38.501416 148.758363,-38.502419 148.743216,-38.502649 148.733034

Acknowledgements

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-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 2.3 - Protected Matters Search (Noise Exposure Area)

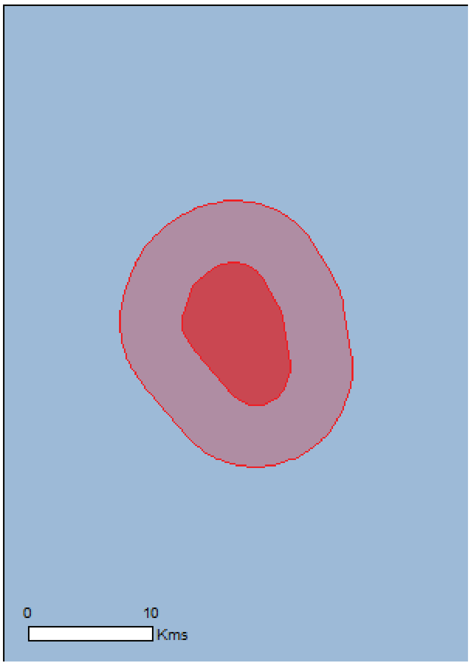
EPBC Act Protected Matters Report

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.

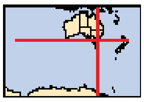
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

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

Report created: 05/11/21 12:33:45



Coordinates
Buffer: 5.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	35
Listed Migratory Species:	42

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	57
Whales and Other Cetaceans:	28
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

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

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

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

Name
South-east

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	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
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

Name	Status	Type of Presence
		area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	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 cauta Shy Albatross [89224]	Endangered	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 eremita Chatham Albatross [64457]	Endangered	Species or species habitat likely to 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 may 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
Mammals		
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

Name	Status	Type of Presence
		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
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

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

Name	Threatened	Type of Presence
Migratory Marine Birds		
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	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 may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Phoebetria fusca Sooty Albatross [1075]	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 cauta Shy Albatross [89224]	Endangered	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 eremita Chatham Albatross [64457]	Endangered	Species or species habitat likely to 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 may 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		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat known to occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may 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 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	Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	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 gibsoni Gibson's Albatross [64466]	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 may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	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 eremita Chatham Albatross [64457]	Endangered	Species or species habitat likely to 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 may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche sp. nov. Pacific Albatross [66511]	Vulnerable*	Species or species habitat may 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 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

Name	Threatened	Type of Presence
		area
Hypselognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Kimblaeus bassensis Trawl Pipefish, Bass Strait Pipefish [66247]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys semistriatus Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
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
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

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

Whales and other Cetaceans

[Resource Information]

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

Name	Status	Type of Presence
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon hectori Hector's Beaked Whale [76]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Extra Information

Key Ecological Features (Marine) [Resource Information]

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

Name	Region
Upwelling East of Eden	South-east

Caveat

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

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

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

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

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

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-38.340478 148.731682,-38.340139 148.727047,-38.339117 148.72267,-38.338311 148.720474,-38.337352 148.718431,-38.336288 148.716598,-38.3349 148.714661,-38.310174 148.687625,-38.302515 148.680784,-38.299951 148.679219,-38.297127 148.678136,-38.294811 148.677684,-38.292498 148.6776,-38.290183 148.677879,-38.288112 148.678447,-38.278262 148.682817,-38.275486 148.684413,-38.271878 148.687102,-38.269172 148.689694,-38.266897 148.692883,-38.266152 148.694207,-38.262791 148.700749,-38.261519 148.703675,-38.260648 148.706478,-38.26011 148.709148,-38.259584 148.712822,-38.259427 148.715331,-38.259498 148.718117,-38.259858 148.721068,-38.26025 148.722967,-38.261211 148.726099,-38.262523 148.729019,-38.264158 148.731663,-38.266081 148.733975,-38.268251 148.735905,-38.284095 148.747894,-38.286816 148.749578,-38.290071 148.75083,-38.316352 148.756232,-38.318854 148.756517,-38.321363 148.756357,-38.32383 148.755757,-38.326207 148.754726,-38.329353 148.753042,-38.331728 148.7515,-38.333898 148.749529,-38.335814 148.747172,-38.337827 148.743688,-38.339317 148.739748,-38.34017 148.735817,-38.340478 148.731682

Acknowledgements

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

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

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

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

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

Australian Government
Department of Agriculture, Water and the Environment

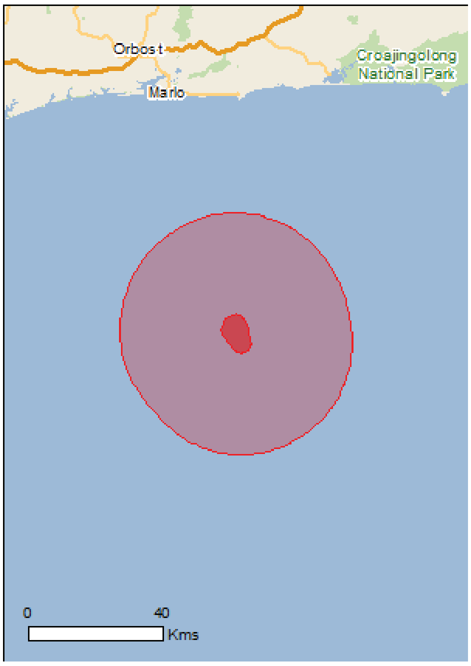
EPBC Act Protected Matters Report

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

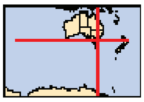
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

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

Report created: 05/11/21 14:09:16



Coordinates
Buffer: 30.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	38
Listed Migratory Species:	44

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	62
Whales and Other Cetaceans:	29
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

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

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

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

Name
South-east

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea 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
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

Name	Status	Type of Presence
		area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	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 cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thinornis cucullatus cucullatus Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat may occur within area
Fish		
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat may occur within

Name	Status	Type of Presence
		area
Mammals		
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
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

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

Name	Threatened	Type of Presence
Migratory Marine Birds		
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely

Name	Threatened	Type of Presence
		to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat known to occur within area
Balaenoptera 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	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely

Name	Threatened	Type of Presence
		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	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

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

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea gibsoni Gibson's Albatross [64466]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche sp. nov. Pacific Albatross [66511]	Vulnerable*	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Thalassarche steadi		
White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thinornis rubricollis rubricollis		
Hooded Plover (eastern) [66726]	Vulnerable*	Species or species habitat may occur within area
Fish		
Heraldia nocturna		
Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis		
Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps		
Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus minotaur		
Bullneck Seahorse [66705]		Species or species habitat may occur within area
Histiogamphelus briggsii		
Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Histiogamphelus cristatus		
Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypselognathus rostratus		
Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus		
Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Kimblaeus bassensis		
Trawl Pipefish, Bass Strait Pipefish [66247]		Species or species habitat may occur within area
Leptoichthys fistularius		
Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus runa		
Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata		
Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys semistriatus		
Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri		
Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber		
Red Pipefish [66265]		Species or species habitat may occur within area
Phyllopteryx taeniolatus		
Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
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
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area

Whales and other Cetaceans [Resource Information]

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

Name	Status	Type of Presence
		area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may 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
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
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area

Name	Status	Type of Presence
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon grayi Gray's Beaked Whale, Scamperdown Whale [75]		Species or species habitat may occur within area
Mesoplodon hectori Hector's Beaked Whale [76]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Extra Information

Key Ecological Features (Marine) [Resource Information]

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

Name	Region
Upwelling East of Eden	South-east

Caveat

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

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

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

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

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

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-38.340478 148.731682,-38.340139 148.727047,-38.339117 148.72267,-38.338311 148.720474,-38.337352 148.718431,-38.336288 148.716598,-38.3349 148.714661,-38.310174 148.687625,-38.302515 148.680784,-38.299951 148.679219,-38.297127 148.678136,-38.294811 148.677684,-38.292498 148.6776,-38.290183 148.677879,-38.288112 148.678447,-38.278262 148.682817,-38.275486 148.684413,-38.271878 148.687102,-38.269172 148.689694,-38.266897 148.692883,-38.266152 148.694207,-38.262791 148.700749,-38.261519 148.703675,-38.260648 148.706478,-38.26011 148.709148,-38.259584 148.712822,-38.259427 148.715331,-38.259498 148.718117,-38.259858 148.721068,-38.26025 148.722967,-38.261211 148.726099,-38.262523 148.729019,-38.264158 148.731663,-38.266081 148.733975,-38.268251 148.735905,-38.284095 148.747894,-38.286816 148.749578,-38.290071 148.75083,-38.316352 148.756232,-38.318854 148.756517,-38.321363 148.756357,-38.32383 148.755757,-38.326207 148.754726,-38.329353 148.753042,-38.331728 148.7515,-38.333898 148.749529,-38.335814 148.747172,-38.337827 148.743688,-38.339317 148.739748,-38.34017 148.735817,-38.340478 148.731682

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 2.4 - Protected Matters Search (Spill EMBA)

EPBC Act Protected Matters Report

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

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

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

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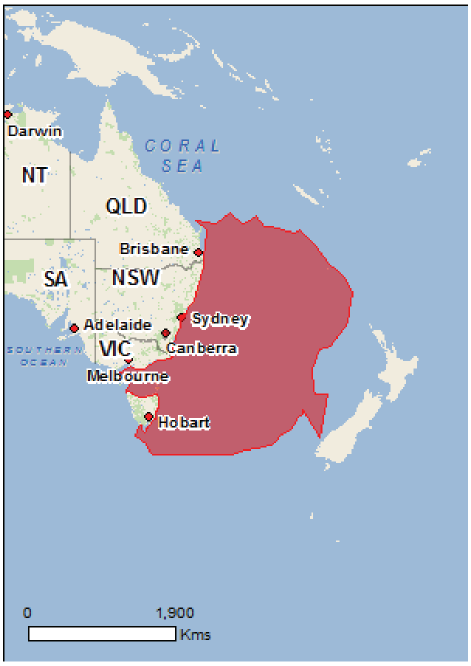
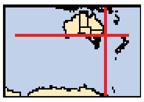


Coordinates
Buffer: 0.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	13
National Heritage Places:	21
Wetlands of International Importance:	15
Great Barrier Reef Marine Park:	7
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	25
Listed Threatened Species:	373
Listed Migratory Species:	105

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	78
Commonwealth Heritage Places:	98
Listed Marine Species:	200
Whales and Other Cetaceans:	44
Critical Habitats:	1
Commonwealth Reserves Terrestrial:	5
Australian Marine Parks:	37

Extra Information

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

State and Territory Reserves:	562
Regional Forest Agreements:	6
Invasive Species:	71
Nationally Important Wetlands:	117
Key Ecological Features (Marine)	12

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Status
Australian Convict Sites (Darlington Probation Station Buffer Zone)	TAS	Buffer zone
Australian Convict Sites (Hyde Park Barracks Buffer Zone)	NSW	Buffer zone
Australian Convict Sites (Port Arthur Historic Site Buffer Zone)	TAS	Buffer zone
Sydney Opera House - Buffer Zone	NSW	Buffer zone
Australian Convict Sites (Darlington Probation Station)	TAS	Declared property
Australian Convict Sites (Hyde Park Barracks)	NSW	Declared property
Australian Convict Sites (Kingston and Arthurs Vale Historic Area)	EXT	Declared property
Australian Convict Sites (Port Arthur Historic Site)	TAS	Declared property
Gondwana Rainforests of Australia	NSW	Declared property
Great Barrier Reef	QLD	Declared property
Lord Howe Island Group	NSW	Declared property
Sydney Opera House	NSW	Declared property
Tasmanian Wilderness	TAS	Declared property

National Heritage Properties [Resource Information]

Name	State	Status
Natural		
Gondwana Rainforests of Australia	NSW	Listed place
Great Barrier Reef	QLD	Listed place
Ku-ring-gai Chase National Park, Lion, Long and Spectacle Island Nature Reserves	NSW	Listed place
Lord Howe Island Group	NSW	Listed place
Royal National Park and Garawarra State Conservation Area	NSW	Listed place
Tasmanian Wilderness	TAS	Listed place
Indigenous		
Cyprus Hellene Club - Australian Hall	NSW	Listed place
Historic		
Bondi Beach	NSW	Listed place
Centennial Park	NSW	Listed place
Darlington Probation Station	TAS	Listed place
First Government House Site	NSW	Listed place
HMS Sirius Shipwreck	EXT	Listed place
Hyde Park Barracks	NSW	Listed place
Kamay Botany Bay: botanical collection sites	NSW	Listed place
Kingston and Arthurs Vale Historic Area	EXT	Listed place
Kurnell Peninsula Headland	NSW	Listed place
North Head - Sydney	NSW	Listed place
Port Arthur Historic Site	TAS	Listed place
Sydney Harbour Bridge	NSW	Listed place
Sydney Opera House	NSW	Listed place
Bondi Surf Pavilion	NSW	Within listed place

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Apsley marshes	Within 10km of Ramsar
Corner inlet	Within Ramsar site
East coast cape barren island lagoons	Within Ramsar site
Elizabeth and middleton reefs marine national nature reserve	Within Ramsar site
Flood plain lower ringarooma river	Within Ramsar site
Gippsland lakes	Within Ramsar site
Hunter estuary wetlands	Within Ramsar site
Jocks lagoon	Within Ramsar site
Little waterhouse lake	Within Ramsar site
Logan lagoon	Within Ramsar site
Moreton bay	Within Ramsar site
Moulting lagoon	Within Ramsar site
Myall lakes	Within Ramsar site
Towra point nature reserve	Within Ramsar site
Western port	Within 10km of Ramsar

Great Barrier Reef Marine Park [Resource Information]

Type	Zone	IUCN
Buffer	B-22-3012	IV
Commonwealth Island (GBRMPA)	Lady Elliot Island (24008100)	II
General Use	GU-21-6016	VI
Habitat Protection	HP-24-5376	VI
Marine National Park	MNP-22-1154	II
Marine National Park	MNP-24-1172	II
Marine National Park	MNP-23-1169	II

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea
Extended Continental Shelf

Marine Regions [Resource Information]

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

Name
Coral Sea
South-east
Temperate East

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
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
Castlereagh Scribbly Gum and Agnes Banks Woodlands of the Sydney Basin Bioregion	Endangered	Community may occur within area
Central Hunter Valley eucalypt forest and woodland	Critically Endangered	Community may occur within area
Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community	Endangered	Community likely to occur within area
Coastal Upland Swamps in the Sydney Basin Bioregion	Endangered	Community likely to occur within area
Cooks River/Castlereagh Ironbark Forest of the Sydney Basin Bioregion	Critically Endangered	Community may occur within area
Eastern Suburbs Banksia Scrub of the Sydney Region	Endangered	Community known to occur within area
Eucalyptus ovata - Callitris oblonga Forest	Vulnerable	Community likely to occur within area
Giant Kelp Marine Forests of South East Australia	Endangered	Community likely to occur within area
Gippsland Red Gum (Eucalyptus tereticornis subsp. mediana) Grassy Woodland and Associated Native Grassland	Critically Endangered	Community likely to occur within area
Illawarra and south coast lowland forest and woodland ecological community	Critically Endangered	Community likely to occur within area
Illawarra-Shoalhaven Subtropical Rainforest of the Sydney Basin Bioregion	Critically Endangered	Community likely to 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 likely to occur within area
Lowland Native Grasslands of Tasmania	Critically Endangered	Community likely to

Name	Status	Type of Presence
		occur within area
Lowland Rainforest of Subtropical Australia	Critically Endangered	Community likely to occur within area
Natural Damp Grassland of the Victorian Coastal Plains	Critically Endangered	Community likely to occur within area
Posidonia australis seagrass meadows of the Manning-Hawkesbury ecoregion	Endangered	Community likely to occur within area
Robertson Rainforest in the Sydney Basin Bioregion	Critically Endangered	Community likely to occur within area
Shale Sandstone Transition Forest of the Sydney Basin Bioregion	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
Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion	Endangered	Community may occur within area
Western Sydney Dry Rainforest and Moist Woodland on Shale	Critically Endangered	Community may occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anthochaera phrygia		
Regent Honeyeater [82338]	Critically Endangered	Species or species habitat known to occur within area
Aquila audax fleayi		
Tasmanian Wedge-tailed Eagle, Wedge-tailed Eagle (Tasmanian) [64435]	Endangered	Breeding likely to occur within area
Atrichornis rufescens		
Rufous Scrub-bird [655]	Endangered	Species or species habitat may occur within area
Botaurus poiciloptilus		
Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris canutus		
Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris		
Great Knot [862]	Critically Endangered	Roosting known to occur within area
Ceyx azureus diemenensis		
Tasmanian Azure Kingfisher [25977]	Endangered	Breeding known to occur within area
Charadrius leschenaultii		
Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus		
Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Cyanoramphus cookii		
Norfolk Island Green Parrot, Tasman Parakeet, Norfolk Island Parakeet [67046]	Endangered	Breeding known to occur within area
Cyclopsitta diophthalma coxeni		
Coxen's Fig-Parrot [59714]	Endangered	Species or species habitat 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

Name	Status	Type of Presence
		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
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat known to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area
Fregetta grallaria grallaria White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Breeding known to occur within area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat may 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
Hypotaenidia sylvestris Lord Howe Woodhen [87732]	Endangered	Breeding likely to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Breeding known to occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route known to occur within area
Ninox novaeseelandiae undulata Norfolk Island Boobook, Norfolk Island Morepork, Southern Boobook (Norfolk Island) [26188]	Endangered	Breeding known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Pachycephala pectoralis xanthoprocta Golden Whistler (Norfolk Island) [64444]	Vulnerable	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Pardalotus quadragintus Forty-spotted Pardalote [418]	Endangered	Species or species habitat known to occur within area
Petroica multicolor Norfolk Island Robin, Pacific Robin [604]	Vulnerable	Breeding likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma heraldica Herald Petrel [66973]	Critically Endangered	Species or species habitat likely to occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Breeding known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Breeding known to occur within area
Pterodroma neglecta neglecta Kermadec Petrel (western) [64450]	Vulnerable	Breeding known to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat known to occur within area
Strepera graculina crissalis Lord Howe Island Currawong, Pied Currawong (Lord Howe Island) [25994]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Breeding known to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Foraging, feeding or related behaviour likely to 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

Name	Status	Type of Presence
		related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thinornis cucullatus cucullatus Hooded Plover (eastern), Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area
Turnix melanogaster Black-breasted Button-quail [923]	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
Crustaceans		
Astacopsis gouldi Giant Freshwater Crayfish, Tasmanian Giant Freshwater Lobster [64415]	Vulnerable	Species or species habitat known to occur within area
Engaeus granulatus Central North Burrowing Crayfish [78959]	Endangered	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
Engaeus yabbimunna Burnie Burrowing Crayfish [66781]	Vulnerable	Species or species habitat known to occur within area
Fish		
Brachionichthys hirsutus Spotted Handfish [64418]	Critically Endangered	Species or species habitat may occur within area
Brachiopsilus ziebelli Ziebell's Handfish, Waterfall Bay Handfish [83757]	Vulnerable	Species or species habitat likely to occur within area
Epinephelus daemelii Black Rockcod, Black Cod, Saddled Rockcod [68449]	Vulnerable	Species or species habitat likely to occur within area
Galaxiella pusilla Eastern Dwarf Galaxias, Dwarf Galaxias [56790]	Vulnerable	Species or species habitat known to occur within area
Maccullochella ikei Clarence River Cod, Eastern Freshwater Cod [26170]	Endangered	Species or species habitat known to occur within area
Macquaria australasica Macquarie Perch [66632]	Endangered	Species or species habitat may occur within area
Nannoperca oxleyana Oxleyan Pygmy Perch [64468]	Endangered	Species or species habitat known to occur within area
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat known to occur within area
Thymichthys politus Red Handfish [83756]	Critically Endangered	Species or species habitat likely to occur within area
Frogs		

Name	Status	Type of Presence
Heleioporus australiacus Giant Burrowing Frog [1973]	Vulnerable	Species or species habitat known to occur within area
Litoria aurea Green and Golden Bell Frog [1870]	Vulnerable	Species or species habitat known to occur within area
Litoria littlejohni Littlejohn's Tree Frog, Heath Frog [64733]	Vulnerable	Species or species habitat known to occur within area
Litoria olongburensis Wallum Sedge Frog [1821]	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
Mixophyes balbus Stuttering Frog, Southern Barred Frog (in Victoria) [1942]	Vulnerable	Species or species habitat known to occur within area
Mixophyes fleayi Fleay's Frog [25960]	Endangered	Species or species habitat likely to occur within area
Mixophyes iteratus Giant Barred Frog, Southern Barred Frog [1944]	Endangered	Species or species habitat known to occur within area
Insects		
Antipodia chaostola leucophaea Tasmanian Chaostola Skipper, Heath-sand Skipper [77672]	Endangered	Species or species habitat known to occur within area
Argynnis hyperbius inconstans Australian Fritillary [88056]	Critically Endangered	Species or species habitat likely to occur within area
Dryococelus australis Lord Howe Island Phasmid, Land Lobster [66752]	Critically Endangered	Species or species habitat known to occur within area
Lissotes latidens Broad-toothed Stag Beetle, Wielangta Stag Beetle [66760]	Endangered	Species or species habitat known to occur within area
Phyllodes imperialis smithersi Pink Underwing Moth [86084]	Endangered	Breeding may occur within area
Mammals		
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	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
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat known to occur within area

Name	Status	Type of Presence
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
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
Dasyurus viverrinus Eastern Quoll, Luaner [333]	Endangered	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 known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Mirounga leonina Southern Elephant Seal [26]	Vulnerable	Breeding may 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 known to occur within area
Petrogale penicillata Brush-tailed Rock-wallaby [225]	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]	Vulnerable	Species or species habitat known to occur within area
Potorous longipes Long-footed Potoroo [217]	Endangered	Species or species habitat known 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 likely to occur within area
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	Roosting known to occur within area
Sarcophilus harrisii Tasmanian Devil [299]	Endangered	Translocated population known to occur within area
Xeromys myoides Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat known to occur within area

Name	Status	Type of Presence
Other		
Advena campbellii Campbell's Helicarionid Land Snail [81250]	Critically Endangered	Species or species habitat known to occur within area
Gudeoconcha sophiae magnifica Magnificent Helicarionid Land Snail [82864]	Critically Endangered	Species or species habitat likely to occur within area
Leucopatus anophthalmus Blind Velvet Worm [90855]	Endangered	Species or species habitat known to occur within area
Mathewsoconcha grayi ms Gray's Helicarionid Land Snail [81852]	Critically Endangered	Species or species habitat likely to occur within area
Mathewsoconcha phillipii Phillip Island Helicarionid Land Snail [81252]	Critically Endangered	Species or species habitat likely to occur within area
Mathewsoconcha suteri a helicarionid land snail [81851]	Critically Endangered	Species or species habitat likely to occur within area
Mystivagor mastersi Masters' Charopid Land Snail [81247]	Critically Endangered	Species or species habitat known to occur within area
Parvulastra vivipara Tasmanian Live-bearing Seastar [85451]	Vulnerable	Species or species habitat likely to occur within area
Placostylus bivaricosus Lord Howe Flax Snail, Lord Howe Placostylus [66769]	Endangered	Species or species habitat known to occur within area
Pseudocharopa ledgbirdi Mount Lidgbird Charopid Land Snail [85279]	Critically Endangered	Species or species habitat likely to occur within area
Pseudocharopa whiteleggei Whitelegge's Land Snail [81249]	Critically Endangered	Species or species habitat likely to occur within area
Quintalia stoddartii Stoddart's Helicarionid Land Snail [81253]	Critically Endangered	Species or species habitat likely to occur within area
Thersites mitchellae Mitchell's Rainforest Snail [66774]	Critically Endangered	Species or species habitat known to occur within area
Plants		
Abutilon julianae Norfolk Island Abutilon [27797]	Critically Endangered	Species or species habitat known to occur within area
Acacia attenuata [10690]	Vulnerable	Species or species habitat likely to occur within area
Acacia axillaris Midlands Mimosa, Midlands Wattle [13563]	Vulnerable	Species or species habitat known to occur within area
Acacia bynoeana Bynoe's Wattle, Tiny Wattle [8575]	Vulnerable	Species or species habitat likely to occur within area
Acacia caerulescens Limestone Blue Wattle, Buchan Blue, Buchan Blue Wattle [21883]	Vulnerable	Species or species habitat known to occur

Name	Status	Type of Presence
		within area
Acacia constablei Narrabarba Wattle [10798]	Vulnerable	Species or species habitat known to occur within area
Acacia courtii Northern Brother Wattle [56299]	Vulnerable	Species or species habitat known to occur within area
Acacia georgensis Bega Wattle [9848]	Vulnerable	Species or species habitat known to occur within area
Acacia pubescens Downy Wattle, Hairy Stemmed Wattle [18800]	Vulnerable	Species or species habitat likely to occur within area
Acacia terminalis subsp. terminalis MS Sunshine Wattle (Sydney region) [88882]	Endangered	Species or species habitat known to occur within area
Achyranthes arborescens Chaff Tree, Soft-wood [65879]	Critically Endangered	Species or species habitat known to occur within area
Achyranthes margaretarum Phillip Island Chaffy Tree [68426]	Critically Endangered	Species or species habitat known to occur within area
Acronychia littoralis Scented Acronychia [8582]	Endangered	Species or species habitat known to occur within area
Allocasuarina defungens Dwarf Heath Casuarina [21924]	Endangered	Species or species habitat known to occur within area
Allocasuarina glareicola [21932]	Endangered	Species or species habitat may occur within area
Allocasuarina portuensis Nielsen Park She-oak [21937]	Endangered	Species or species habitat known to occur within area
Allocasuarina simulans Nabiac Casuarina [21935]	Vulnerable	Species or species habitat known to occur within area
Allocasuarina thalassoscopica [21927]	Endangered	Species or species habitat known to occur within area
Amphibromus fluitans River Swamp Wallaby-grass, Floating Swamp Wallaby-grass [19215]	Vulnerable	Species or species habitat known to occur within area
Amyema plicatula [81879]	Endangered	Species or species habitat may occur within area
Angophora inopina Charmhaven Apple [64832]	Vulnerable	Species or species habitat known to occur within area
Angophora robur Sandstone Rough-barked Apple [56088]	Vulnerable	Species or species habitat may occur within area
Anthosachne kingiana subsp. kingiana Phillip Island Wheat Grass [87946]	Critically Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Arthraxon hispidus Hairy-joint Grass [9338]	Vulnerable	Species or species habitat known to occur within area
Asperula asthenes Trailing Woodruff [14004]	Vulnerable	Species or species habitat known to occur within area
Asterolasia elegans [56780]	Endangered	Species or species habitat known to occur within area
Astrotricha crassifolia Thick-leaf Star-hair [10352]	Vulnerable	Species or species habitat known to occur within area
Baloghia marmorata Marbled Balogia, Jointed Baloghia [8463]	Vulnerable	Species or species habitat likely to occur within area
Banksia vincentia [88276]	Critically Endangered	Species or species habitat known to occur within area
Bertya tasmanica subsp. tasmanica Tasmanian Bertya [78359]	Endangered	Species or species habitat known to occur within area
Blechnum norfolkianum Norfolk Island Water-fern [65885]	Endangered	Species or species habitat known to occur within area
Boehmeria australis subsp. australis Tree Nettle, Nettletree [83309]	Critically Endangered	Species or species habitat known to occur within area
Boronia gunnii Gunn's Boronia, Cataract Gorge Boronia [29394]	Vulnerable	Species or species habitat likely to occur within area
Boronia umbellata Orara Boronia [56301]	Vulnerable	Species or species habitat known to occur within area
Bosistoa transversa Three-leaved Bosistoa, Yellow Satinheart [16091]	Vulnerable	Species or species habitat likely to occur within area
Bulbophyllum globuliforme Miniature Moss-orchid, Hoop Pine Orchid [6649]	Vulnerable	Species or species habitat may occur within area
Caladenia campbellii Thick-stem Caladenia [64857]	Critically Endangered	Species or species habitat known to occur within area
Caladenia caudata Tailed Spider-orchid [17067]	Vulnerable	Species or species habitat known to occur within area
Caladenia dienema Windswept Spider-orchid [64858]	Endangered	Species or species habitat may occur within area
Caladenia lindleyana Lindley's Spider-orchid [9305]	Critically Endangered	Species or species habitat may occur within area
Caladenia orientalis Eastern Spider Orchid [83410]	Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
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
Callitris oblonga Pygmy Cypress-pine, Pigmy Cypress-pine, Dwarf Cypress-pine [66687]	Vulnerable	Species or species habitat known to occur within area
Callitris oblonga subsp. oblonga South Esk Pine [64864]	Endangered	Species or species habitat known to occur within area
Calystegia affinis [48909]	Critically Endangered	Species or species habitat known to occur within area
Cassinia rugata Wrinkled Cassinia, Wrinkled Dollybush [21885]	Vulnerable	Species or species habitat may occur within area
Clematis dubia a creeper, Clematis [22035]	Critically Endangered	Species or species habitat known to occur within area
Clematis fawcettii Stream Clematis [4311]	Vulnerable	Species or species habitat may occur within area
Commersonia prostrata Dwarf Kerrawang [87152]	Endangered	Species or species habitat known to occur within area
Conospermum hookeri Variable Smoke-bush [68161]	Vulnerable	Species or species habitat likely to occur within area
Coprosma baueri Coastal Coprosma [37851]	Endangered	Species or species habitat known to occur within area
Coprosma pilosa Mountain Coprosma [37884]	Endangered	Species or species habitat known to occur within area
Cordyline obtecta Ti [65878]	Vulnerable	Species or species habitat known to occur within area
Corokia whiteana [17820]	Vulnerable	Species or species habitat known to occur within area
Correa baeuerlenii Chef's Cap [17007]	Vulnerable	Species or species habitat known to occur within area
Corunastylis brachystachya Short-spiked Midge-orchid [76410]	Endangered	Species or species habitat known to occur within area
Corunastylis firthii Firth's Midge-orchid [76411]	Critically Endangered	Species or species habitat known to occur within area
Corunastylis insignis Wyong Midge Orchid 1, Variable Midge Orchid 1 [84692]	Critically Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Corunastylis littoralis Tuncurry Midge Orchid [82945]	Critically Endangered	Species or species habitat known to occur within area
Corynocarpus rupestris subsp. rupestris Glenugie Karaka [19303]	Vulnerable	Species or species habitat known to occur within area
Cryptocarya foetida Stinking Cryptocarya, Stinking Laurel [11976]	Vulnerable	Species or species habitat known to occur within area
Cryptostylis hunteriana Leafless Tongue-orchid [19533]	Vulnerable	Species or species habitat known to occur within area
Cynanchum elegans White-flowered Wax Plant [12533]	Endangered	Species or species habitat known to occur within area
Daphnandra johnsonii Illawarra Socketwood [67186]	Endangered	Species or species habitat likely to occur within area
Darwinia biflora [14619]	Vulnerable	Species or species habitat known to occur within area
Davidsonia jerseyana Davidson's Plum [67219]	Endangered	Species or species habitat known to occur within area
Davidsonia johnsonii Smooth Davidsonia, Smooth Davidson's Plum, Small-leaved Davidson's Plum [67178]	Endangered	Species or species habitat known to occur within area
Dendrobium brachypus Norfolk Island Orchid [2592]	Endangered	Species or species habitat known to occur within area
Desmodium acanthocladum Thorny Pea [17972]	Vulnerable	Species or species habitat known to occur within area
Dianella amoena Matted Flax-lily [64886]	Endangered	Species or species habitat known to occur within area
Diospyros mabacea Red-fruited Ebony, Silky Persimmon, Ebony [18548]	Endangered	Species or species habitat known to occur within area
Diploglottis campbellii Small-leaved Tamarind [21484]	Endangered	Species or species habitat known to occur within area
Diuris lanceolata Snake Orchid [10231]	Endangered	Species or species habitat known to occur within area
Diuris praecox Newcastle Doubletail [55086]	Vulnerable	Species or species habitat known to occur within area
Dodonaea procumbens Trailing Hop-bush [12149]	Vulnerable	Species or species habitat known to occur within area
Dysoxylum bijugum Sharkwood, a tree [65892]	Vulnerable	Species or species habitat known to occur within area

Name	Status	Type of Presence
Elaeocarpus williamsianus Hairy Quandong [8956]	Endangered	Species or species habitat known to occur within area
Elatostema montanum Mountain Procris [33862]	Critically Endangered	Species or species habitat known to occur within area
Endiandra floydii Floyd's Walnut [52955]	Endangered	Species or species habitat known to occur within area
Endiandra hayesii Rusty Rose Walnut, Velvet Laurel [13866]	Vulnerable	Species or species habitat likely to occur within area
Epacris apsleyensis Apsley Heath [15428]	Endangered	Species or species habitat known to occur within area
Epacris barbata Bearded Heath, Freycinet Heath [17625]	Endangered	Species or species habitat likely to occur within area
Epacris exserta South Esk Heath [19879]	Endangered	Species or species habitat likely to occur within area
Epacris grandis Grand Heath, Tall Heath [18719]	Endangered	Species or species habitat likely to occur within area
Epacris virgata Pretty Heath, Dan Hill Heath [20375]	Endangered	Species or species habitat known to occur within area
Eucalyptus camfieldii Camfield's Stringybark [15460]	Vulnerable	Species or species habitat known to occur within area
Eucalyptus glaucina Slaty Red Gum [5670]	Vulnerable	Species or species habitat may occur within area
Eucalyptus parramattensis subsp. decadens Earp's Gum, Earp's Dirty Gum [56148]	Vulnerable	Species or species habitat known to occur within area
Eucalyptus strzeleckii Strzelecki Gum [55400]	Vulnerable	Species or species habitat known to occur within area
Eucalyptus tetrapleura Square-fruited Ironbark [7490]	Vulnerable	Species or species habitat known to occur within area
Euphorbia norfolkiana Norfolk Island Euphorbia [65887]	Critically Endangered	Species or species habitat known to occur within area
Euphorbia obliqua a herb [44385]	Vulnerable	Species or species habitat likely to occur within area
Euphrasia amphisysepala Shiny Cliff Eyebright [4534]	Vulnerable	Species or species habitat known to occur within area
Euphrasia arguta [4325]	Critically Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Euphrasia collina subsp. muelleri Purple Eyebright, Mueller's Eyebright [16151]	Endangered	Species or species habitat likely to occur within area
Euphrasia phragmostoma Buftons Eyebright, Hairy Cliff Eyebright [7720]	Vulnerable	Species or species habitat known to occur within area
Euphrasia semipicta Peninsula Eyebright [9986]	Endangered	Species or species habitat known to occur within area
Euphrasia sp. Bivouac Bay (W.R.Barker 7626 et al.) Masked Eyebright, Masked Cliff Eyebright [82044]	Endangered	Species or species habitat known to occur within area
Floydia praealta Ball Nut, Possum Nut, Big Nut, Beefwood [15762]	Vulnerable	Species or species habitat known to occur within area
Fontainea australis Southern Fontainea [24037]	Vulnerable	Species or species habitat known to occur within area
Fontainea oraria Coastal Fontainea [24038]	Critically Endangered	Species or species habitat known to occur within area
Geniostoma huttonii [56368]	Endangered	Species or species habitat known to occur within area
Genoplesium baueri Yellow Gnat-orchid, Bauer's Midge Orchid, Brittle Midge Orchiid [7528]	Endangered	Species or species habitat known to occur within area
Genoplesium rhyoliticum Pambula Midge-orchid [55116]	Endangered	Species or species habitat likely to occur within area
Genoplesium vernale East Lynne Midge-orchid [68379]	Vulnerable	Species or species habitat known to occur within area
Glycine latrobeana Clover Glycine, Purple Clover [13910]	Vulnerable	Species or species habitat known to occur within area
Gossia fragrantissima Sweet Myrtle, Small-leaved Myrtle [78867]	Endangered	Species or species habitat known to occur within area
Grevillea caleyi Caley's Grevillea [9683]	Critically Endangered	Species or species habitat likely to occur within area
Grevillea parviflora subsp. parviflora Small-flower Grevillea [64910]	Vulnerable	Species or species habitat known to occur within area
Grevillea shiressii [19186]	Vulnerable	Species or species habitat known to occur within area
Hakea archaeoides [66702]	Vulnerable	Species or species habitat likely to occur within area
Haloragis exalata subsp. exalata Wingless Raspwort, Square Raspwort [24636]	Vulnerable	Species or species habitat known to occur within area

Name	Status	Type of Presence
Haloragis exalata subsp. velutina Tall Velvet Sea-berry [16839]	Vulnerable	Species or species habitat may occur within area
Haloragodendron lucasii Hal [6480]	Endangered	Species or species habitat may occur within area
Hibiscus insularis Phillip Island Hibiscus [30614]	Critically Endangered	Species or species habitat likely to occur within area
Hicksbeachia pinnatifolia Monkey Nut, Bopple Nut, Red Bopple, Red Bopple Nut, Red Nut, Beef Nut, Red Apple Nut, Red Boppel Nut, Ivory Silky Oak [21189]	Vulnerable	Species or species habitat known to occur within area
Hypolepis dicksonioides Downy Ground-fern, Brake Fern, Ground Fern [10243]	Vulnerable	Species or species habitat likely to occur within area
Ileostylus micranthus Mistletoe [65891]	Vulnerable	Species or species habitat known to occur within area
Isoglossa eranthemoides Isoglossa [16663]	Endangered	Species or species habitat known to occur within area
Kunzea rupestris [8798]	Vulnerable	Species or species habitat likely to occur within area
Lasiopetalum joyceae [20311]	Vulnerable	Species or species habitat known to occur within area
Lastreopsis calantha Shield-fern, Shieldfern [65884]	Endangered	Species or species habitat known to occur within area
Leionema ralstonii [64926]	Vulnerable	Species or species habitat likely to occur within area
Lepidium hyssopifolium Basalt Pepper-cress, Peppercress, Rubble Pepper-cress, Pepperweed [16542]	Endangered	Species or species habitat known to occur within area
Lepidorrhachis mooreana Little Mountain Palm, Moorei Palm [6388]	Critically Endangered	Species or species habitat known to occur within area
Leucochrysum albicans subsp. tricolor Hoary Sunray, Grassland Paper-daisy [89104]	Endangered	Species or species habitat known to occur within area
Leucopogon exolasius Woronora Beard-heath [14251]	Vulnerable	Species or species habitat likely to occur within area
Macadamia integrifolia Macadamia Nut, Queensland Nut Tree, Smooth-shelled Macadamia, Bush Nut, Nut Oak [7326]	Vulnerable	Species or species habitat known to occur within area
Macadamia tetraphylla Rough-shelled Bush Nut, Macadamia Nut, Rough-shelled Macadamia, Rough-leaved Queensland Nut [6581]	Vulnerable	Species or species habitat known to occur within area
Marattia salicina King Fern, Para, Potato Fern [16197]	Endangered	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Marsdenia longiloba Clear Milkvine [2794]	Vulnerable	Species or species habitat known to occur within area
Melaleuca biconvexa Biconvex Paperbark [5583]	Vulnerable	Species or species habitat known to occur within area
Melaleuca deanei Deane's Melaleuca [5818]	Vulnerable	Species or species habitat known to occur within area
Melichrus sp. Newfoundland State Forest (P.Gilmour 7852) Hairy Melichrus [82048]	Endangered	Species or species habitat known to occur within area
Melicope littoralis Shade Tree [22042]	Vulnerable	Species or species habitat known to occur within area
Melicytus latifolius Norfolk Island Mahoe [56677]	Critically Endangered	Species or species habitat known to occur within area
Melicytus ramiflorus subsp. oblongifolius Whiteywood, a tree [56680]	Vulnerable	Species or species habitat likely to occur within area
Meryta angustifolia a tree [65881]	Vulnerable	Species or species habitat known to occur within area
Meryta latifolia Shade Tree, Broad-leaved Meryta [65882]	Critically Endangered	Species or species habitat likely to occur within area
Micromyrtus blakelyi [6870]	Vulnerable	Species or species habitat likely to occur within area
Muehlenbeckia australis Shrubby Creeper, Pohuehue [68510]	Endangered	Species or species habitat known to occur within area
Myoporum obscurum Popwood, Sandalwood, Bastard Ironwood [50255]	Critically Endangered	Species or species habitat known to occur within area
Myrsine ralstoniae Beech [83889]	Vulnerable	Species or species habitat known to occur within area
Ochrosia moorei Southern Ochrosia [11350]	Endangered	Species or species habitat known to occur within area
Olax angulata Minnie Waters Olax [10666]	Vulnerable	Species or species habitat known to occur within area
Olearia hygrophila Swamp Daisy, Water Daisy [5631]	Endangered	Species or species habitat may occur within area
Owenia cepiodora Onionwood, Bog Onion, Onion Cedar [11344]	Vulnerable	Species or species habitat likely to occur within area
Parsonsia dorrigoensis Milky Silkpod [64684]	Endangered	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Pennantia endlicheri Pennantia [65890]	Endangered	Species or species habitat known to occur within area
Persicaria elatior Knotweed, Tall Knotweed [5831]	Vulnerable	Species or species habitat known to occur within area
Persoonia hirsuta Hairy Geebung, Hairy Persoonia [19006]	Endangered	Species or species habitat known to occur within area
Persoonia mollis subsp. maxima [56075]	Endangered	Species or species habitat may occur within area
Persoonia nutans Nodding Geebung [18119]	Endangered	Species or species habitat known to occur within area
Phaius australis Lesser Swamp-orchid [5872]	Endangered	Species or species habitat known to occur within area
Phaius bernaysii Yellow Swamp-orchid [4918]	Endangered	Species or species habitat likely to occur within area
Phebalium daviesii Davies' Waxflower, St Helens Waxflower [16959]	Critically Endangered	Species or species habitat known to occur within area
Philotheca freyciana Freycinet Waxflower [68227]	Endangered	Species or species habitat known to occur within area
Phreatia limenophylax Norfolk Island Phreatia [9239]	Critically Endangered	Species or species habitat known to occur within area
Phreatia paleata an orchid [20193]	Endangered	Species or species habitat known to occur within area
Pimelea curviflora var. curviflora [4182]	Vulnerable	Species or species habitat known to occur within area
Pimelea spicata Spiked Rice-flower [20834]	Endangered	Species or species habitat known to occur within area
Pittosporum bracteolatum Oleander [47181]	Vulnerable	Species or species habitat known to occur within area
Planchonella costata [30944]	Endangered	Species or species habitat known to occur within area
Plectranthus nitidus Nightcap Plectranthus, Silver Plectranthus [55742]	Endangered	Species or species habitat likely to occur within area
Polyphlebium endlicherianum Middle Filmy Fern [87494]	Endangered	Species or species habitat known to occur within area
Polystichum moorei Rock Shield Fern [40755]	Endangered	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Pomaderris cotoneaster Cotoneaster Pomaderris [2043]	Endangered	Species or species habitat may occur within area
Pomaderris parrisiae Parris' Pomaderris [22119]	Vulnerable	Species or species habitat likely to occur within area
Prasophyllum affine Jervis Bay Leek Orchid, Culburra Leek-orchid, Kinghorn Point Leek-orchid [2210]	Endangered	Species or species habitat known to occur within area
Prasophyllum apoxychilum Tapered Leek-orchid [64947]	Endangered	Species or species habitat known to occur within area
Prasophyllum atratum Three Hummock Leek-orchid [82677]	Critically Endangered	Species or species habitat known to occur within area
Prasophyllum castaneum Chestnut Leek-orchid [64948]	Critically Endangered	Species or species habitat likely to occur within area
Prasophyllum frenchii Maroon Leek-orchid, Slaty Leek-orchid, Stout Leek-orchid, French's Leek-orchid, Swamp Leek-orchid [9704]	Endangered	Species or species habitat likely to occur within area
Prasophyllum limnetes Marsh Leek-orchid [82678]	Critically Endangered	Species or species habitat may 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 sp. Wybong (C.Phelps ORG 5269) a leek-orchid [81964]	Critically Endangered	Species or species habitat may occur within area
Prasophyllum spicatum Dense Leek-orchid [55146]	Vulnerable	Species or species habitat known to occur within area
Prostanthera askania Tranquillity Mintbush, Tranquility Mintbush [64958]	Endangered	Species or species habitat known to occur within area
Prostanthera densa Villous Mintbush [12233]	Vulnerable	Species or species habitat likely to occur within area
Prostanthera galbraithiae Wellington Mintbush [64959]	Vulnerable	Species or species habitat known to occur within area
Prostanthera junonis Somersby Mintbush [64960]	Endangered	Species or species habitat known to occur within area
Prostanthera marifolia Seaforth Mintbush [7555]	Critically Endangered	Species or species habitat known to occur within area
Prostanthera palustris Swamp Mint-bush [66703]	Vulnerable	Species or species habitat known to occur within area

Name	Status	Type of Presence
Pteris kingiana King's Brakefern [35183]	Endangered	Species or species habitat likely to occur within area
Pteris zahlbruckneriana Netted Brakefern [65893]	Endangered	Species or species habitat likely to occur within area
Pterostylis chlorogramma Green-striped Greenhood [56510]	Vulnerable	Species or species habitat known to occur within area
Pterostylis cucullata Leafy Greenhood [15459]	Vulnerable	Species or species habitat known to occur within area
Pterostylis gibbosa Illawarra Greenhood, Rufa Greenhood, Pouched Greenhood [4562]	Endangered	Species or species habitat likely to occur within area
Pterostylis saxicola Sydney Plains Greenhood [64537]	Endangered	Species or species habitat likely to occur within area
Pterostylis sp. Botany Bay (A.Bishop J221/1-13) Botany Bay Bearded Greenhood, Botany Bay Bearded Orchid [64965]	Endangered	Species or species habitat likely 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
Pultenaea aristata [18062]	Vulnerable	Species or species habitat likely to occur within area
Randia moorei Spiny Gardenia [10577]	Endangered	Species or species habitat known to occur within area
Rhizanthella slateri Eastern Underground Orchid [11768]	Endangered	Species or species habitat known to occur within area
Rutidosis heterogama Heath Wrinklewort [13132]	Vulnerable	Species or species habitat known to occur within area
Samadera bidwillii Quassia [29708]	Vulnerable	Species or species habitat likely to occur within area
Samadera sp. Moonee Creek (J.King s.n. Nov. 1949) [86885]	Endangered	Species or species habitat known to occur within area
Sarcochilus fitzgeraldii Ravine Orchid [19131]	Vulnerable	Species or species habitat likely to occur within area
Sarcochilus hartmannii Waxy Sarcochilus, Blue Knob Orchid [4124]	Vulnerable	Species or species habitat may occur within area
Senecio australis a daisy [40250]	Vulnerable	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Senecio evansianus a daisy [55340]	Endangered	Species or species habitat known to occur within area
Senecio hooglandii a daisy [55346]	Vulnerable	Species or species habitat known to occur within area
Senecio psilocarpus Swamp Fireweed, Smooth-fruited Groundsel [64976]	Vulnerable	Species or species habitat known to occur within area
Sophora fraseri [8836]	Vulnerable	Species or species habitat likely to occur within area
Spyridium lawrencei Small-leaf Spyridium [27036]	Endangered	Species or species habitat likely to occur within area
Spyridium obcordatum Creeping Dusty Miller [17447]	Vulnerable	Species or species habitat likely to occur within area
Stenanthemum pimeleoides Spreading Stenanthemum, Propellor Plant [15450]	Vulnerable	Species or species habitat may occur within area
Stonesiella selaginoides Clubmoss Bush-pea [68100]	Endangered	Species or species habitat likely to occur within area
Streblus pendulinus Siah's Backbone, Sia's Backbone, Isaac Wood [21618]	Endangered	Species or species habitat known to occur within area
Symplocos baeuerlenii Small-leaved Hazelwood, Shrubby Hazelwood [19010]	Vulnerable	Species or species habitat known to occur within area
Syzygium hodgkinsoniae Smooth-bark Rose Apple, Red Lilly Pilly [3539]	Vulnerable	Species or species habitat likely to occur within area
Syzygium moorei Rose Apple, Coolamon, Robby, Durobby, Watermelon Tree, Coolamon Rose Apple [12284]	Vulnerable	Species or species habitat known to occur within area
Syzygium paniculatum Magenta Lilly Pilly, Magenta Cherry, Daguba, Scrub Cherry, Creek Lilly Pilly, Brush Cherry [20307]	Vulnerable	Species or species habitat known to occur within area
Taeniophyllum norfolkianum Minute Orchid, Ribbon-root Orchid [82347]	Vulnerable	Species or species habitat likely to occur within area
Tetratheca juncea Black-eyed Susan [21407]	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 kangaloonica Kangaloon Sun Orchid [81861]	Critically Endangered	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Thelymitra matthewsii Spiral Sun-orchid [4168]	Vulnerable	Species or species habitat likely to occur within area
Thesium australe Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat known to occur within area
Tmesipteris norfolkensis Hanging Fork-fern [65895]	Vulnerable	Species or species habitat known to occur within area
Triplarina nowraensis Nowra Heath-myrtle [64544]	Endangered	Species or species habitat may occur within area
Tylophora woollsii [20503]	Endangered	Species or species habitat known to occur within area
Ungeria floribunda Bastard Oak [41714]	Vulnerable	Species or species habitat known to occur within area
Wikstroemia australis Kurrajong [42074]	Critically Endangered	Species or species habitat known to occur within area
Xanthorrhoea arenaria Sand Grasstree [21603]	Vulnerable	Species or species habitat likely to occur within area
Xanthorrhoea bracteata Shiny Grasstree [7950]	Endangered	Species or species habitat known to occur within area
Xerochrysum palustre Swamp Everlasting, Swamp Paper Daisy [76215]	Vulnerable	Species or species habitat known to occur within area
Xylosma parvifolia [48040]	Endangered	Species or species habitat known to occur within area
Zehneria baueriana Native Cucumber, Giant Cucumber [39253]	Endangered	Species or species habitat known to occur within area
Zieria granulata Hill Zieria, Hilly Zieria, Illawarra Zieria [17147]	Endangered	Species or species habitat likely to occur within area
Zieria prostrata Headland Zieria [56782]	Endangered	Species or species habitat known to occur within area
Zieria tuberculata Warty Zieria [56736]	Vulnerable	Species or species habitat known to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Carinascincus palfreymani Pedra Branca Skink, Pedra Branca Cool-skink, Red-throated Skink [90203]	Vulnerable	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Name	Status	Type of Presence
Christinus guentheri		
Lord Howe Island Gecko, Lord Howe Island Southern Gecko [59250]	Vulnerable	Species or species habitat known to occur within area
Coeranoscincus reticulatus		
Three-toed Snake-tooth Skink [59628]	Vulnerable	Species or species habitat known to occur within area
Delma torquata		
Adorned Delma, Collared Delma [1656]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding known to occur within area
Eretmochelys imbricata		
Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Furina dunmalli		
Dunmall's Snake [59254]	Vulnerable	Species or species habitat may occur within area
Hoplocephalus bungaroides		
Broad-headed Snake [1182]	Vulnerable	Species or species habitat known to occur within area
Lepidochelys olivacea		
Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat known to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Oligosoma lichenigera		
Lord Howe Island Skink [82034]	Vulnerable	Species or species habitat known to occur within area
Sharks		
Carcharias taurus (east coast population)		
Grey Nurse Shark (east coast population) [68751]	Critically Endangered	Species or species habitat known to occur within area
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Breeding known to occur within area
Pristis zijsron		
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding may occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

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

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus		
Common Noddy [825]		Breeding known to occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes		
Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Breeding known to occur within area
Ardenna grisea		
Sooty Shearwater [82651]		Breeding known to occur within area

Name	Threatened	Type of Presence
Ardenna pacifica Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Ardenna tenuirostris Short-tailed Shearwater [82652]		Breeding known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat known to occur within area
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Onychoprion anaethetus Bridled Tern [82845]		Breeding known to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sterna sumatrana Black-naped Tern [800]		Breeding known to occur within area
Sternula albifrons Little Tern [82849]		Breeding known to occur within area
Sula dactylatra Masked Booby [1021]		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

Name	Threatened	Type of Presence
Thalassarche cauta Shy Albatross [89224]	Endangered	Breeding known to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Foraging, feeding or related behaviour likely to 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
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat known to occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat 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 likely to occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Breeding known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur

Name	Threatened	Type of Presence
		within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding known to occur within area
Dugong dugon Dugong [28]		Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		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
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat known to occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]		Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Phocoena dioptrica Spectacled Porpoise [66728]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Breeding known to occur within area

Name	Threatened	Type of Presence
Migratory Terrestrial Species		
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat known to occur within area
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
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Breeding known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris subminuta Long-toed Stint [861]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area

Name	Threatened	Type of Presence
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		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]		Species or species habitat known to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting known to occur within area
Glareola maldivarum Oriental Pratincole [840]		Roosting known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Roosting known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting known to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus Osprey [952]		Breeding 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 Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area
Tringa incana Wandering Tattler [831]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area

Name	Threatened	Type of Presence
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

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

Name
Commonwealth Land -
Commonwealth Land - Airservices Australia
Commonwealth Land - Australian & Overseas Telecommunications Corporation
Commonwealth Land - Australian Academy of Science
Commonwealth Land - Australian Broadcasting Commission
Commonwealth Land - Australian Broadcasting Corporation
Commonwealth Land - Australian National University
Commonwealth Land - Australian Postal Commission
Commonwealth Land - Australian Postal Corporation
Commonwealth Land - Australian Telecommunications Commission
Commonwealth Land - Australian Telecommunications Corporation
Commonwealth Land - Booderee National Park
Commonwealth Land - Commonwealth Bank of Australia
Commonwealth Land - Commonwealth Trading Bank of Australia
Commonwealth Land - Defence Housing Authority
Commonwealth Land - Defence Service Homes Corporation
Commonwealth Land - Defence Service Homes Corporation & Alice Isabel Patterson
Commonwealth Land - Director of War Service Homes
Commonwealth Land - Norfolk Island National Park
Commonwealth Land - Reserve Bank of Australia
Commonwealth Land - Royal Australian Navy Central Canteens Board
Commonwealth Land - Telstra Corporation Limited
Defence - 41 RNSWR KEMPSEY ; KEMPSEY GRES DEPOT
Defence - ADF CAREERS REFERENCE CENTRE
Defence - AIRTC WOLLONGONG
Defence - BANKSMEADOW DEPOT (Sydney Workshop Company)
Defence - BEECROFT RAPIER RANGE
Defence - BURNIE TRAINING DEPOT
Defence - DEE WHY DEPOT
Defence - DEFENCE PLAZA SYDNEY
Defence - DEGAUSSING RANGE
Defence - DEVONPORT TRAINING DEPOT
Defence - ENDEAVOUR HOUSE - COOGEE
Defence - FLEET BASE WHARVES
Defence - GARDEN ISLAND
Defence - Graovac House
Defence - HMAS KUTTABUL (AC 30/5 Lot4 DP218946)
Defence - HMAS PENGUIN
Defence - HMAS PLATYPUS - SPDU FOR DISPOSAL

Name
Defence - HMAS WATSON
Defence - HYDROGRAPHIC OFFICE
Defence - JENNER BUILDING
Defence - KENSINGTON DEPOT
Defence - KISMET/HMAS KUTTABUL-POTTS PT
Defence - LADY GOWRIE HOUSE
Defence - LAKE ILLAWARRA CADET FACILITY
Defence - MARITIME COMD CTRE-POTTS POINT ; BOMERAH/TARANA
Defence - MARITIME HEADQUARTERS
Defence - MATERIAL RESEARCH LAB
Defence - MILLER'S POINT TRAINING DEPOT
Defence - NFI CHOWDER BAY (fuel depot)
Defence - OFFICES
Defence - OXFORD ST SYDNEY
Defence - PARKVIEW BUILDING - SYDNEY
Defence - PITTWATER DIVING ANNEX (forms part of "RAN Torpedo Range")
Defence - RAAF BASE WILLIAMTOWN
Defence - RANDWICK (CARRINGTON RD)
Defence - RANDWICK BARRACKS
Defence - RANDWICK FRENCHMANS TRG
Defence - ROCKDALE TRAINING DEPOT
Defence - STOCKTON RIFLE RANGE
Defence - STONYHEAD TRAINING AREA
Defence - SUSSEX INLET - DEFENCE RESERVE
Defence - SYDNEY UNIVERSITY REGIMENT - DARLINGTON
Defence - THROSBY TRG DEPOT-PORT KEMBLA
Defence - TRAINING SHIP CONDAMINE
Defence - TRESCO
Defence - TS ALBATROSS-WOLLONGONG
Defence - TS Leven
Defence - TS TOBRUK
Defence - TS VAMPIRE
Defence - Training Depot
Defence - VAUCLUSE TRAINING DEPOT
Defence - VICTORIA BARRACKS - PADDINGTON
Defence - WEST HEAD GUNNERY RANGE
Defence - WOLLONGONG MULTI-USER DEPOT
Defence - WOOLLOOMOOLOO CARPARK
Defence - ZETLAND NAVY SUPPLY CENTRE

Commonwealth Heritage Places

[Resource Information]

Name	State	Status
Natural		
Beecroft Peninsula	NSW	Listed place
Malabar Headland	NSW	Listed place
Nepean Island Reserve	EXT	Listed place
Phillip Island	EXT	Listed place
Selwyn Reserve (2003 boundary)	EXT	Listed place
Tasmanian Seamounts Area	EXT	Listed place
Indigenous		
Jervis Bay Territory	ACT	Listed place
Crocodile Head Area	NSW	Within listed place
Currarong Rockshelters Area	NSW	Within listed place
Historic		
Admiralty House Garden and Fortifications	NSW	Listed place
Admiralty House and Lodge	NSW	Listed place
Arched Building, Longridge	EXT	Listed place
Army Cottage with return verandah	NSW	Listed place
Barracks Group HMAS Watson	NSW	Listed place
Batteries A83 and C9A	NSW	Listed place
Battery B42	NSW	Listed place
Battery for Five Guns	NSW	Listed place
Bondi Beach Post Office	NSW	Listed place
Botany Post Office	NSW	Listed place
Building VB1 and Parade Ground	NSW	Listed place
Building VB2 Guard House	NSW	Listed place

Name	State	Status
Buildings 31 and 32	NSW	Listed place
Buildings MQVB16 and VB56	NSW	Listed place
Buildings VB13, 15, 16 & 17	NSW	Listed place
Buildings VB41, 45 & 53	NSW	Listed place
Buildings VB60 and VB62	NSW	Listed place
Buildings VB69, 75 & 76 including Garden	NSW	Listed place
Buildings VB83, 84, 85, 87 & 89	NSW	Listed place
Buildings VB90, 91, 91A & 92	NSW	Listed place
Byron Bay Post Office	NSW	Listed place
Cape Baily Lighthouse	NSW	Listed place
Cape Byron Lighthouse	NSW	Listed place
Cape St George Lighthouse Ruins & Curtilage	ACT	Listed place
Chain and Anchor Store (former)	NSW	Listed place
Chowder Bay Barracks Group	NSW	Listed place
Christians Minde Settlement	ACT	Listed place
Cliff House	NSW	Listed place
Commonwealth Avenue Defence Housing	NSW	Listed place
Cottage at Macquarie Lighthouse	NSW	Listed place
Cronulla Post Office	NSW	Listed place
Customs Marine Centre	NSW	Listed place
Defence site - Georges Heights and Middle Head	NSW	Listed place
Eddystone Lighthouse	TAS	Listed place
Factory	NSW	Listed place
Fort Wallace	NSW	Listed place
Gabo Island Lighthouse	VIC	Listed place
Garden Island Precinct	NSW	Listed place
Gazebo	NSW	Listed place
General Post Office	NSW	Listed place
Golf Clubhouse (former)	NSW	Listed place
Goose Island Lighthouse	TAS	Listed place
HMAS Penguin	NSW	Listed place
HMS Sirius Shipwreck	EXT	Listed place
Headquarters 8th Brigade Precinct	NSW	Listed place
Headquarters Training Command Precinct	NSW	Listed place
Jervis Bay Botanic Gardens	ACT	Listed place
Kempsey Post Office	NSW	Listed place
Kiama Post Office	NSW	Listed place
Kingston and Arthurs Vale Commonwealth Tenure Area	EXT	Listed place
Kirribilli House	NSW	Listed place
Kirribilli House Garden & Grounds	NSW	Listed place
Lady Elliot Island Lightstation	QLD	Listed place
Macquarie Lighthouse	NSW	Listed place
Macquarie Lighthouse Group	NSW	Listed place
Macquarie Lighthouse Surrounding Wall	NSW	Listed place
Marine Biological Station (former)	NSW	Listed place
Mersey Bluff Lighthouse	TAS	Listed place
Military Road Framework - Defence Land	NSW	Listed place
Montague Island Lighthouse	NSW	Listed place
Naval Store	NSW	Listed place
Navy Refuelling Depot and Caretakers House	NSW	Listed place
Nobbys Lighthouse	NSW	Listed place
North Head Artillery Barracks	NSW	Listed place
Office Building	NSW	Listed place
Officers Mess, HQ Training Command	NSW	Listed place
Paddington Post Office	NSW	Listed place
Point Perpendicular Lightstation	NSW	Listed place
Pyrmont Post Office	NSW	Listed place
Reserve Bank	NSW	Listed place
Residences Group	NSW	Listed place
Rigging Shed and Chapel	NSW	Listed place
Royal Australian Naval College	ACT	Listed place
School of Musketry and Officers Mess, Randwick Army Barracks	NSW	Listed place
Shark Point Battery	NSW	Listed place
Smoky Cape Lighthouse	NSW	Listed place
Sugarloaf Point Lighthouse	NSW	Listed place

Name	State	Status
Swan Island Lighthouse	TAS	Listed place
Sydney Airport Air Traffic Control Tower	NSW	Listed place
Sydney Customs House (former)	NSW	Listed place
Table Cape Lighthouse	TAS	Listed place
Tasman Island Lighthouse	TAS	Listed place
Ten Terminal Regiment Headquarters and AusAid Training Centre	NSW	Listed place
Thirty Terminal Squadron Precinct	NSW	Listed place
Victoria Barracks Perimeter Wall and Gates	NSW	Listed place
Victoria Barracks Precinct	NSW	Listed place
Victoria Barracks Squash Courts	NSW	Listed place
Williamtown RAAF Base Group	NSW	Listed place
Wilsons Promontory Lighthouse	VIC	Listed place

Listed Marine Species

[Resource Information]

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

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous minutus Black Noddy [824]		Breeding known to occur within area
Anous stolidus Common Noddy [825]		Breeding known to occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Breeding known to occur within area
Ardea ibis Cattle Egret [59542]		Breeding likely to occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris subminuta Long-toed Stint [861]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur

Name	Threatened	Type of Presence
		within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea gibsoni Gibson's Albatross [64466]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Eudyptula minor Little Penguin [1085]		Breeding known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat 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]		Species or species habitat known to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting known to occur within area
Glareola maldivarum Oriental Pratincole [840]		Roosting known to occur within area

Name	Threatened	Type of Presence
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Breeding known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Roosting known to occur within area
Heteroscelus incanus Wandering Tattler [59547]		Roosting known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Larus dominicanus Kelp Gull [809]		Breeding known to occur within area
Larus novaehollandiae Silver Gull [810]		Breeding known to occur within area
Larus pacificus Pacific Gull [811]		Breeding known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Breeding known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Roosting known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat known to occur within area
Morus serrator Australasian Gannet [1020]		Breeding known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Myiagra cyanoleuca Satin Flycatcher [612]		Breeding known to occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting known to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding 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
Phaethon rubricauda Red-tailed Tropicbird [994]		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
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
Procelsterna cerulea Grey Noddy, Blue Noddy [64378]		Breeding known to occur within area
Pterodroma cervicalis White-necked Petrel [59642]		Breeding known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Breeding known to occur within area
Pterodroma nigripennis Black-winged Petrel [1038]		Breeding known to occur within area
Pterodroma solandri Providence Petrel [1040]		Breeding known to occur within area
Puffinus assimilis Little Shearwater [59363]		Breeding known to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Breeding known to occur within area
Puffinus griseus Sooty Shearwater [1024]		Breeding known to occur within area

Name	Threatened	Type of Presence
Puffinus pacificus		
Wedge-tailed Shearwater [1027]		Breeding known to occur within area
Puffinus tenuirostris		
Short-tailed Shearwater [1029]		Breeding known to occur within area
Recurvirostra novaehollandiae		
Red-necked Avocet [871]		Roosting known to occur within area
Rhipidura rufifrons		
Rufous Fantail [592]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato)		
Painted Snipe [889]	Endangered*	Species or species habitat known to occur within area
Sterna albifrons		
Little Tern [813]		Breeding known to occur within area
Sterna anaethetus		
Bridled Tern [814]		Breeding known to occur within area
Sterna bergii		
Crested Tern [816]		Breeding known to occur within area
Sterna caspia		
Caspian Tern [59467]		Breeding known to occur within area
Sterna dougallii		
Roseate Tern [817]		Breeding known to occur within area
Sterna fuscata		
Sooty Tern [794]		Breeding known to occur within area
Sterna nereis		
Fairy Tern [796]		Breeding known to occur within area
Sterna striata		
White-fronted Tern [799]		Breeding known to occur within area
Sterna sumatrana		
Black-naped Tern [800]		Breeding known to occur within area
Sula dactylatra		
Masked Booby [1021]		Breeding known to occur within area
Thalassarche bulleri		
Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta		
Shy Albatross [89224]	Endangered	Breeding known to occur within area
Thalassarche chrysostoma		
Grey-headed Albatross [66491]	Endangered	Foraging, feeding or related behaviour likely to 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

Name	Threatened	Type of Presence
		related behaviour likely to occur within area
Thalassarche sp. nov. Pacific Albatross [66511]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat known to occur within area
Thinornis rubricollis rubricollis Hooded Plover (eastern) [66726]	Vulnerable*	Species or species habitat known to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area
Fish		
Acentronura tentaculata Shortpouch Pygmy Pipehorse [66187]		Species or species habitat may occur within area
Campichthys tryoni Tryon's Pipefish [66193]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Corythoichthys haematopterus Reef-top Pipefish [66201]		Species or species habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area
Corythoichthys ocellatus Orange-spotted Pipefish, Ocellated Pipefish [66203]		Species or species habitat may occur within area
Corythoichthys paxtoni Paxton's Pipefish [66204]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Cosmocampus howensis Lord Howe Pipefish [66208]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Festucalex cinctus Girdled Pipefish [66214]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus boothae Booth's Pipefish [66218]		Species or species habitat may occur within area
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish [66220]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippichthys cyanospilos Blue-speckled Pipefish, Blue-spotted Pipefish [66228]		Species or species habitat may occur within area
Hippichthys heptagonus Madura Pipefish, Reticulated Freshwater Pipefish [66229]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		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 bargibanti Pygmy Seahorse [66721]		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 kelloggi Kellogg's Seahorse, Great Seahorse [66723]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Hippocampus minotaur Bullneck Seahorse [66705]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
Hippocampus whitei White's Seahorse, Crowned Seahorse, Sydney Seahorse [66240]		Species or species habitat known to occur within area
Hippocampus zebra Zebra Seahorse [66241]		Species or species habitat may occur within area
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypselognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Kimblaeus bassensis Trawl Pipefish, Bass Strait Pipefish [66247]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Micrognathus andersonii Anderson's Pipefish, Shortnose Pipefish [66253]		Species or species habitat may occur within area
Micrognathus brevirostris thorntail Pipefish, Thorn-tailed Pipefish [66254]		Species or species habitat may occur within area
Microphis manadensis Manado Pipefish, Manado River Pipefish [66258]		Species or species habitat may occur within area
Mitotichthys mollisoni Mollison's Pipefish [66260]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Mitotichthys semistriatus Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus dunckeri Duncker's Pipehorse [66271]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Solenostomus paradoxus Ornate Ghostpipefish, Harlequin Ghost Pipefish, Ornate Ghost Pipefish [66184]		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
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Breeding known to occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Breeding known to occur within area
Dugong dugon Dugong [28]		Species or species habitat known to occur within area
Mirounga leonina Southern Elephant Seal [26]	Vulnerable	Breeding may occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding known to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake [1125]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Laticauda colubrina a sea krait [1092]		Species or species habitat may occur within area
Laticauda laticaudata a sea krait [1093]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat 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
Berardius arnuxii Arnoux's Beaked Whale [70]		Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may 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
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
Lagenorhynchus cruciger Hourglass Dolphin [42]		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	Breeding 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 ginkgodens Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale [59564]		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

Name	Status	Type of Presence
		habitat may occur within area
Orcaella brevirostris Irrawaddy Dolphin [45]		Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Phocoena dioptrica Spectacled Porpoise [66728]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Breeding known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may 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

Commonwealth ReservesTerrestrial [Resource Information]

Name	State	Type
Booderee	JBT	Botanic Gardens
Booderee	JBT	National Park (Commonwealth)
Norfolk Island	EXT	Botanic Gardens

Name	State	Type
Norfolk Island (Mt Pitt)	EXT	National Park (Commonwealth)
Norfolk Island (Phillip Island)	EXT	National Park (Commonwealth)

Australian Marine Parks [Resource Information]

Name	Label
Apollo	Multiple Use Zone (IUCN VI)
Beagle	Multiple Use Zone (IUCN VI)
Boags	Multiple Use Zone (IUCN VI)
Central Eastern	Habitat Protection Zone (IUCN IV)
Central Eastern	Multiple Use Zone (IUCN VI)
Central Eastern	National Park Zone (IUCN II)
Cod Grounds	National Park Zone (IUCN II)
Coral Sea	Habitat Protection Zone (IUCN IV)
Coral Sea	National Park Zone (IUCN II)
Coral Sea	Special Purpose Zone (Trawl) (IUCN VI)
East Gippsland	Multiple Use Zone (IUCN VI)
Flinders	Marine National Park Zone (IUCN II)
Flinders	Multiple Use Zone (IUCN VI)
Freycinet	Marine National Park Zone (IUCN II)
Freycinet	Multiple Use Zone (IUCN VI)
Freycinet	Recreational Use Zone (IUCN IV)
Gifford	Habitat Protection Zone (IUCN IV)
Hunter	Habitat Protection Zone (IUCN IV)
Hunter	Special Purpose Zone (Trawl) (IUCN VI)
Huon	Habitat Protection Zone (IUCN IV)
Huon	Multiple Use Zone (IUCN VI)
Jervis	Habitat Protection Zone (IUCN IV)
Jervis	Special Purpose Zone (Trawl) (IUCN VI)
Lord Howe	Habitat Protection Zone (IUCN IV)
Lord Howe	Habitat Protection Zone (Lord Howe)
Lord Howe	Multiple Use Zone (IUCN VI)
Lord Howe	National Park Zone (IUCN II)
Lord Howe	Recreational Use Zone (IUCN IV)
Norfolk	Habitat Protection Zone (IUCN IV)
Norfolk	National Park Zone (IUCN II)
Norfolk	Special Purpose Zone (Norfolk) (IUCN
Solitary Islands	Multiple Use Zone (IUCN VI)
Solitary Islands	National Park Zone (IUCN II)
Solitary Islands	Special Purpose Zone (Trawl) (IUCN VI)
South Tasman Rise	Special Purpose Zone (IUCN VI)
Tasman Fracture	Marine National Park Zone (IUCN II)
Tasman Fracture	Multiple Use Zone (IUCN VI)

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Albatross Island	TAS
Anderson Islands	TAS
Anser Island	VIC
Ansons Bay	TAS
Apex Point	TAS
Apsley	TAS
Apsley River	TAS
Arakoon	NSW
Arakwal	NSW
Awabakal	NSW
Baawang	VIC
Babel Island	TAS
Badger Corner	TAS
Badger Head	TAS
Badger Island	TAS
Bago Bluff	NSW
Bald Hills Creek W.R	VIC
Ballina	NSW
Bancroft Bay - Kalimna G.L.R.	VIC

Name	State
Bandicoot Island	NSW
Bangor	TAS
Bangor #2	TAS
Bangor - Musk Gully	TAS
Barga	VIC
Bass Pyramid	TAS
Battery Island	TAS
Bay of Fires	TAS
Baynes Island	TAS
Bell Bird Creek	NSW
Bellettes Bay	TAS
Bellingham	TAS
Belowla Island	NSW
Bemm, Goolengook, Arte and Errinundra Rivers	VIC
Ben Boyd	NSW
Bennison F.F.R.	VIC
Berkeley	NSW
Bermaguee	NSW
Bermagui	NSW
Biamanga	NSW
Big Green Island	TAS
Big Silver	TAS
Billinudgel	NSW
Billy Blue Hill	TAS
Binalongtime	TAS
Bird Island	NSW
Bird Island	TAS
Blowhole Road #1	TAS
Blowhole Road #2	TAS
Blowhole Road #3	TAS
Blowhole Road #4	TAS
Blyth Point	TAS
Blythe River	TAS
Boat Harbour Road	TAS
Boltons Beach	TAS
Bongil Bongil	NSW
Boobyalla	TAS
Boobyalla Downs	TAS
Boondelbah	NSW
Boot Bay	TAS
Booti Booti	NSW
Bouddi	NSW
Bournda	NSW
Boxen Island	TAS
Briggs	TAS
Briggs Islet	TAS
Brisbane Water	NSW
Broadwater	NSW
Brodribb River F.F.R	VIC
Broken Head	NSW
Brother and Sister	TAS
Brougham Sugarloaf	TAS
Broulee Island	NSW
Brunswick Heads	NSW
Bruny Island Neck	TAS
Brush Island	NSW
Bruxner Park	NSW
Bull Island	NSW
Bull Rock	TAS
Bun Beetons Point	TAS
Bundjalung	NSW
Burleigh Head	QLD
Bushy Island	NSW
Cam River	TAS
Cameron	TAS
Cape Bernier	TAS

Name	State
Cape Byron	NSW
Cape Conran Coastal Park	VIC
Cape Howe	VIC
Cape Liptrap Coastal Park	VIC
Cape Patterson N.C.R	VIC
Cape Portland	TAS
Cape Portland	TAS
Cat Island	TAS
Chalky Island	TAS
Chasm Creek	TAS
Chronicle Point	TAS
Clarence Estuary	NSW
Clovelly	TAS
Clybucca	NSW
Clybucca	NSW
Cobaki	NSW
Cockle Bay	NSW
Coffs Coast	NSW
Coles Bay	TAS
Colongra Swamp	NSW
Comerong Island	NSW
Cone Islet	TAS
Conjola	NSW
Connemara	TAS
Cook Island	NSW
Cooperabung Creek	NSW
Corrie Island	NSW
Craggy Island	TAS
Crayfish Creek	TAS
Croajingolong	VIC
Crooked Billet Bay	TAS
Crowdy Bay	NSW
Cudgen	NSW
Cudgera Creek	NSW
Cullendulla Creek	NSW
Cumbebin Swamp	NSW
Currumbin Hill	QLD
Curtis Island	TAS
Darawank	NSW
Darling Range	TAS
Darriman H29 B.R	VIC
Dart Island	TAS
David Fleay	QLD
Denison Rivulet	TAS
Devils Tower	TAS
Dharawal	NSW
Dharawal	NSW
Diamond Island	TAS
Doctors Rocks Conservation Area	TAS
Don Heads	TAS
Doomburrin B.R	VIC
Dooragan	NSW
Double Creek	VIC
Double Sandy Point	TAS
Doughboy Island	TAS
Douglas-Apsley	TAS
Durands Island	NSW
Eaglehawk Bay	TAS
Eaglehawk Bay-Flinders Bay	TAS
Eaglehawk Neck	TAS
Eagles Claw	NSW
East Gippsland Coastal streams	VIC
East Kangaroo Island	TAS
East Moncoeur Island	TAS
Eddystone Point Lighthouse	TAS
Eden Region	NSW

Name	State
Edgcumbe Beach	TAS
Egg Beach	TAS
Elephant Farm Elephant Pass	TAS
Emita	TAS
Entrance Point	VIC
Eurobodalla	NSW
Ewing Morass W.R	VIC
Fannys Bay	TAS
First and Second Islands F.R.	VIC
Fishermans Bend	NSW
Five Islands	NSW
Five Mile Bluff	TAS
Flat Island	NSW
Foochow	TAS
Forestry Management Areas in Batemans Bay (FMZ2)	NSW
Forestry Management Areas in Coffs Harbour (FMZ1)	NSW
Forestry Management Areas in Coffs Harbour (FMZ2)	NSW
Forestry Management Areas in Eden (FMZ2)	NSW
Forestry Management Areas in Kendall (FMZ2)	NSW
Forestry Management Areas in Urunga (FMZ1)	NSW
Forestry Management Areas in Urunga (FMZ2)	NSW
Forestry Management Areas in Wauchope (FMZ2)	NSW
Forsyth Island	TAS
Forwards Beach	TAS
Fossil Bluff	TAS
Foster Islands	TAS
Fotheringate Bay	TAS
Four Mile Creek	TAS
Four Mile Creek #1	TAS
Four Mile Creek #2	TAS
Fozards	TAS
Franklin River SS.R.	VIC
Fraser Island G.L.R.	VIC
Fresh-water Swamp, Woodside Beach W.R	VIC
Freycinet	TAS
Friendly Beaches	TAS
Friendly Beaches	TAS
Friendly Beaches #3	TAS
Friendly Beaches #4	TAS
Gaagal Wanggaan (South Beach)	NSW
Garawarra	NSW
Garby	NSW
Gardens Road	TAS
George Rocks	TAS
Gippsland Lakes Coastal Park	VIC
Gir-um-bit	NSW
Gir-um-bit	NSW
Glenrock	NSW
Goolawah	NSW
Goolawah	NSW
Goose Island	TAS
Gosford Coastal Open Space System	NSW
Granite Point	TAS
Great Dog Island	TAS
Great Musselroe River	TAS
Greens Beach Conservation Area	TAS
Gulaga	NSW
Gull Island	TAS
Gumma	NSW
Hardys Hill	TAS
Hat Head	NSW
Hawks Hill	TAS
Hawley	TAS
Hayters Hill	NSW
Henderson Islets	TAS
Heybridge	TAS

Name	State
Highfield	TAS
Hoddle Range F.R.	VIC
Hogan Group	TAS
Holts Point	TAS
Honeysuckle Avenue	TAS
Humbug Point	TAS
Hunter Island	TAS
Hunter Wetlands	NSW
Ile des Phoques	TAS
Illawarra Escarpment	NSW
Illawong	NSW
Iluka	NSW
Isabella Island	TAS
Jack Smith Lake W.R	VIC
Jacksons Cove	TAS
Jagun	NSW
Jervis Bay	NSW
Jinangong	NSW
John Gould	NSW
Julian Rocks Nguthungulli	NSW
Kamay Botany Bay	NSW
Karuah	NSW
Kattang	NSW
Khappinghat	NSW
Khappinghat	NSW
Killiecrankie	TAS
Kings Flat F.R	VIC
Koonya	TAS
Kororo	NSW
Ku-ring-gai Chase	NSW
Kumbatine	NSW
LNE Special Management Zone No1	NSW
Lachlan Island	TAS
Lackrana	TAS
Lagoons Beach	TAS
Lake Corringle W.R	VIC
Lake Curlip W.R.	VIC
Lake Denison W.R	VIC
Lake Innes	NSW
Lake Innes	NSW
Lake Macquarie	NSW
Lake Tyers	VIC
Lanark Farm #1	TAS
Lanark Farm #2	TAS
Lanark Farm #3	TAS
Lanark Farm #4	TAS
Lanark Farm #5	TAS
Lanark Farm #6	TAS
Lands End	TAS
Lefroy	TAS
Lighthouse Point	TAS
Lime Pit Road	TAS
Limeburners Creek	NSW
Lion Island	NSW
Little Beach	TAS
Little Beach	TAS
Little Broughton Island	NSW
Little Chalky Island	TAS
Little Dog Island	TAS
Little Green Island	TAS
Little Island	TAS
Little Peggs Beach	TAS
Little Pimlico Island	NSW
Little Pipers River	TAS
Little Silver	TAS
Little Swan Island	TAS

Name	State
Little Waterhouse Island	TAS
Littles Road	TAS
Logan Lagoon	TAS
Logan Lagoon	TAS
Logans Lagoon	TAS
Long Bay	TAS
Long Island	NSW
Long Island	TAS
Long Spit	TAS
Lookout Rock	TAS
Lord Howe Island	NSW
Low Head	TAS
Low Head	TAS
Low Islets	TAS
Low Point	TAS
Lower Marsh Creek	TAS
Lughrata	TAS
Lyall Road Binalong Bay	TAS
Lyons Cottage	TAS
Macquarie	NSW
Madmans Creek	NSW
Malabar Headland	NSW
Mallacoota B.R.	VIC
Marchwiel #3	TAS
Marchwiel #4	TAS
Marchwiel #5	TAS
Marchwiel #6	TAS
Marchwiel Bream Creek	TAS
Marchwiel Cockle Bay	TAS
Maria	NSW
Maria Island	TAS
Marion Beach	TAS
Marshall Beach	TAS
Marshalls Creek	NSW
McDonalds Point Conservation Area	TAS
Medowie	NSW
Medowie	NSW
Memana	TAS
Meroo	NSW
Mersey Bluff	TAS
Middle Brother	NSW
Mile Island	TAS
Mimosa Rocks	NSW
Minyumai	NSW
Moffats Swamp	NSW
Montague Island	NSW
Mooball	NSW
Moon Island	NSW
Moonee Beach	NSW
Mornington Peninsula	VIC
Mortimers Paddock B.R.	VIC
Moulting Lagoon Game Reserve	TAS
Mount Arthur	TAS
Mount Bruny	TAS
Mount Midway	TAS
Mount Pearson	TAS
Mount Tanner	TAS
Mount Vereker Creek	VIC
Mount William	TAS
Mount William	TAS
Mt Chappell Island	TAS
Mt Murray	TAS
Mulligans Hill	TAS
Mulligans Hill	TAS
Mumbulla	NSW
Munmorah	NSW

Name	State
Muogamarra	NSW
Murrah	NSW
Murramarang	NSW
Musselroe Bay	TAS
Musselroe Bay	TAS
Muttonbird Island	NSW
Myall Lakes	NSW
Nadgee	NSW
Narawntapu	TAS
Naree Budjong Djara	QLD
Nares Rocks	TAS
Narrawallee Creek	NSW
Neds Reef	TAS
Newmans Beach	TAS
Newmans Creek Koonya	TAS
Ngunya Jargoon	NSW
Night Island	TAS
Ninth Island	TAS
Norfolk Bay	TAS
North East Islet	TAS
North East River	TAS
North Head	NSW
North Passage Point	TAS
North Rock	NSW
North Solitary Island	NSW
North-West Solitary Island	NSW
Nubeena #1	TAS
Nunguu Mirral	NSW
Okehampton	TAS
Old Billys Creek	TAS
One Tree Island	NSW
Oyster Rocks	TAS
Paddys Island	TAS
Palana Beach	TAS
Parnella	TAS
Pasco Group	TAS
Passage Island	TAS
Patriarchs	TAS
Patriarchs	TAS
Peggs Beach	TAS
Pelican Island	NSW
Penguin Islet	TAS
Petrel Islands	TAS
Phillip Island Nature Park	VIC
Pirates Bay	TAS
Point Bailly	TAS
Point du Ressac	TAS
Popran	NSW
Port Arthur	TAS
Possums Place	TAS
Premaydena Point	TAS
Prime Seal Island	TAS
Queens Lake	NSW
Queens Lake	NSW
Ram Island	TAS
Rame Head	VIC
Rawdon Creek	NSW
Redbanks Sisters Creek	TAS
Reedy Lagoon	TAS
Regatta Island	NSW
Richmond River	NSW
Rigby Island G.L.R.	VIC
Rileys Island	NSW
Ringarooma Tier	TAS
Roaring Beach	TAS
Roaring Beach	TAS

Name	State
Rocky Cape	TAS
Rodondo Island	TAS
Royal	NSW
Roydon Island	TAS
Safety Cove	TAS
Saltwater	NSW
Sandpatch	VIC
Sandridge	TAS
Sandspit River	TAS
Saratoga Island	NSW
Scamander	TAS
Sea Acres	NSW
Seacrow Islet	TAS
Seal Creek	VIC
Seal Islands W.R.	VIC
Seal Rocks	NSW
Sellars Lagoon	TAS
Semaphore Farm	TAS
Sentinel Island	TAS
Settlement Point	TAS
Seven Mile Beach	NSW
Seymour	TAS
Seymour #1	TAS
Seymour #2	TAS
Seymour #3	TAS
Seymour #4	TAS
Shag Lagoon	TAS
Shark Island	NSW
Sherwood	NSW
Single Tree Plain	TAS
Sister Islands	TAS
Sisters Beach	TAS
Sisters Island	TAS
Smiths Lake	NSW
Snapper Island	NSW
Snowy River	VIC
South Bruny	TAS
South Coast Subregion of Southern Region	NSW
South Pats River	TAS
South Stradbroke Island	QLD
South West Solitary Island	NSW
Southern Wilsons Promontory	VIC
Southwest	TAS
Spectacle Island	NSW
Spike Island	TAS
Split Solitary Island	NSW
St Helens	TAS
St Helens 2	TAS
St Patricks Head	TAS
Stack Island	TAS
Stanley	TAS
Stewarts Bay	TAS
Storehouse Island	TAS
Stormpetrel	NSW
Stotts Island	NSW
Strzelecki	TAS
Sugarloaf Rock	TAS
Summer Camp	TAS
Summerhill Drive Port Sorell	TAS
Sydney Cove	TAS
Sydney Harbour	NSW
Sympathy Hills	TAS
Table Cape	TAS
Table Cape	TAS
Tallebudgera Creek	QLD
Tamar Crescent	TAS

Name	State
Tanja	NSW
Tarra Tarra B.R	VIC
Tarwin Lower F.R.	VIC
Tarwin South B.R	VIC
Tasman	TAS
Tatlows Beach	TAS
Tenth Island	TAS
Tessellated Pavement	TAS
The Dock	TAS
The Dutchman	TAS
The Lakes	VIC
The Nut	TAS
The Run #1	TAS
The Run #2	TAS
The Run #3	TAS
The Run #4	TAS
Three Hummock Island	TAS
Three Sisters-Goat Island	TAS
Tilligerry	NSW
Tilligerry	NSW
Tilligerry	NSW
Tollgate Islands	NSW
Tomaree	NSW
Towibakh	NSW
Towra Point	NSW
Trefula	TAS
Trousers Point Beach	TAS
Tweed Estuary	NSW
Two Mile Creek	TAS
Tyagarah	NSW
UNE Special Management Zone No1	NSW
UNE_LNE_OldGrowth	NSW
Ukerebagh	NSW
Ulidarra	NSW
Umtali	TAS
Unnamed (Badger Head Road)	TAS
Unnamed (Fern Glade)	TAS
Unnamed Conservation Area (Sandspit River)	TAS
Unnamed P0155	VIC
Uralba	NSW
Valla	NSW
Vansittart Island	TAS
Vereker Creek	VIC
Wallarah	NSW
Wallingat	NSW
Wallis Island	NSW
Wamberal Lagoon	NSW
Waratah B.R	VIC
Warrigal Creek SS.R.	VIC
Waterfall Bay Road	TAS
Waterhouse	TAS
Waterhouse Island	TAS
Waubadebars Grave	TAS
Wedge Island	TAS
West Moncoeur Island	TAS
Whalers Lookout	TAS
Whipstick Gully N.F.R.	VIC
White Beach	TAS
William Hunter F.R	VIC
Wilsons Promontory	VIC
Wilsons Promontory	VIC
Wilsons Promontory Islands	VIC
Wingaroo	TAS
Wonthaggi Heathlands N.C.R	VIC
Woodside H28 B.R	VIC
Wooyung	NSW

Name	State
Woregore	NSW
Worimi	NSW
Worimi	NSW
Worimi	NSW
Wright Rock	TAS
Wybalenna Island	TAS
Wyrrabalong	NSW
Yahoo Island	NSW
Yanakie F.R	VIC
Yarrahapinni Wetlands	NSW
Yarriabini	NSW
Yellow Bluff Creek	TAS
Youngs Creek	TAS
Yuraygir	NSW
lungatalanana	TAS

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
East Gippsland RFA	Victoria
Eden RFA	New South Wales
Gippsland RFA	Victoria
North East NSW RFA	New South Wales
Southern RFA	New South Wales
Tasmania RFA	Tasmania

Invasive Species [Resource Information]

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

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Alauda arvensis Skylark [656]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Callipepla californica California Quail [59451]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Carduelis chloris European Greenfinch [404]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Gallus gallus Red Junglefowl, Feral Chicken, Domestic Fowl [917]		Species or species habitat likely to occur within area
Lonchura punctulata Nutmeg Mannikin [399]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Meleagris gallopavo Wild Turkey [64380]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Pavo cristatus Indian Peafowl, Peacock [919]		Species or species habitat likely to occur within area
Phasianus colchicus Common Pheasant [920]		Species or species habitat likely to occur within area
Pycnonotus jocosus Red-whiskered Bulbul [631]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Turdus philomelos Song Thrush [597]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat known to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus exulans Pacific Rat, Polynesian Rat [79]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Alternanthera philoxeroides Alligator Weed [11620]		Species or species habitat likely to occur within area
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area
Asparagus africanus Climbing Asparagus, Climbing Asparagus Fern [66907]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Asparagus plumosus Climbing Asparagus-fern [48993]		Species or species habitat likely to occur within area
Asparagus scandens Asparagus Fern, Climbing Asparagus Fern [23255]		Species or species habitat likely to occur within area
Cabomba caroliniana Cabomba, Fanwort, Carolina Watershield, Fish Grass, Washington Grass, Watershield, Carolina Fanwort, Common Cabomba [5171]		Species or species habitat likely to occur within area
Carrichtera annua Ward's Weed [9511]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Chrysanthemoides monilifera subsp. rotundata		
Bitou Bush [16332]		Species or species habitat likely to occur within area
Cryptostegia grandiflora		
Rubber Vine, Rubbervine, India Rubber Vine, India Rubbervine, Palay Rubbervine, Purple Allamanda [18913]		Species or species habitat likely to occur within area
Cytisus scoparius		
Broom, English Broom, Scotch Broom, Common Broom, Scottish Broom, Spanish Broom [5934]		Species or species habitat likely to occur within area
Dolichandra unguis-cati		
Cat's Claw Vine, Yellow Trumpet Vine, Cat's Claw Creeper, Funnel Creeper [85119]		Species or species habitat likely to occur within area
Eichhornia crassipes		
Water Hyacinth, Water Orchid, Nile Lily [13466]		Species or species habitat likely to occur within area
Genista linifolia		
Flax-leaved Broom, Mediterranean Broom, Flax Broom [2800]		Species or species habitat likely to occur within area
Genista monspessulana		
Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana		
Broom [67538]		Species or species habitat may occur within area
Hymenachne amplexicaulis		
Hymenachne, Olive Hymenachne, Water Stargrass, West Indian Grass, West Indian Marsh Grass [31754]		Species or species habitat likely to occur within area
Lantana camara		
Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum		
African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Nassella neesiana		
Chilean Needle grass [67699]		Species or species habitat likely to occur within area
Nassella trichotoma		
Serrated Tussock, Yass River Tussock, Yass Tussock, Nassella Tussock (NZ) [18884]		Species or species habitat likely to occur within area
Olea europaea		
Olive, Common Olive [9160]		Species or species habitat may occur within area
Opuntia spp.		
Prickly Pears [82753]		Species or species habitat likely to occur within area
Parthenium hysterophorus		
Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat likely to occur within area
Pinus radiata		
Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate		
Blackberry, European Blackberry [68406]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Senecio madagascariensis Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area
Solanum elaeagnifolium Silver Nightshade, Silver-leaved Nightshade, White Horse Nettle, Silver-leaf Nightshade, Tomato Weed, White Nightshade, Bull-nettle, Prairie-berry, Satansbos, Silver-leaf Bitter-apple, Silverleaf-nettle, Trompillo [12323]		Species or species habitat likely to occur within area
Ulex europaeus Gorse, Furze [7693]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area
Ramphotyphlops braminus Flowerpot Blind Snake, Brahminy Blind Snake, Cacing Besi [1258]		Species or species habitat likely to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
Anderson Inlet	VIC
Avoca Lagoon	NSW
Bald Hills State Wildlife Reserve	VIC
Beecroft Peninsula	NSW
Bemm, Goolengook, Arte and Errinundra Rivers	VIC
Benedore River	VIC
Billinudgel Nature Reserve	NSW
Blackmans Lagoon	TAS
Bondi Lake	NSW
Botany Wetlands	NSW
Brisbane Water Estuary	NSW
Bundjalung National Park	NSW
Clarence River Estuary	NSW
Clybucca Creek Estuary	NSW
Clyde River Estuary	NSW
Cockrone Lagoon	NSW
Colongra Swamp	NSW
Cook Island Nature Reserve	NSW
Coomaditchy Lagoon	NSW
Coomonderry Swamp	NSW
Cormorant Beach	NSW
Corner Inlet	VIC
Crowdy Bay National Park	NSW
Cudgen Nature Reserve	NSW
Cullendulla Creek and Embayment	NSW
Douglas River	TAS
Durras Lake	NSW
Earlham Lagoon	TAS
Elizabeth and Middleton Reefs	EXT
Ewing's Marsh (Morass)	VIC

Name	State
Fergusons Lagoon	TAS
Five Islands Nature Reserve	NSW
Flyover Lagoon 1	TAS
Flyover Lagoon 2	TAS
Freshwater Lagoon	TAS
Great Barrier Reef Marine Park	QLD
Hogans Lagoon	TAS
Jack Smith Lake State Game Reserve	VIC
Jervis Bay	NSW
Jervis Bay Sea Cliffs	NSW
Jewells Wetland	NSW
Jocks Lagoon	TAS
Killalea Lagoon	NSW
Kooragang Nature Reserve	NSW
Lagoon Head	NSW
Lake Bunga	VIC
Lake Hiawatha and Minnie Water	NSW
Lake Illawarra	NSW
Lake King Wetlands	VIC
Lake Macquarie	NSW
Lake Tyers	VIC
Limeburners Creek Nature Reserve	NSW
Little Thirsty Lagoon	TAS
Little Waterhouse Lake	TAS
Logan Lagoon	TAS
Lower Snowy River Wetlands System	VIC
Mallacoota Inlet Wetlands	VIC
Maria Island Marine Reserve	TAS
Merimbula Lake	NSW
Meroo Lake Wetland Complex	NSW
Minnamurra River Estuary	NSW
Moreton Bay	QLD
Moruya River Estuary Saltmarshes	NSW
Myall Lakes	NSW
Nadgee Lake and tributary wetlands	NSW
Nargal Lake	NSW
Nelson Lagoon	NSW
North Stradbroke Island	QLD
Pambula Estuarine Wetlands	NSW
Port Stephens Estuary	NSW
Rocky Cape Marine Area	TAS
Salt Ash Air Weapons Range	NSW
Sellars Lagoon	TAS
Shallow Inlet Marine & Coastal Park	VIC
Shoalhaven/Crookhaven Estuary	NSW
Snowy River	VIC
Solitary Islands Marine Park	NSW
St Georges Basin	NSW
Stans Lagoon	TAS
Stotts Island Nature Reserve	NSW
Swan Lagoon	NSW
Swan Pool/Belmore Swamp	NSW
Sydenham Inlet Wetlands	VIC
Syndicate Lagoon	TAS
Tabourie Lake	NSW
Tamboon Inlet Wetlands	VIC
Termeil Lake Wetland Complex	NSW
Terrigal Lagoon	NSW
Thompsons Lagoon	TAS
Thurra River	VIC
Towra Point Estuarine Wetlands	NSW
Tregaron Lagoons 1	TAS
Tregaron Lagoons 2	TAS
Tuggerah Lake	NSW
Tuross River Estuary	NSW
Twofold Bay	NSW

Name	State
Ukerebagh Island Nature Reserve	NSW
Unnamed Wetland	TAS
Unnamed Wetland	TAS
Unnamed Wetland	TAS
Unnamed Wetland	TAS
Unnamed Wetland	TAS
Unnamed Wetland	TAS
Unnamed Wetland	TAS
Unnamed Wetland	TAS
Unnamed Wetland	TAS
Unnamed Wetland	TAS
Unnamed Wetland	TAS
Unnamed Wetland	TAS
Waldrons Swamp	NSW
Wallaga Lake	NSW
Wallagoot Lagoon (Wallagoot Lake)	NSW
Wallis Lake and adjacent estuarine islands	NSW
Wamberal Lagoon	NSW
Western Port	VIC
Wollumboola Lake	NSW
Wooloweyah Lagoon	NSW

Key Ecological Features (Marine) [Resource Information]

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

Name	Region
Tasmantid seamount chain	Coral Sea
Big Horseshoe Canyon	South-east
Seamounts South and east of Tasmania	South-east
Upwelling East of Eden	South-east
Canyons on the eastern continental slope	Temperate east
Elizabeth and Middleton reefs	Temperate east
Lord Howe seamount chain	Temperate east
Norfolk Ridge	Temperate east
Shelf rocky reefs	Temperate east
Tasman Front and eddy field	Temperate east
Tasmantid seamount chain	Temperate east
Upwelling off Fraser Island	Temperate east

Caveat

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

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

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

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

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

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-24.01475 152.58044,-24.29245 154.87035,-23.10543 156.58182,-24.26542 158.04857,-24.22037 158.50098,-23.42192 159.60789,-24.60008 160.5544,-24.68799 161.37122,-25.32979 163.85336,-25.29058 164.16667,-25.01892 164.71496,-25.06722 164.86839,-26.80729 166.64449,-28.32981 167.84269,-29.05953 168.9508,-29.93508 169.87057,-31.29809 170.74685,-34.27301 170.22175,-36.47385 168.29151,-36.7985 167.05591,-38.72424 166.0499,-40.28488 166.3031,-40.84332 166.38323,-40.90305 167.93961,-44.5547 166.9753,-42.17108 165.06693,-42.52437 165.05075,-42.6365475376953 164.9948702,-42.959805670008 164.3278492,-43.4099098471925 164.0157189,-43.5904363159089 163.9855069,-43.7782990252404 163.680527,-44.0859318234025 163.3999213,-44.4539747172771 162.3111576,-44.8615582723729 161.8757272,-45.1768735953234 161.3171687,-45.3400426653177 160.3918924,-45.4121147391349 159.7972978,-45.5652678959966 158.3378383,-45.9796823204458 156.7432436,-45.9876844257675 154.7819313,-45.9966934349947 152.0431925,-46.0057024442218 149.61076,-45.9786754165404 147.4846338,-45.8396906703555 147.3276311,-45.1026233816324 146.7699242,-44.4690662997995 145.5455736,-43.6881661346412 145.9241013,-43.6609641659446 145.9801293,-43.5834046752761 146.3297009,-43.9277358598282 146.2230626,-44.1537038352571 146.6178877,-44.0134839661054 146.8277245,-43.7596107009109 146.814514,-43.806744613177 147.0150099,-43.5730522135468 147.2383926,-43.50943 147.2922,-43.364855058022 147.3339221,-43.3478269828679 147.3374917,-43.2577368905963 147.4095638,-43.1212752677501 147.5910705,-43.05017 147.77233,-42.98137 147.84154,-42.8923145978798 147.8810386,-42.77254 147.87669,-42.5567056387819 147.9132167,-42.3846240169006 147.9724478,-42.35021 148.02663,-42.0913038959766 148.1515102,-42.0461363353013 148.2688636,-41.8549003569967 148.2607361,-41.46611 148.2668,-41.1493591195391 148.2636046,-40.8714693385651 148.1546001,-40.8872 147.83549,-41.0080835405665 147.4439194,-41.01271 147.15121,-41.1266498471154 146.814753,-41.16121 146.55536,-41.1770883363932 146.3688146,-41.1568890361848 146.1655069,-41.0459721687681 145.8284535,-40.9886013752767 145.7309231,-40.81118 145.21824,-40.80226 145.14558,-40.7947187961209 145.1114763,-40.7178158484054 145.0463081,-40.6612120643007 144.8404418,-40.6263877363049 144.7461136,-40.6496880540588 144.5990012,-40.7255713816731 144.5080289,-40.7304328045655 144.4850805,-40.5206695534445 144.4897932,-40.3568359194519 144.643798,-40.1325689144441 144.9143986,-39.8926904580119 144.9036705,-39.695157501952 144.6697761,-39.7084049944393 144.5296788,-39.5391810078944 144.0923958,-39.4102560345082 143.8703497,-39.2901409622126 143.8051085,-39.0963213699523 143.7889217,-39.0041580509395 143.8433226,-38.914067958668 143.9514307,-38.7793477359124 144.1364931,-38.7240271094627 144.2954446,-38.6798540296406 144.5743689,-38.5593117656296 144.7206014,-38.52074207 144.7829055,-38.48523 144.88452,-38.4299 145.0511,-38.48035 145.1558,-38.517 145.23241,-38.5266805619002 145.2828037,-38.5790735800154 145.3519527,-38.62118 145.54366,-38.63693 145.72656,-38.6722555880618 145.8667604,-38.6263589532687 146.7426212,-37.9455588705042 147.7427854,-37.7963948074266 148.2342618,-37.7657970508979 148.7066147,-37.68876 149.65671,-37.5152779193188 149.6398463,-37.4521700464783 149.7813609,-37.51727 149.96297,-37.0907340474825 149.8387317,-36.89307 149.90914,-35.7029 150.17697,-35.28833 150.47883,-35.03673 150.67161,-34.7672169110812 150.7451902,-34.3656213566415 150.8752307,-34.0730303098354 151.0664667,-33.6953392526837 151.3012088,-33.6563 151.27006,-33.59253 151.18902,-33.50229 151.18193,

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30.4173155395694 153.013488,-28.8377063587731 153.4686296,-28.05203 153.44058,-27.87032 153.42101,-27.6306301858276 153.4684688,-
26.8693689061329 153.6959937,-25.0251736827351 153.8771808,-24.0147573963921 152.5804431,-24.01475 152.58044

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 3 - EP Changes Register

Date	Revision	Section Changed	Change	MOC #	Trigger Resubmission
09/03/2022	1	Various	As detailed in EP Rev 0 Response to OMR Letter - BMG (Phase 1) - Not Reasonably Satisfied_Cooper Energy Response.xlsx	N/a	Yes - response to OMR

Appendix 4 - Stakeholder Consultation

Please refer to Sensitive Information

Appendix 5 - JASCO Acoustic Modelling Report

JASCO APPLIED SCIENCES

BMG Wells Plug and Abandonment Activities

Acoustic Modelling for Assessing Marine Fauna Sound Exposures

Submitted to:

Joe Morris
Cooper Energy Limited
Purchase Order: 1810

Authors:

Steven C. Connell
Matthew W. Koessler
Craig R. McPherson

17 May 2021

P001595-001
Document 02381
Version 1.0

JASCO Applied Sciences (Australia) Pty Ltd
Unit 1, 14 Hook Street
Capalaba, Queensland, 4157
Tel: +61 7 3823 2620
www.jasco.com

Suggested citation:

Connell, S.C., M.W. Koessler, and C.R. McPherson. 2021. *BMG Wells Plug and Abandonment Activities: Acoustic Modelling for Assessing Marine Fauna Sound Exposures*. Document 02381, Version 1.0. Technical report by JASCO Applied Sciences for Cooper Energy Limited.

Disclaimer:

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

Contents

Figures

Tables

Executive Summary

JASCO Applied Sciences (JASCO) performed a modelling study of underwater sound levels associated with the Cooper Energy BMG Plug and Abandonment (P&A) Campaign. The modelling study considers specific components of the program at the Basker-A, Basker-6, and Manta-2A well locations as they are representative of the entire P&A region. The study considers the dynamic positioning of the Helix *Q7000*, a dynamic positioning (DP) Class 3 semi-submersible well intervention unit, a platform support vessel (PSV) under DP, and a support vessel hosting a remotely operated underwater vehicle (ROV) under DP, and the ROV cutting tool. These four sources are considered in different combinations across the three well locations, for a total of 12 scenarios, four with the Helix *Q7000* located at Basker-A (Scenario A), two with a vessel with a Remotely Operated Vehicle (ROV) and cutter at Basker-A (Scenario A), and six with the Helix *Q7000* located at Manta-2A (Scenario B).

The modelling study specifically assessed distances from operations where underwater sound levels reached thresholds corresponding to behavioural response, impairment (temporary reduction in hearing sensitivity or TTS) and injury (permanent threshold shift or PTS). The animals considered here included low-, mid-, and high-frequency cetaceans, otariid seals, sea turtles, and fish including fish larvae and eggs.

The modelling methodology considered the source levels of the Helix *Q7000*, support vessels, and ROV cutting tools as well as environmental properties that effect sound propagation. Estimated underwater acoustic levels are presented as sound pressure levels (SPL, L_p), and accumulated sound exposure levels (SEL, L_E) as appropriate for non-impulsive (continuous) noise sources.

The study assessed sound levels at the boundary of the Southern Right Whale (SRW) Biologically Important Area (BIA) for each scenario, and the maximum sound level from operations predicted to occur at the receiver location was 110 dB re 1 µPa.

Marine mammals

For marine mammals, this study considered SEL over accumulation periods of eight hours or 24 hours (SEL_{8h} or SEL_{24h}), to provide results for different periods of operations. During different periods of the Campaign, the different vessels will likely operate in different combinations, and not always be present. Eight hours was selected as a nominal secondary timeframe to help understand how a shorter exposure period translates into potential impact contours.

The SEL_{8h} or SEL_{24h} is a cumulative metric that reflects the dosimetric effect of noise levels within eight or 24 hours based on the assumption that an animal is consistently exposed to such noise levels at a fixed position. The corresponding SEL 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 this length of time. Therefore, a reported radius for SEL_{8h} or SEL_{24h} criteria does not mean that marine fauna travelling within this radius of the source will be impaired, but rather that an animal could be exposed to the sound level associated with impairment (either PTS or TTS) if it remained in that location for 8 or 24 hours.

- The results for the NMFS (2018) criteria applied for marine mammal PTS and TTS for MODU and vessel operations are assessed for 12 scenarios. Each scenario was assessed for either 8 hours or one day of operations (24-hour period). PTS is only predicted to occur in low-and high-frequency cetaceans at short ranges and is unlikely to occur at distances greater than 110 m (SEL_{24h}) or 70 m (SEL_{8h}). The maximum distance predicted for TTS onset in low-frequency cetaceans is 5.07 km (SEL_{24h}) or 1.70 km (SEL_{8h}) and is associated with all considered noise sources operational at the same time.
- The maximum distances to the NOAA (2019) marine mammal behavioural response criterion of 120 dB re 1 µPa (SPL) are presented in Table 1 for each scenario considered. The distances to this isopleth are calculated in relation to the most dominant noise source or the centroid of all sources as appropriate.

Table 1. Maximum (R_{max}) distances (km) to marine mammal behavioural response threshold (NOAA 2019) for considered scenarios.

SPL (L_p; dB re 1 µPa)	Helix Q7000 under DP	PSV under DP	Helix Q7000 with PSV both under DP	ROV vessel under DP	ROV vessel under DP& cutter tool	All sources
Scenario A – Basker-A and Basker-6						
120	20.9	7.93	22.8	7.44	7.44	26.6
Scenario B – Manta-2A and Basker-A						
120	25.6	8.62	28.7	7.93	7.93	29.5

DP: Dynamic Positioning

Otariid seals

Using NMFS (2018), the threshold criteria for PTS is not predicated to occur within the modelling resolution step size (20 m) and TTS is only predicted to occur very near the source, up to 30 m.

Sea turtles

The threshold criteria from Finneran et al. (2017) gives the PTS and TTS for sea turtles. PTS is predicted to occur at distances less than 20 m only while all sound sources are operational, while TTS occurs up to 110 m away.

Fish

Popper et al. (2014) gives guidelines regarding recoverable injury and TTS for fish species which are predicted to occur in close proximity to the sound sources, 20 and 50 m respectively. However, to exceed these guidelines the fish must remain at these distances for either 12 or 48 hours. For all scenarios the fish thresholds at the seafloor are not predicted to be exceeded.

1. Introduction

JASCO Applied Sciences (Australia) performed a modelling study of underwater acoustic noise levels associated with the Cooper Energy BMG Plug and Abandonment (P&A) Campaign. The modelling study considers specific components of the program at the Basker-A, Basker-6, and Manta-2A well locations as they are representative of the entire plug and abandonment campaign.

The modelling study specifically predicted distances from operations to where underwater sound levels reached noise effect thresholds and criteria. The corresponding thresholds include levels associated with behavioural response, impairment (temporary reduction in hearing sensitivity), and injury (permanent threshold shift). The animals considered included low-, mid-, and high-frequency cetaceans, otariid seals, turtles, and fish including fish larvae and eggs. Estimated underwater acoustic levels are presented as sound pressure levels (SPL, L_p), and accumulated sound exposure levels (SEL, L_E), as appropriate for non-impulsive (continuous) noise sources.

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

1.1. Acoustic Modelling Scenario Details

Three well locations were considered for modelling (see Table 2), Basker-A, Basker-6, and Manta-2A to estimate sound levels, these being the only well centres at BMG, the main areas of work for the Q7000, and encompass the extremities of the field from closest to further from shore, and thus representative of all locations for the P&A activities and operations. Modelling considered operations that will likely contribute substantially to underwater noise emissions at each well location; The significant noise emitting activities considered in this study are:

- Dynamic positioning (DP) operations of the Helix *Q7000* DP Class 3 semi-submersible well intervention unit
- DP operations from two support vessels, a platform support vessel (PSV) and a vessel that hosts a Remotely Operated Underwater Vehicle (ROV) (ROV vessel)
- Cutting tool noise from the ROV performing underwater cutting of subsea infrastructure.

These four sources are considered in different combinations across the three well locations, for a total of 12 scenarios, four with the Helix *Q7000* located at Basker-A (Scenario A), two with a vessel with a Remotely Operated Vehicle (ROV) and cutter at Basker-A (Scenario A), and six with the Helix *Q7000* located at Manta-2A (Scenario B). Figure 1 presents an overview map of the well locations, Biologically Important Areas (BIAs), and the bathymetry within the study area, whilst the maps in Figure 2 show the operations at each well location. Whilst the depth reported in Table 2 and shown in Figure 1 for Basker-A is 193.5 m, this is an error in the bathymetry, with ROV dives and survey work by Cooper demonstrating an actual depth of 155 m. However, no usable bathymetry with this depth exists, and the only bathymetry available was therefore applied (Appendix B.1.1).

For marine mammals, this study considered SEL over accumulation periods of eight hours or 24 hours (SEL_{8h} or SEL_{24h}), to provide results for different periods of operations. During different periods of the Campaign, the different vessels will likely operate in different combinations, and not always be present. Eight hours was selected as a nominal secondary timeframe to help understand how a shorter exposure period translates into potential impact distances as compared to the nominal 24h time period.

Eight individual modelled sites are used to assess the 12 scenarios (Table 3 and Figure 1), and where differently numbered modelled sites share the same geographic coordinates, the sites differ in the depth of the associated source. Further detail on source depths is provided in Section 3.1. All scenarios are summarised in Table 4, which details the considered well location and the associated operations. Table 5 provides the geographic coordinates of a receiver location to assist with understanding the noise levels at the boundary of the Southern Right Whale (SRW) BIA shown in Figure 1.

Table 2. Location details for representative P&A wells.

Well	Latitude (S)	Longitude (E)	MGA Zone 55 (GDA94)		Water depth (m)*
			X (m)	*Y* (m)	
Basker-A	38° 17' 58.5096"	148° 42' 24.7212"	649252	5759566	193.5[a]
Basker-6	38° 19' 17.5372"	148° 43' 54.7000"	651392	5757090	259.0
Manta-2A	38° 16' 39.4104"	148° 42' 58.0284"	650106	5761990	132.2

* Whiteway (2009)
[a] Actual depth according to survey work is 155 m.

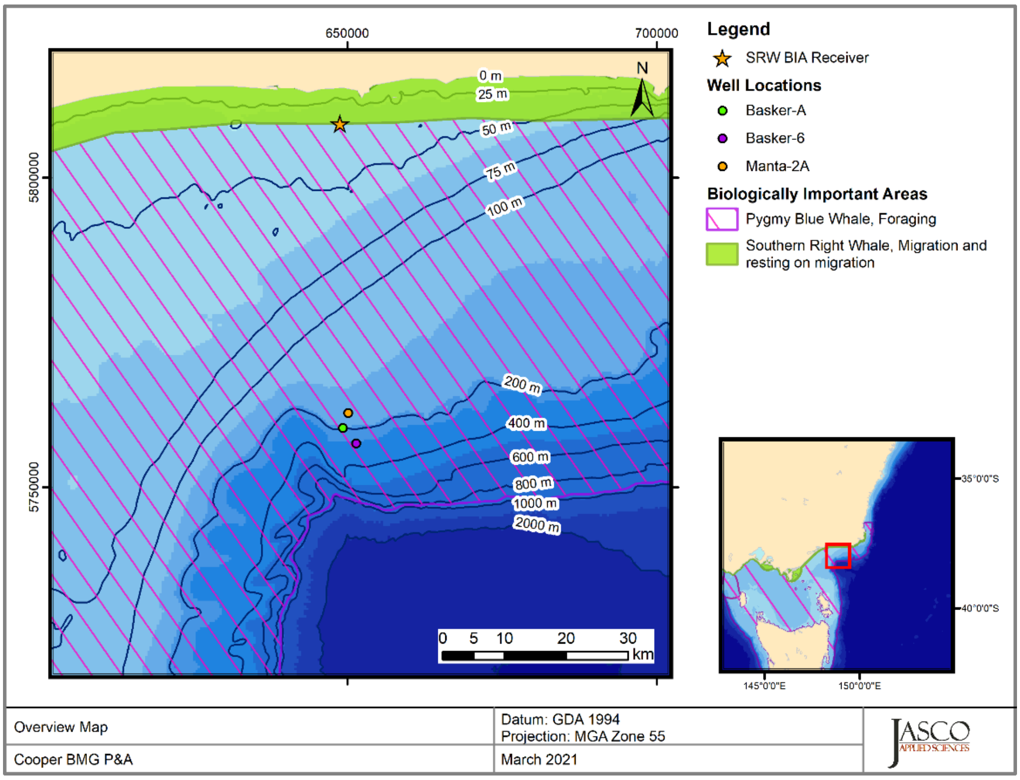


Figure 1. Overview of the modelled area, well locations, and local features.

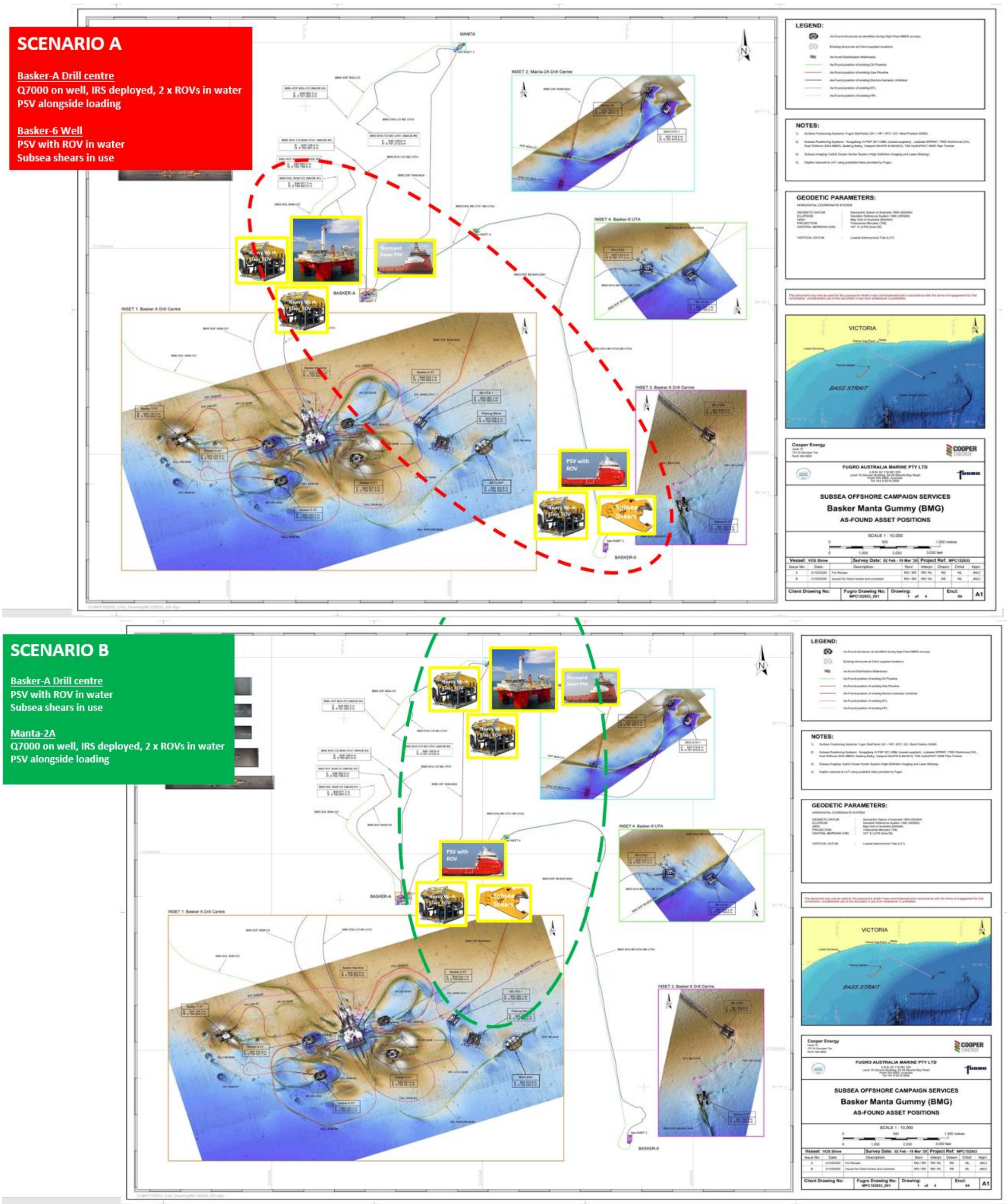


Figure 2. Scenario overview maps

Table 3. Modelled site locations and source information.

Well	Site	Source	Latitude (S)	Longitude (E)	MGA Zone 55 (GDA94)		Source depth (m)	Water depth (m)*
					X (m)	*Y* (m)		
Basker-A	1	Helix *Q7000*	38° 17' 58.5096"	148° 42' 24.7212"	649252	5759566	15.3	193.5[a]
	2	PSV					6.2	
Basker-6	3	ROV vessel	38° 19' 17.5372"	148° 43' 54.7000"	651392	5757090	6.2	259.0
	4	ROV cutter					254	
Manta-2A	5	Helix *Q7000*	38° 16' 39.4104"	148° 42' 58.0284"	650106	5761990	15.3	132.2
	6	PSV					6.2	
Basker-A	7	ROV vessel	38° 17' 58.5096"	148° 42' 24.7212"	649252	5759566	6.2	193.5
	8	ROV cutter					188.5	

* Whiteway (2009)
[a] Actual depth according to survey work is 155 m.

Table 4. Description of modelling scenarios.

Scenario number	Modelled site*	Vessel	Description	Location
A1	1	Helix *Q7000*	Helix operations	Basker-A
A2	2	PSV	PSV under DP during resupply (by itself for context only) (ROV not cutting, not modelled)	
A3	1, 2	Helix *Q7000* and PSV	Helix operations and PSV under DP during resupply (by itself for context only) (ROV not cutting, not modelled)	
A4	3	ROV vessel	ROV vessel under DP	Basker-6
A5	3, 4	ROV cutter	ROV vessel under DP with ROV at seafloor cutting	
A6	1, 2, 3, 4	All	Helix operations + PSV resupply ROV vessel under DP with ROV	Basker-A and Basker-6
B1	5	Helix *Q7000*	Helix operations	Manta 2A
B2	6	PSV	PSV under DP during resupply (by itself for context only) (ROV not cutting, not modelled)	
B3	5, 6	Helix *Q7000* and PSV	Helix operations and PSV under DP during resupply (by itself for context only) (ROV not cutting, not modelled)	
B4	7	ROV vessel	ROV vessel under DP	Basker-A
B5	7, 8	ROV cutter	ROV vessel under DP with ROV at seafloor cutting	
B6	5, 6, 7, 8	All	Helix operations + PSV resupply ROV vessel under DP with ROV	Manta-2A and Basker-A

* Associated modelled sites are provided in Table 3.

Table 5. Receiver coordinates on the boundary of the Southern Right Whale Biologically Important Area (BIA).

Latitude (S)	Longitude (E)	MGA Zone 55 (GDA94)	
		X (m)	*Y* (m)
37° 51' 24.0302"	148° 41' 27.8841"	648766	5808739

2. Noise Effect Criteria

To assess the potential effects of a sound-producing activity, it is necessary to first establish exposure criteria for which sound levels may be expected to have a negative effect on fauna. 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.

Several sound level metrics, such as, SPL and SEL, are commonly used to evaluate noise and its effects on marine life (Appendix A). In this report, the duration of the SEL accumulation is defined as integrated over both an eight and 24 h 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).

The following thresholds and guidelines for this study were chosen because they represent the best available science:

1. Marine mammal behavioural threshold based on the current interim NOAA (2019) criterion for marine mammals of 120 dB re 1 µPa (SPL; L_p) for non-impulsive sound sources.
2. Frequency-weighted accumulated sound exposure levels (SEL; $L_{E,24h}$ and $L_{E,8h}$) from the US National Oceanic and Atmospheric Administration (NOAA) Technical Guidance (NMFS 2018) for the onset of permanent threshold shift (PTS) and temporary threshold shift (TTS) in marine mammals for non-impulsive sources.
3. Sound exposure guidelines for fish, fish eggs, and larvae from Popper et al. (2014).
4. Frequency-weighted accumulated sound exposure levels (SEL; $L_{E,24h}$ and $L_{E,8h}$) from Finneran et al. (2017) for the onset of permanent threshold shift (PTS) and temporary threshold shift (TTS) in turtles for non-impulsive sources.

Sections 2.1–2.2, along with Appendix A.3, expand on the thresholds, guidelines and sound levels for marine mammals, fish, fish eggs, fish larvae, and sea turtles.

2.1. Marine Mammals

The criteria applied in this study to assess possible effects of non-impulsive noise sources on marine mammals are summarised in Table 6 and detailed in Sections 2.1.1 and 2.1.2, with frequency weighting explained in Appendix A.4. Cetaceans and otariid seals were identified as the hearing groups requiring assessment.

Table 6. Criteria for effects of continuous noise exposure, including vessel noise, for marine mammals: Unweighted SPL and SEL_{24h} thresholds.

Hearing group	NOAA (2019)	NMFS (2018)	
	Behaviour	PTS onset thresholds (received level)	TTS onset thresholds (received level)
	SPL (L_p; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^2·s)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^2·s)
Low-Frequency (LF) cetaceans	120	199	179
Mid-frequency (MF) cetaceans		198	178
High-frequency (HF) 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.

2.1.1. Behavioural Response

The NMFS non-pulsed noise criterion was selected for this assessment because it represents the most commonly applied behavioural response criterion by regulators. The distances at which behavioural responses could occur were therefore determined to occur in areas ensonified above an unweighted SPL of 120 dB re 1 µPa (NMFS 2014, NOAA 2019). Appendix A.3 provides more information about the development of this criteria.

2.1.2. Injury and Hearing Sensitivity Changes

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

To assist in assessing the potential for effect on marine mammals, this report applies the criteria recommended by NMFS (2018), considering both PTS and TTS (see Table 6). Appendix A.3 provides more information about the NMFS (2018) criteria.

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

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

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

Masking and behavioural effects can be assessed qualitatively, by assessing relative risk rather than by specific sound level thresholds. However, as these depend upon activity-based subjective ranges, these effects are not addressed in this report and are included in Table 7 for completeness only. Because the presence or absence of a swim bladder has a role in hearing, fish's susceptibility to noise exposure depends on the species and the presence and possible role of a swim bladder in hearing. Thus, different thresholds were proposed for fish without a swim bladder (also appropriate for sharks and applied to whale sharks in the absence of other information), fish with a swim bladder not used for hearing, and fish that use their swim bladders for hearing. Turtles, fish eggs, and fish larvae are considered separately.

Table 7 lists the relevant effects guidelines from Popper et al. (2014) for shipping and continuous noise. Some evidence suggests that fish sensitive to acoustic pressure show a recoverable loss in hearing sensitivity, or injury when exposed to high levels of noise (Scholik and Yan 2002, Amoser and Ladich 2003, Smith et al. 2006); this is reflected in the SPL thresholds for fish with a swim bladder involved in hearing.

Finneran et al. (2017) presented revised thresholds for turtle non-impulsive PTS and TTS, considering frequency weighted SEL, which have been applied in this study (Table 8).

Table 7. Guidelines for vessel noise exposure for fish and turtles, adapted from Popper et al. (2014). 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).

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

SPL: Sound pressure level dB re 1 µPa.

Table 8. Acoustic effects of continuous noise on turtles, weighted SEL, Finneran et al. (2017).

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

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

3. Methods and Parameters

The operational locations considered in this study range between 132–259 m water depth (see Appendix B.1.1). Activities could occur at any time of the year, but pre-modelling analysis indicated that winter would yield the most conservative water sound speed profile (i.e., the profile leading to the longest acoustic propagation) and the month June was selected for modelling (see Appendix B.1.2). All wells are located on the continental shelf and have a seabed characterised by interbedded muddy sand and sandy silt. Details on the associated geoacoustic properties used in this modelling study are provided in Appendix B.1.3.

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

3.1. Acoustic Sources

Source specific considerations for underwater noise emission are presented in the subsections below. For the considered vessels, the depths of the source were based on the approximate location of cavitation. For noise from the ROV cutter operations, the source was modelled at a nominal 5 m from the seabed following client supplied information, which indicated that most activities involving ROV cutting will be associated with infrastructure installed on the seafloor.

The exact position of vessels and/or ROV in these scenarios is not known and will likely vary due to operational conditions and requirements during the P&A campaign; therefore, for scenarios involving multiple adjacent sources, i.e., the Helix *Q7000* and PSV undergoing resupply operations or the ROV vessel and the ROV in simultaneous operation, sources were modelled at the same geographic (i.e., horizontal) location but with source depths that reflect the activity being modelled.

3.1.1. Helix *Q7000*

The Helix *Q7000* is a DP Class 3 semi-submersible well intervention vessel that is planned for use in the P&A campaign considered in this study (Figure 3). While in operation, it will hold position by using thrusters under dynamic positioning. As such, the underwater noise emitted from the Helix *Q7000* is expected to originate primarily from cavitation in the thrusters whilst under DP.

Figure 3. Well intervention unit *Helix Q7000* semi-submersible platform (Helix Energy Solutions 2020).

Thruster noise from the *Helix Q7000* was modelled as a point source at a 15.3 m depth. This source depth was determined by selecting the median depth following Gray and Greeley (1980). The vessel schematics, thruster positions and propeller diameter for each thruster module were considered in the selection.

The source level spectrum for the *Helix Q7000* was based on median noise measurements from similarly sized but higher powered semi-submersible vessel previously measured by JASCO whilst under DP. This measured semi-submersible vessel has been used as a reference vessel and is suitable for a proxy because it is a vessel with more installed propulsion power, with a maximum installed power of 26.4 kW, and the same number of thrusters (eight) as the *Helix Q7000*, and the measurement program was conducted over a multi-week period and included periods of rough weather in which the vessel had to use high power levels to maintain station. The energy sound level spectra for the vessel under DP (*Helix Q7000*) were adjusted based on the vessels power ratios, following:

$$\mathrm{SL} = \mathrm{SL}_{ref} + 10\log(P/P_{ref})\,, \quad (1)$$

where SL is the source level, P is the total installed power of the modelled vessel (*Helix Q7000:* 20.6 kW), and the subscript ref represents the total installed power for the reference vessel (*26.4 kW).* The estimated decidecade energy source level (ESL) spectra of the Helix *Q7000* is shown in Figure 4, the broadband ESL (10 Hz to 25 kHz) is 188.9 dB re 1 µPa.

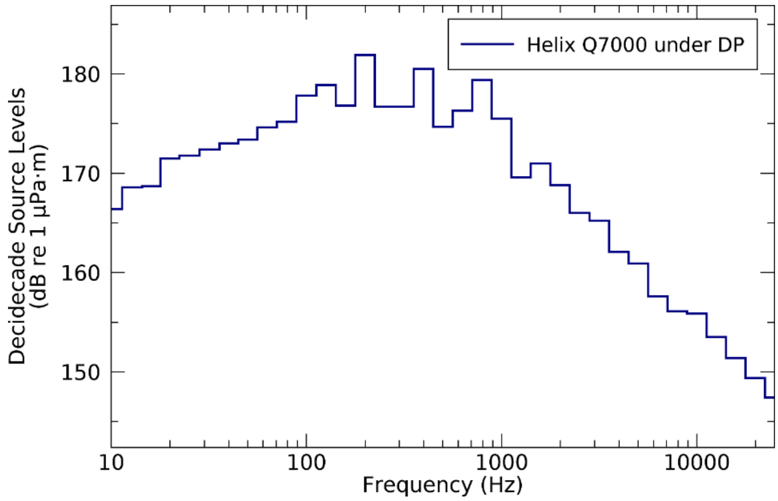


Figure 4. Estimated decidecade energy source level (ESL) spectra of the Helix *Q7000*, with a broadband ESL (10 Hz to 25 kHz) of 188.9 dB re 1 µPa*.*

3.1.2. Platform Support and ROV Vessels

At the time of this study, the Platform Support Vessel (PSV) and ROV vessel to be used in the project were unconfirmed. Four different vessels were identified as either potential PSV or ROV vessels, therefore the source level and spectrum used to represent any of these four vessels was based on the nominal specifications for all indicated vessels, due to similarity in dimensions and total installed power ratings. This nominal vessel has an 89.2 m overall length, 20 m breadth, and 7.6 m maximum draft.

The main propulsion system is likely to be comprised of two aft propellers with the following specifications:

- 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 are likely to have:

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

The bow azimuth thruster is likely to have:

- 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.2. 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.

Source depth was based on the approximate location of cavitation on the propellers (Leggat et al. 1981). Under DP, all thrusters may be used, which results in a 6.2 m source depth based on Gray and Greeley (1980).

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 both the PSV and ROV vessel under typical DP operations.

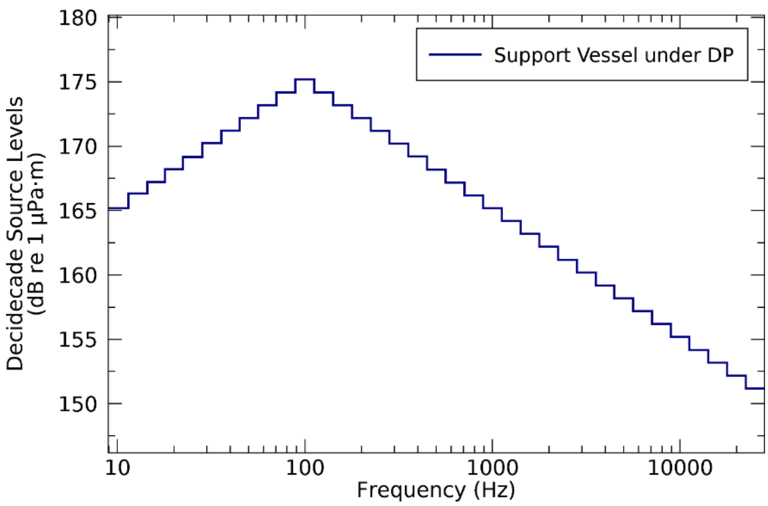


Figure 5. Decidecade energy source level (ESL) spectra of the support vessels. The support vessels have a broadband ESL (10 Hz to 25 kHz) of 185.2 dB re 1 uPa m.

3.1.3. ROV Cutter

A diamond wire saw operated via an ROV is the likely cutting tool for the 150 and 200 mm production pipelines. Published and grey literature available to quantify the underwater sound fields from diamond wire saws, or other cutting technologies, is very limited.

Pangerc et al. (2016) described the underwater sound measurement data during an underwater diamond wire cutting of a 32” conductor (10 m above seabed in ~80 m depth) and found that at lower frequencies, the operation was generally indistinguishable above the background noise; however, the sound that could be associated with the diamond wire cutting was primarily detectable above the background noise at the higher acoustic frequencies (above around 5 kHz). The background noise levels were substantially higher at lower frequencies; therefore, it is likely that the spectra of the noise peaks at lower frequencies, which has been approximated between 2.5 and 20 kHz.

In another study, the US Navy measured underwater sound levels when the diamond saw was cutting caissons for replacing piles at an old fuel pier at Naval Base Point Loma and reported an average SPL for a single cutter at 136.1–141.4 dB re 1 µPa at 10 m, as reported in Fairweather Science (2018).

In the absence of other information representing the cutting of pipes up to 200 mm diameter via a diamond wire saw underwater, the information provided in Pangerc et al. (2016) was used to estimate a representative decidecade-band spectra for the diamond wire saw underwater, which was scaled to have a level of 141.4 dB re 1 µPa at 10 m, and then then backpropagated using spherical spreading (20log10(R)) to determine an ESL spectra (in decidecade frequency band). This was estimated to be the most appropriate approach given the limited information available. Figure 6 shows the representative decidecade-band ESL spectra, with a broadband ESL for the cutter being 161.4 dB re 1 µPa.

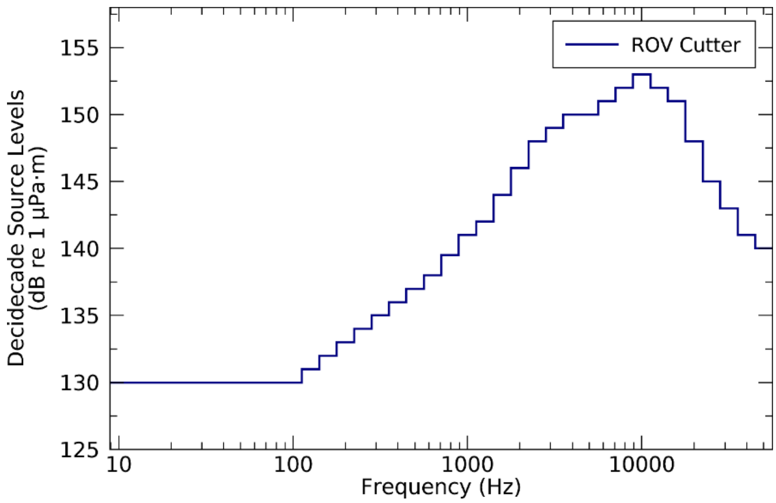


Figure 6. Decidecade energy source level (ESL) spectra of the diamond cutter, operated by the ROV, which has a broadband ESL (10 Hz to 25 kHz) of 161.4 dB re 1 uPa m.

3.2. Geometry and Modelled Regions

JASCO's Marine Operations Noise Model (MONM-BELLHOP; see Appendix B.3.2) was used to predict the underwater acoustic propagation loss at the modelled sites at frequencies of 10 Hz to 25 kHz. This model considers the environmental variations along the propagation path. The final acoustic fields combine Helix *Q7000*, PSV and ROV vessel and ROV cutter source levels (see Section 3.1) with the site-specific propagation loss fields.

To assess sound levels with MONM-BELLHOP, the sound field modelling calculated propagation losses up to distances of 80 km from the source in each cardinal direction, with a horizontal separation of 20 m between receiver points along the modelled radials. The sound fields were modelled with a horizontal angular resolution of $\Delta\theta$ = 2.5° for a total of N = 144 radial planes. Receiver depths were chosen to span the entire water column over the modelled areas, from 1 m to a maximum of 4000 m, with step sizes that increased with depth. To supplement the MONM results, high-frequency results for propagation loss were modelled using BELLHOP (Porter and Liu 1994) for frequencies from 2.5 to 25 kHz. The MONM and BELLHOP results were combined to produce results for the full frequency range of interest.

To produce the maps of received sound level distributions, isopleths, and calculate distances to specified sound level thresholds, the maximum-over-depth level was calculated at each sampling point within the modelled region. The radial grids of maximum-over-depth levels for resampled (by linear triangulation) to produce a regular Cartesian grid. The sound field grids from all sources were summed (see Equation A-3) to produce the cumulative sound field grid with cell sizes of 20 m. The contours and threshold ranges were calculated from these flat Cartesian projections of the modelled acoustic fields.

3.3. Accumulated SEL

Vessels under DP and while operational, and the ROV cutter, continuously produce sound. The reported source levels are usually in terms of sound pressure levels (SPL), representing the average instantaneous acoustic level of the Helix *Q7000*, PSV, ROV vessel, and ROV cutter, during specific operations. The evaluation of the cumulative sound field (e.g., in terms of SEL 24 h or 8 h) depends on the number of seconds of operation during the accumulation period.

In this study, all sound sources were considered to be continuously operating under and stationery during all activities. For all scenarios, the 1 s SEL, equivalent to SPL, was increased by $10*\log_{10}(T)$, where T is the number of seconds in 24 or h.

3.4. Biologically Important Area Calculation

The ensonified area for the modelling scenarios with the furthest ranges to thresholds were presented in the context of the percentage of the foraging pygmy blue whale BIAs in the South East Marine Region. The three considered BIAs are listed in Table 9, and shown in Figure 7.

Table 9. Foraging pygmy blue whale BIAs in the South East Marine Region, individual and combined areas.

BIA Legend Entry	Area (km²)
Foraging (foraging)	181 376
Foraging (abundant food source)	25 149
Foraging (high annual use area)	35 810
Combined	**235 188 (7 147 overlap)**

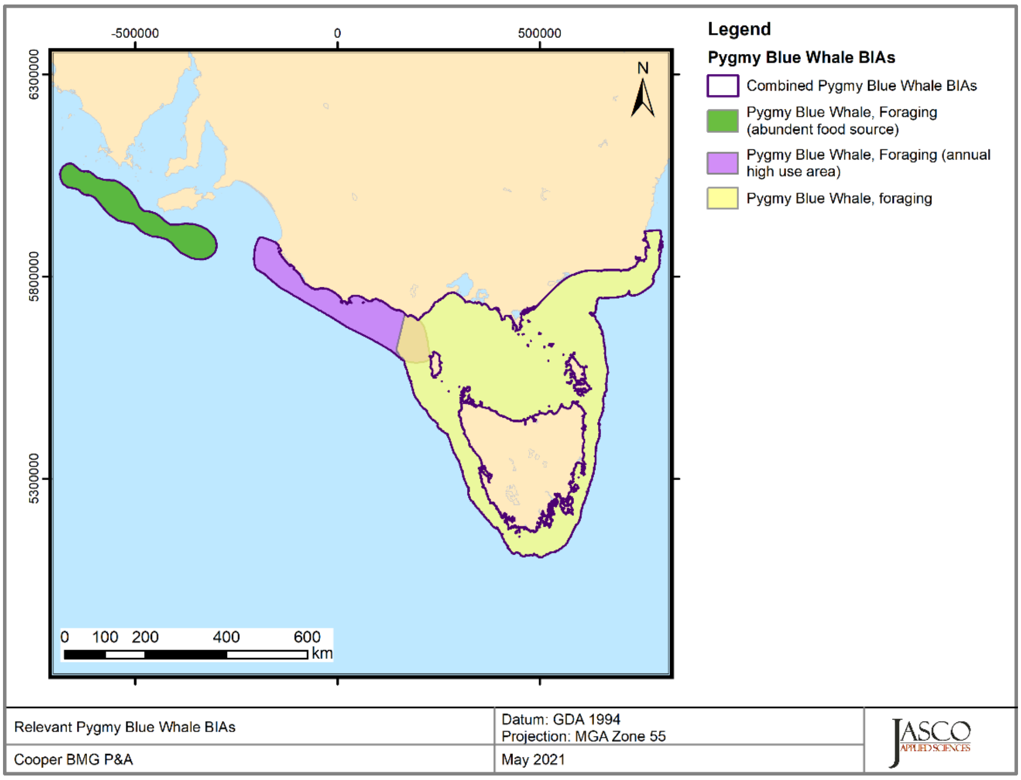


Figure 7. Map of foraging pygmy blue whale BIAs in the South East Marine Region, showing individual and combined areas.

4. Results

The maximum-over-depth sound fields for the twelve modelled scenarios (see 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 distance to various sound levels.

Distances to isopleths/thresholds were reported from either the centroid of several sources or from the most dominant single source. When an isopleth completely enveloped multiple sources, the centroid was used. When several closed isopleths existed, the most dominant source was used.

The criteria for recoverable injury and TTS for fish at the seafloor, as outlined in Section 2.2, was not predicted to occur.

4.1. Tabulated Results

Tables 10 and 11 present the maximum and 95% distances (defined in Appendix B.4) to SPL thresholds, highlighting the 120 dB re 1 µPa threshold for marine mammal behavioural response to continuous noise (NOAA 2019) and the 158 dB re 1 µPa 12 h threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014) at the seafloor.

Tables 12 and 13 present the maximum distances to frequency-weighted SEL_{24h} thresholds for marine mammals and turtles, as well as the total ensonified area of the frequency-weighted SEL_{24h} threshold. Additional frequency-weighted PTS and TTS results with an 8 h accumulation period (SEL_{8h}) are provided in Appendix C.1 to inform the potential distances for alternative operational durations.

The three pygmy blue whale BIAs in the South East Marine Region classified as foraging (foraging), foraging (abundant food source) and foraging (annual high use area)) (Table 9) were compared to the sound field extents for the scenarios with the furthest ranges to thresholds, Table 15.

Table 10. *Scenario A:* 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 A1: Helix ops		Scenario A2: PSV under DP		Scenario A3: Helix ops with PSV under DP		Scenario A4: ROV vessel under DP		Scenario A5: ROV vessel & cutter tool		Scenario A6: All sources	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
180	–	–	–	–	–	–	–	–	–	–	0.02	0.02
170[a]	–	–	–	–	–	–	–	–	–	–	0.02	0.02
160	0.03	0.03	0.02	0.02	0.04	0.04	0.02	0.02	0.02	0.02	0.04	0.04
158[b]	0.05	0.05	0.03	0.03	0.05	0.05	0.03	0.03	0.03	0.03	0.05	0.05
150	0.13	0.13	0.07	0.07	0.14	0.14	0.07	0.07	0.07	0.07	0.14	0.14
140	0.73	0.68	0.47	0.46	0.79	0.75	0.24	0.24	0.24	0.24	0.80	0.76
130	4.18	3.40	2.50	1.59	4.77	3.99	1.57	1.18	1.57	1.18	6.09	5.33
120[c]	20.9	16.3	7.93	6.70	22.8	18.2	7.44	6.36	7.44	6.36	26.6	21.6
110	65.6	54.2	37.2	28.8	68.7	58.3	34.6	25.2	34.6	25.2	71.7	60.0
100	>80	\	>80	\	>80	\	>80	\	>80	\	>80	\

[a] 48 h threshold for recoverable injury for fish with a swim bladder involved in hearing (Popper et al. 2014).
[b] 12 h threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014).
[c] Threshold for marine mammal behavioural response to continuous noise (NOAA 2019).

Table 11. *Scenario B:* 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 B1: Helix ops		Scenario B2: PSV under DP		Scenario B3: Helix ops with PSV under DP		Scenario B4: ROV vessel under DP		Scenario B5: ROV vessel & cutter tool		Scenario B6: All sources	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
180	–	–	–	–	–	–	–	–	–	–	–	–
170[a]	–	–	–	–	–	–	–	–	–	–	0.02	0.02
160	0.03	0.03	0.02	0.02	0.04	0.04	0.02	0.02	0.02	0.02	0.04	0.04
158[b]	0.05	0.05	0.03	0.03	0.05	0.05	0.03	0.03	0.03	0.03	0.05	0.05
150	0.13	0.13	0.07	0.07	0.15	0.14	0.07	0.07	0.07	0.07	0.15	0.14
140	0.80	0.67	0.45	0.43	1.02	0.94	0.47	0.46	0.47	0.46	1.04	0.96
130	5.02	4.33	2.24	1.96	5.51	5.07	2.50	1.59	2.50	1.59	6.75	6.22
120[c]	25.6	19.4	8.62	7.93	28.7	21.1	7.93	6.70	7.93	6.71	29.5	23.2
110	84.0	64.7	43.9	32.8	88.2	67.5	37.2	28.8	37.2	28.8	89.5	68.9
100	>80	\	>80	\	>80	\	>80	\	>80	\	>80	\

[a] 48 h threshold for recoverable injury for fish with a swim bladder involved in hearing (Popper et al. 2014).
[b] 12 h threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014).
[c] Threshold for marine mammal behavioural response to continuous noise (NOAA 2019).

Table 12. *Scenario A:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelled resolution (20 m). Scenario descriptions are given in Table 4.

Hearing group	Frequency-weighted SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)	Scenario A1: Helix ops		Scenario A2: PSV under DP		Scenario A3: Helix ops with PSV under DP		Scenario A4: ROV vessel under DP		Scenario A5: ROV vessel & cutter tool		Scenario A6: All sources[a]	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
PTS													
LF cetaceans	199	0.10	0.04	0.05	0.009	0.11	0.04	0.05	0.009	0.05	0.009	0.11	0.05
MF cetaceans	198	–	–	–	–	–	–	–	–	–	–	–	–
HF cetaceans	173	0.05	0.009	0.06	0.01	0.07	0.02	0.06	0.01	0.06	0.01	0.08	0.03
Otariid seals	219	–	–	–	–	–	–	–	–	–	–	–	–
Sea turtles	220	–	–	–	–	–	–	–	–	–	–	0.02	0.0013
TTS													
LF cetaceans	179	3.13	16.3	1.04	2.37	3.49	22.4	0.94	2.71	0.94	2.72	4.72	30.6
MF cetaceans	178	0.05	0.009	0.05	0.009	0.06	0.015	0.05	0.009	0.05	0.009	0.07	0.023
HF cetaceans	153	0.69	1.34	0.84	1.76	1.68	3.36	0.64	1.27	0.95	2.21	2.70	6.70
Otariid seals	199	0.03	0.004	–	–	0.03	0.004	–	–	–	–	0.03	0.004
Sea turtles	200	0.09	0.028	0.06	0.001	0.10	0.035	0.06	0.001	0.06	0.001	0.10	0.047

A dash indicates the threshold was not reached within the limits of the modelling resolution (20 m).

Table 13. *Scenario B:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds for marine mammals based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelled resolution (20 m). Scenario descriptions are given in Table 4.

Hearing group	Frequency-weighted SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)	Scenario B1: Helix ops		Scenario B2: PSV under DP		Scenario B3: Helix ops with PSV under DP		Scenario B4: ROV vessel under DP		Scenario B5: ROV vessel & cutter tool		Scenario B6: All sources	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
PTS													
LF cetaceans	199	0.10	0.035	0.05	0.009	0.11	0.04	0.05	0.009	0.05	0.009	0.11	0.05
MF cetaceans	198	–	–	–	–	–	–	–	–	–	–	–	–
HF cetaceans	173	0.05	0.009	0.06	0.01	0.07	0.02	0.06	0.01	0.06	0.01	0.08	0.0314
Otariid seals	219	–	–	–	–	–	–	–	–	–	–	–	–
Sea turtles	220	–	–	–	–	–	–	–	–	–	–	0.02	0.002
TTS													
LF cetaceans	179	3.49	28.0	1.09	3.42	3.82	35.6	1.04	2.37	1.04	2.38	5.07	43.4
MF cetaceans	178	0.05	0.009	0.05	0.009	0.06	0.02	0.05	0.009	0.05	0.009	0.07	0.02
HF cetaceans	153	0.69	1.43	0.89	2.33	1.11	3.67	0.84	1.76	1.57	2.51	2.39	8.50
Otariid seals	199	0.03	0.004	–	–	0.03	0.004	–	–	–	–	0.03	0.004
Sea turtles	200	0.09	0.03	0.06	0.001	0.11	0.04	0.06	0.001	0.06	0.001	0.11	0.05

A dash indicates the threshold was not reached within the limits of the modelling resolution (20 m).

Table 14. Received sound pressure level (SPL) levels at Southern Right Whale (SRW) BIA receiver location in Table 5.

Scenario	Description	Location	SPL (L_p; dB re 1 µPa)
A1	Helix operations	Basker-A	108.1
A2	PSV under DP during resupply (by itself for context only) (ROV not cutting, not modelled)	Basker-A	102.7
A3	Helix operations and PSV under DP during resupply (by itself for context only) (ROV not cutting, not modelled)	Basker-A	108.9
A4	ROV vessel under DP	Basker-6	103
A5	ROV vessel under DP with ROV at seafloor cutting	Basker-6	103
A6	Helix operations + PSV resupply ROV vessel under DP with ROV	Basker-A and Basker-6	109.6
B1	Helix operations	Manta 2A	109.2
B2	PSV under DP during resupply (by itself for context only) (ROV not cutting, not modelled)	Manta 2A	102.8
B3	Helix operations and PSV under DP during resupply (by itself for context only) (ROV not cutting, not modelled)	Manta 2A	110.1
B4	ROV vessel under DP	Basker-A	102.7
B5	ROV vessel under DP with ROV at seafloor cutting	Basker-A	102.7
B6	Helix operations + PSV resupply ROV vessel under DP with ROV	Manta 2A and Basker-A	110.6

Table 15. *Scenarios A6 and B6:* Ensonified area as a percentage of the Pygmy Blue Whale (PBW) Foraging Biologically Important Areas (BIA).

Metric	Behaviour	% of PBW Foraging BIAs*	
		Scenario A6: All sources	Scenario B6: All sources
SPL	Behavioural Response	0.42%	0.56%
SEL_{8h}	PTS	0.000007%	0.000007%
	TTS	0.0021%	0.0038%
SEL_{24h}	PTS	0.00002%	0.00002%
	TTS	0.013%	0.018%

* Pygmy Blue Whale Foraging Biologically Important Areas

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 twelve modelled scenarios (see Table 4) in Figures 8–25. Additional maps for an 8 h accumulation period (SEL_{8h}) are provided in Appendix C.2.

4.2.1. Scenario A

4.2.1.1. Maximum-over-depth SPL Sound Fields

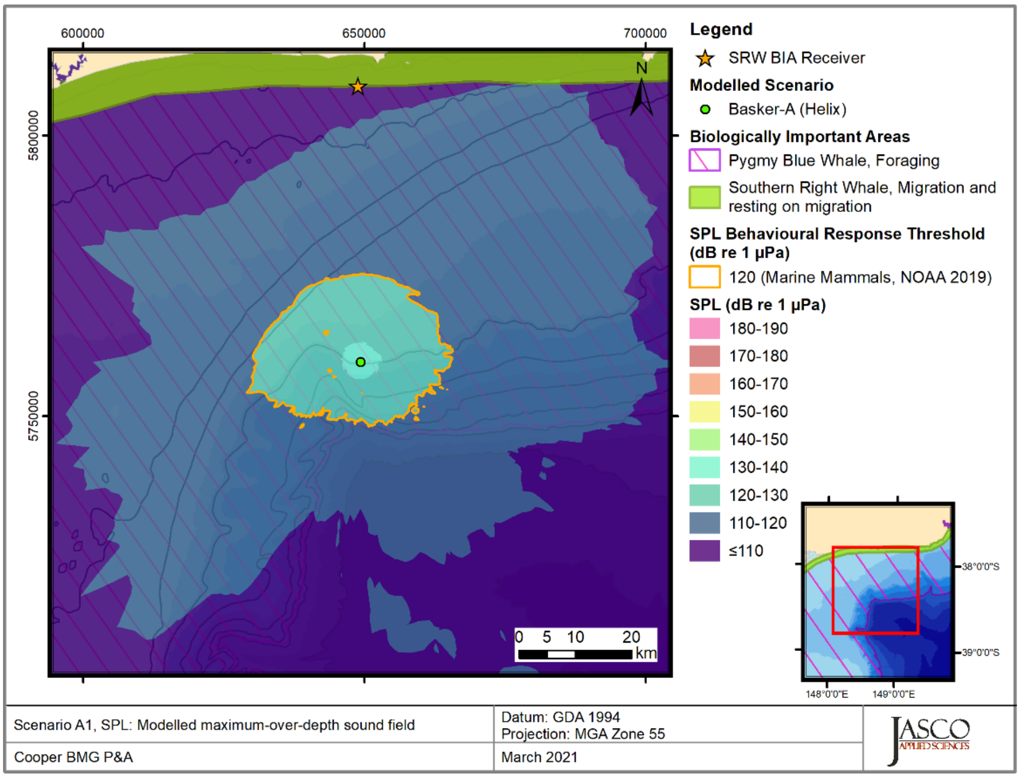


Figure 8. Scenario A1, Helix *Q7000* at Basker-A, SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

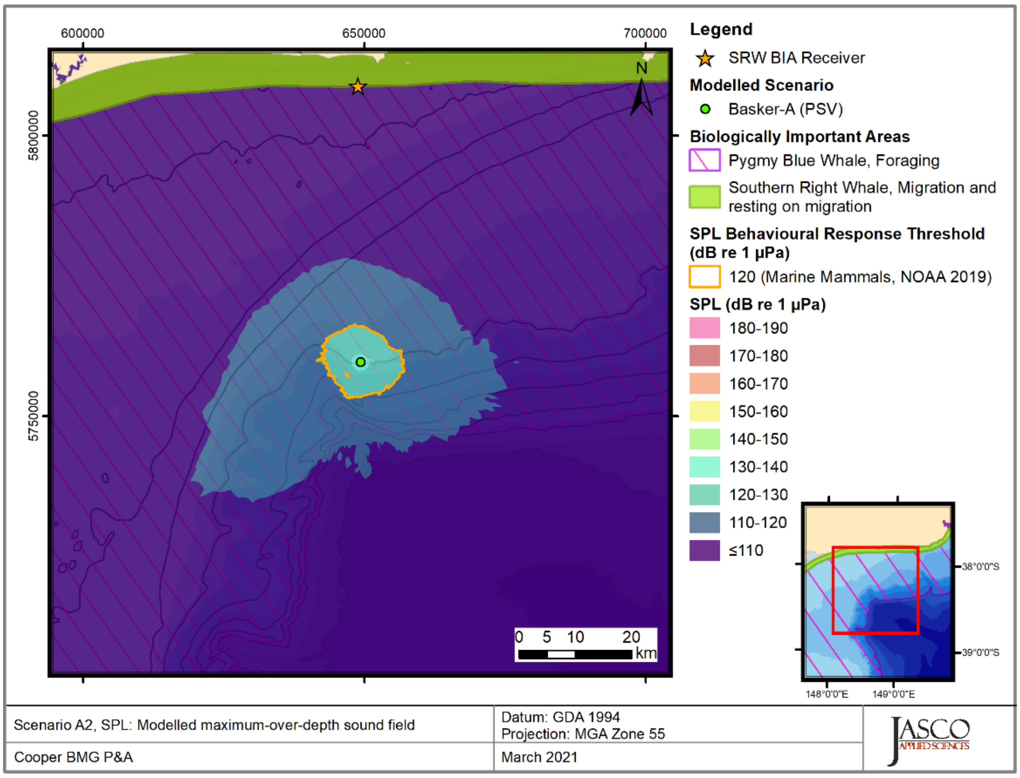


Figure 9. Scenario A2, platform support vessel at Basker-A, SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

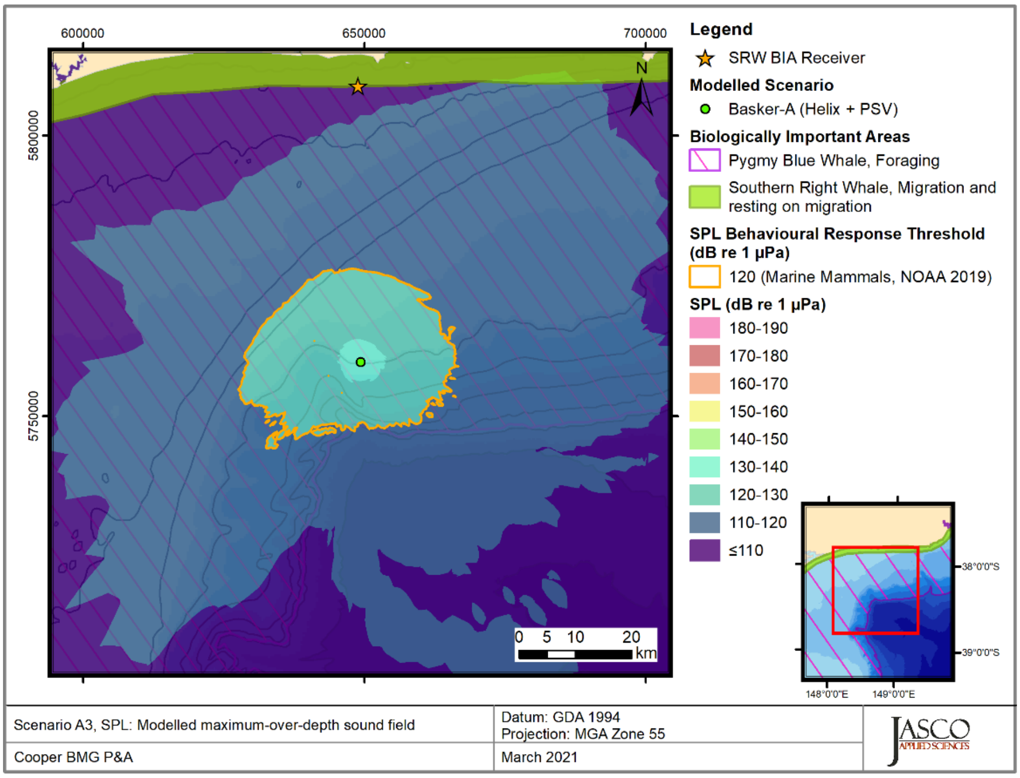


Figure 10. Scenario A3, *Helix Q7000* and platform support vessel at Basker-A, SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

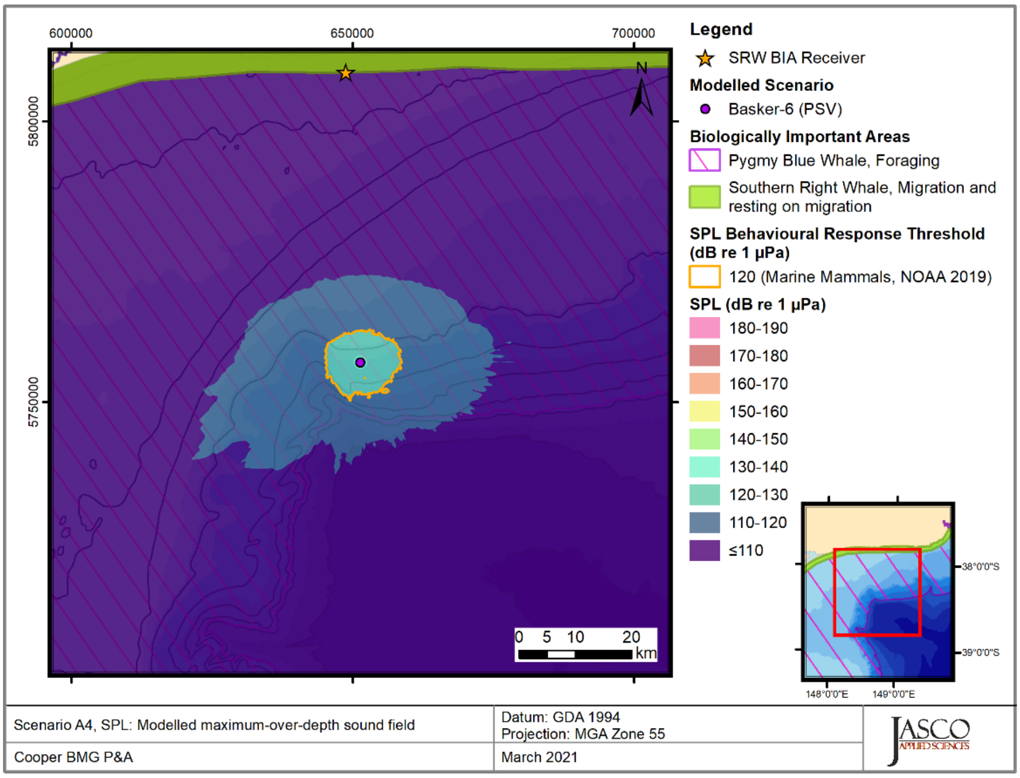


Figure 11. Scenario A4, platform support vessel at Basker-6, SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

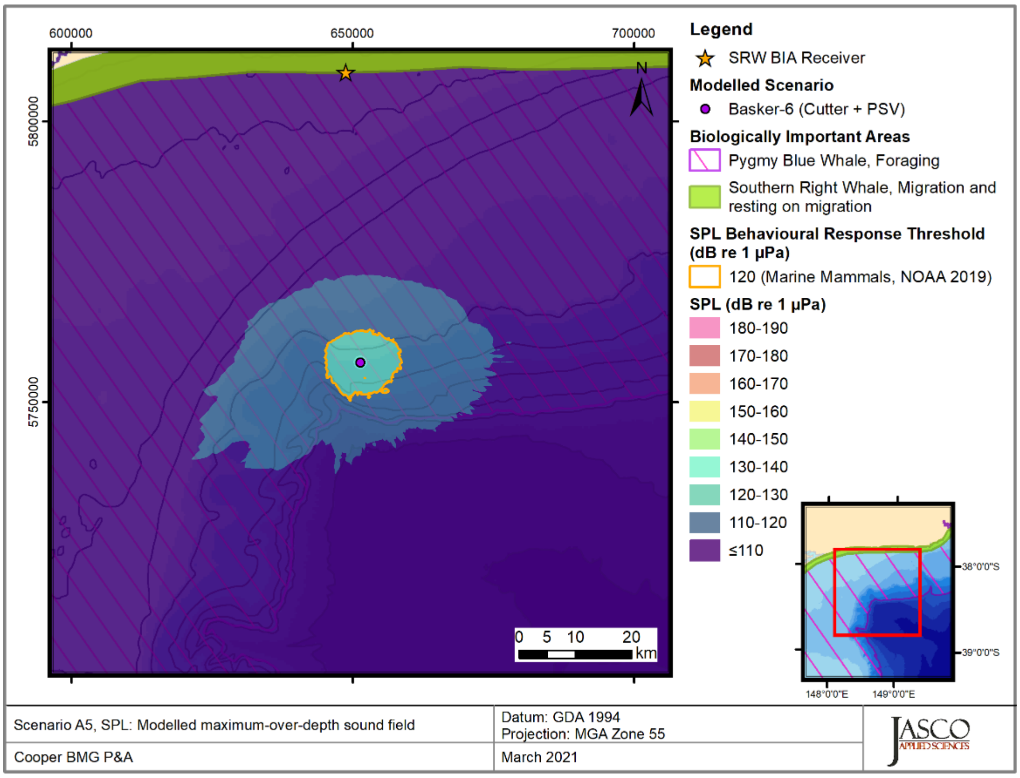


Figure 12. Scenario A5, platform support vessel and ROV cutter at Basker-6, SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

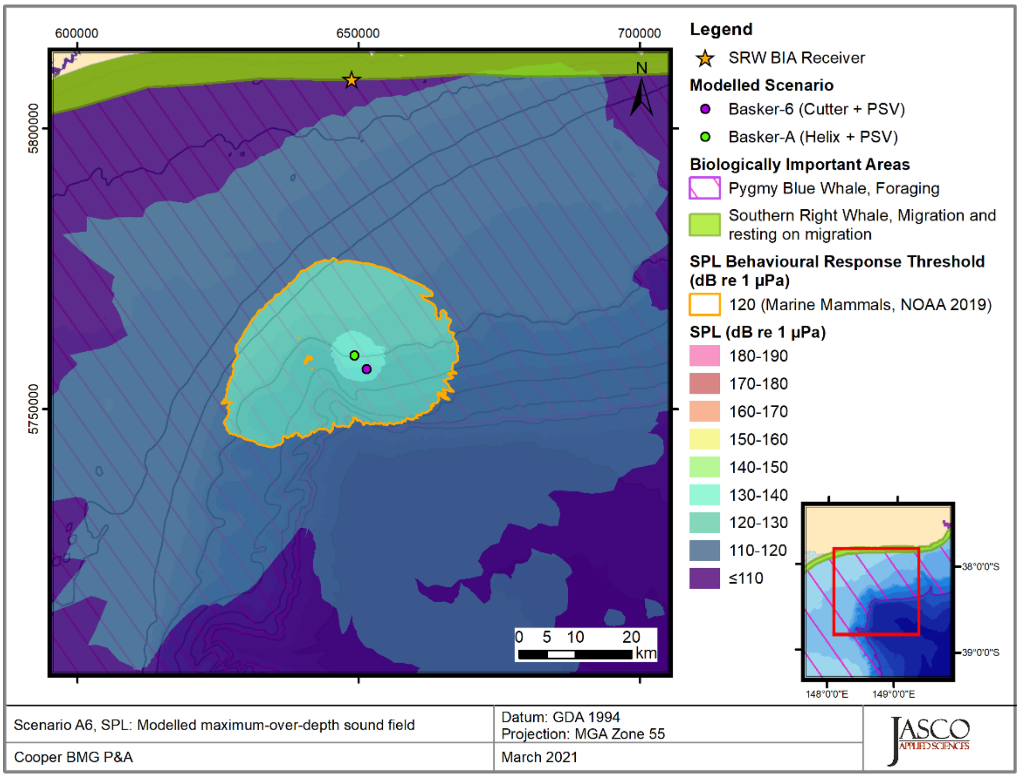


Figure 13. Scenario A6, Helix Q7000 and platform support vessel at Basker-A and ROV Cutter and support vessel at Basker-6, SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

4.2.1.2. Accumulated 24-hour Sound Field

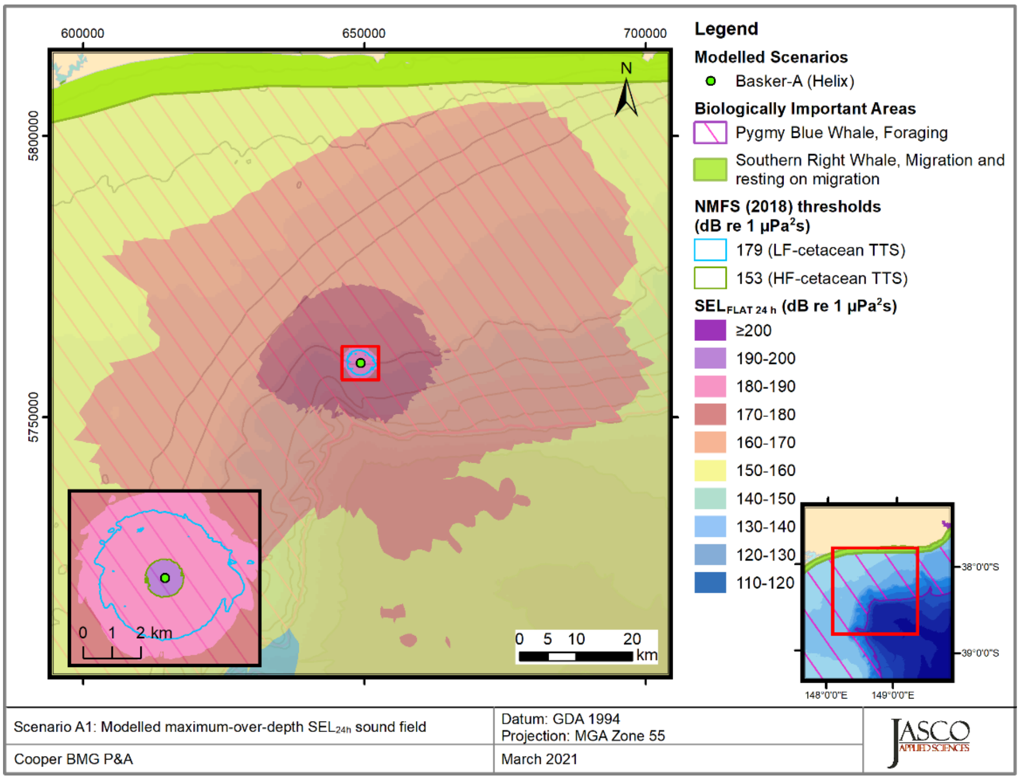


Figure 14. Scenario A1, Helix Q7000 at Basker-A, SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section 4.1 for distances.

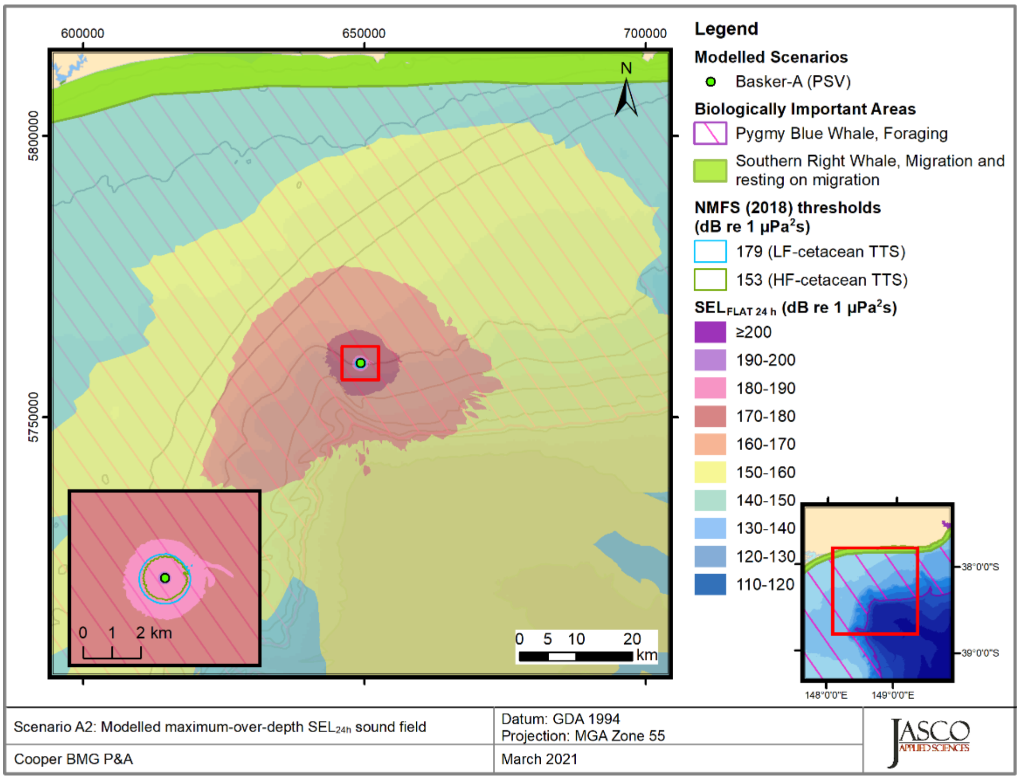


Figure 15. Scenario A2, platform support vessel at Basker-A, SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section 4.1 for distances.

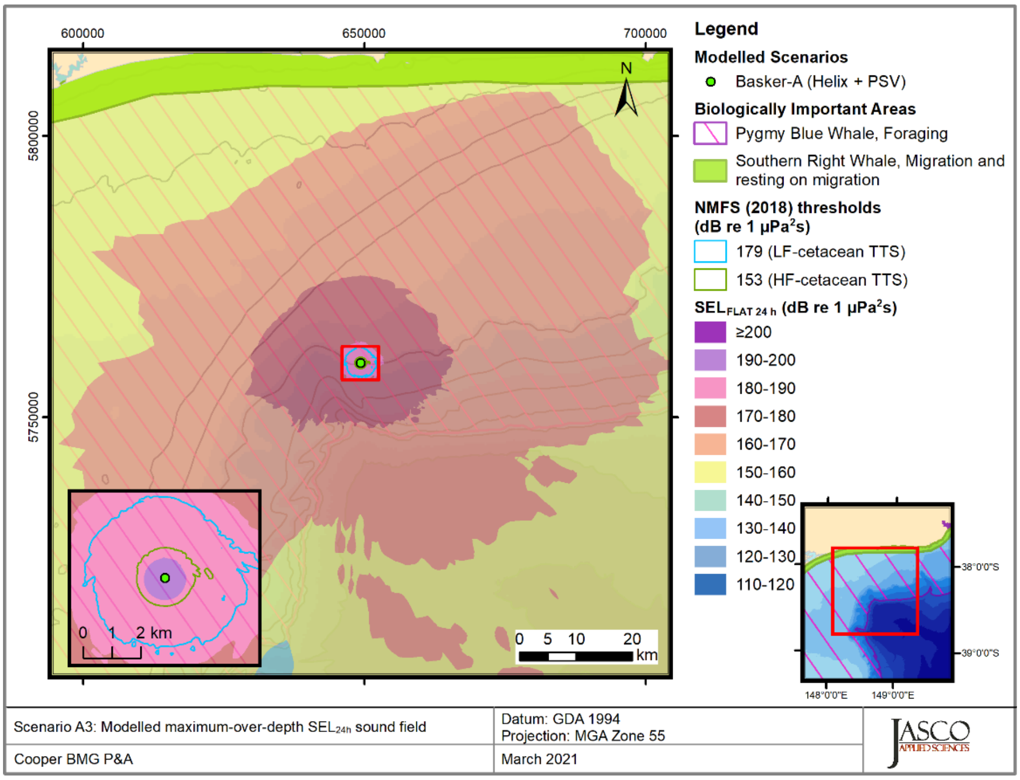


Figure 16. Scenario A3, *Helix Q7000* and platform support vessel at Basker-A, SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section 4.1 for distances.

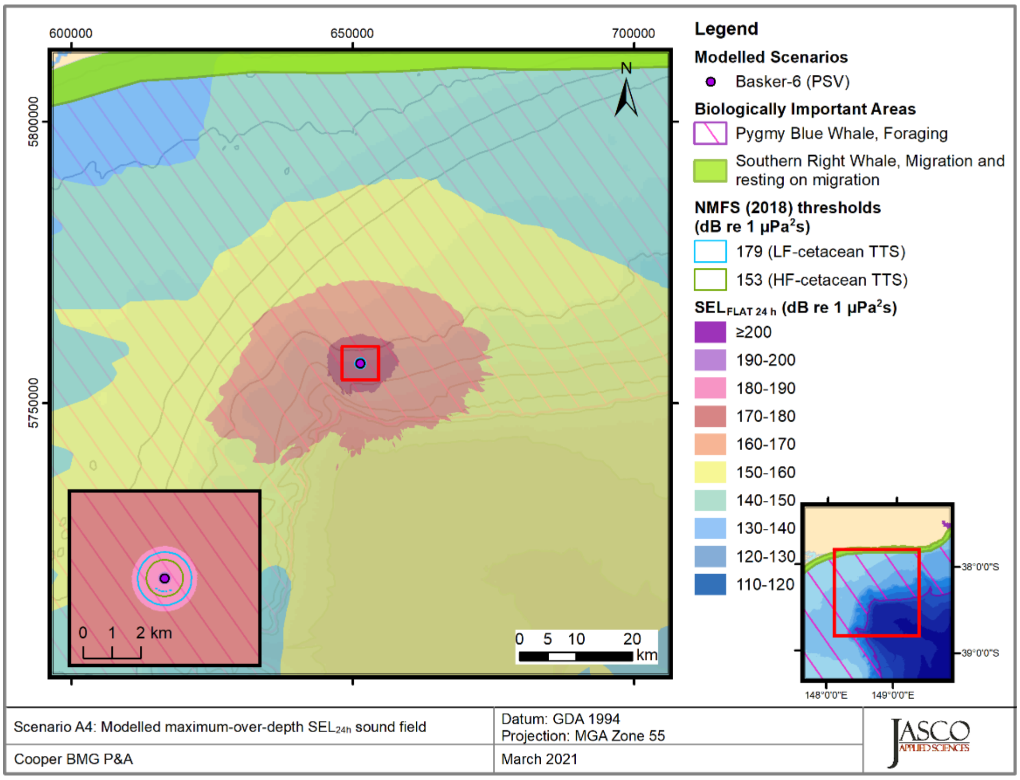


Figure 17. Scenario A4, platform support vessel at Basker-6, SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section 4.1 for distances.

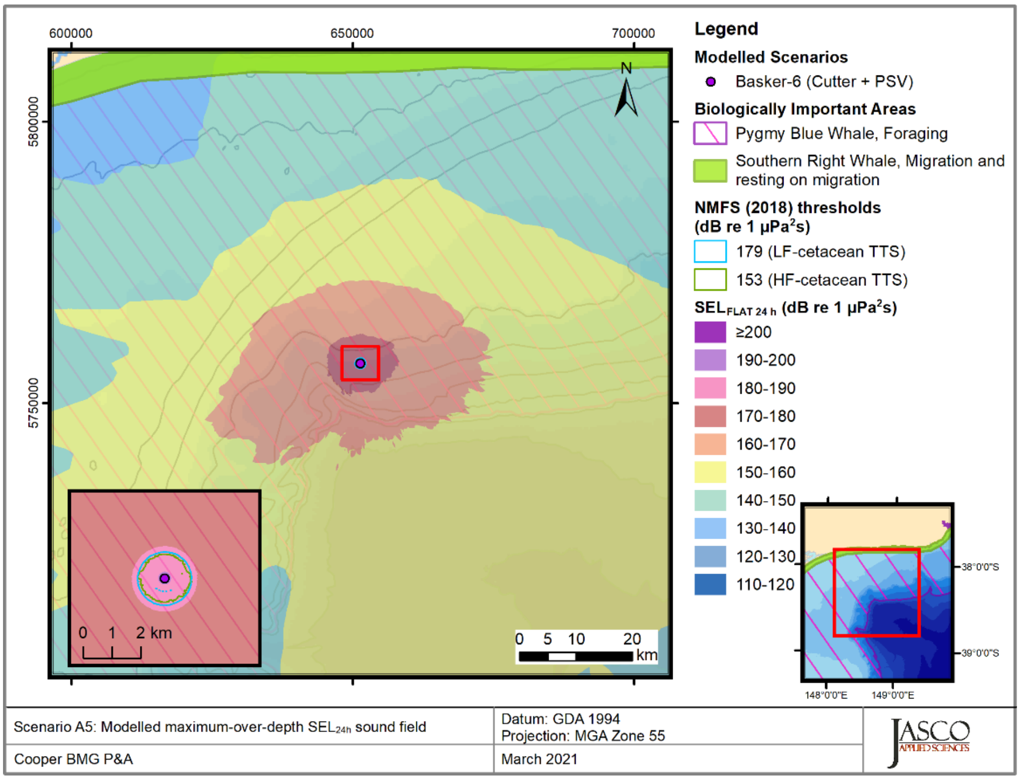


Figure 18. Scenario A5, platform support vessel and ROV cutter at Basker-6, SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section 4.1 for distances.

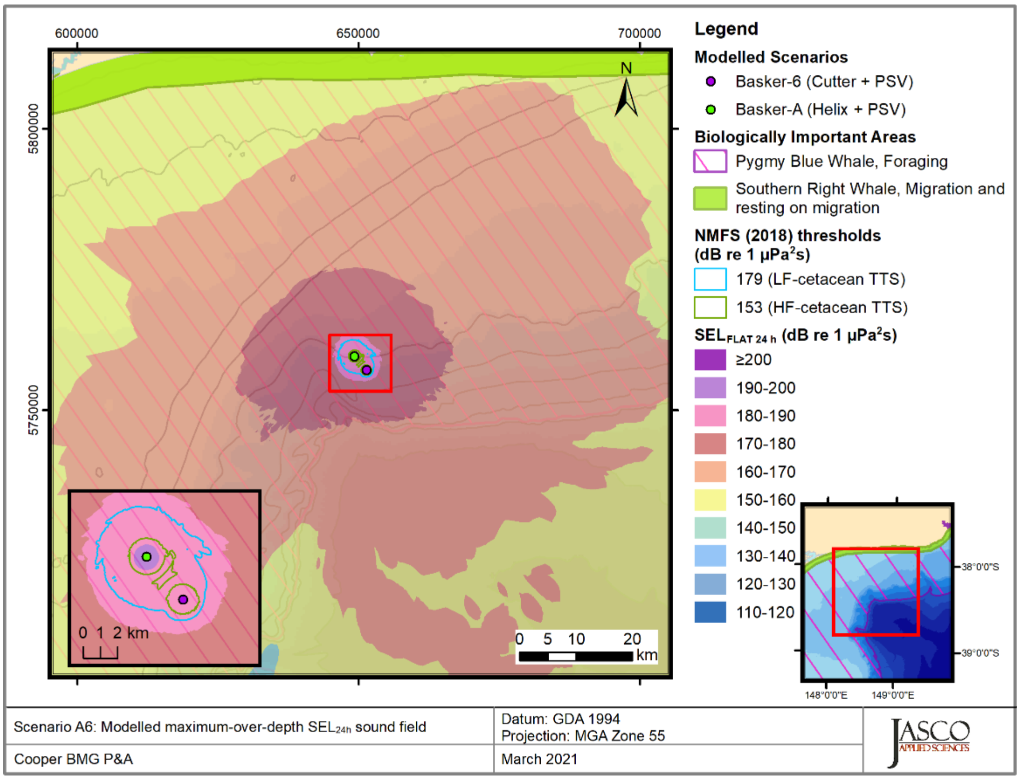


Figure 19. Scenario A6, Helix Q7000 and platform support vessel at Basker-A and ROV Cutter and support vessel at Basker-6, SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section 4.1 for distances.

4.2.2. Scenario B

4.2.2.1. Maximum-over-depth SPL Sound Field

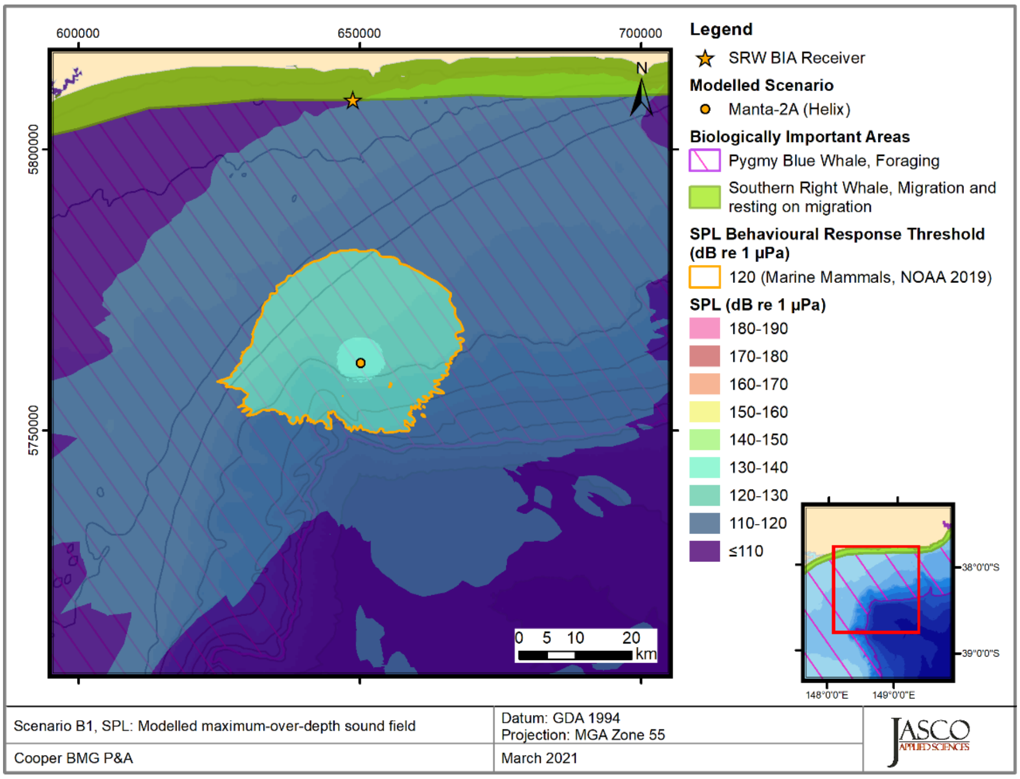


Figure 20. Scenario B1, Helix Q7000 at Basker-A, SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

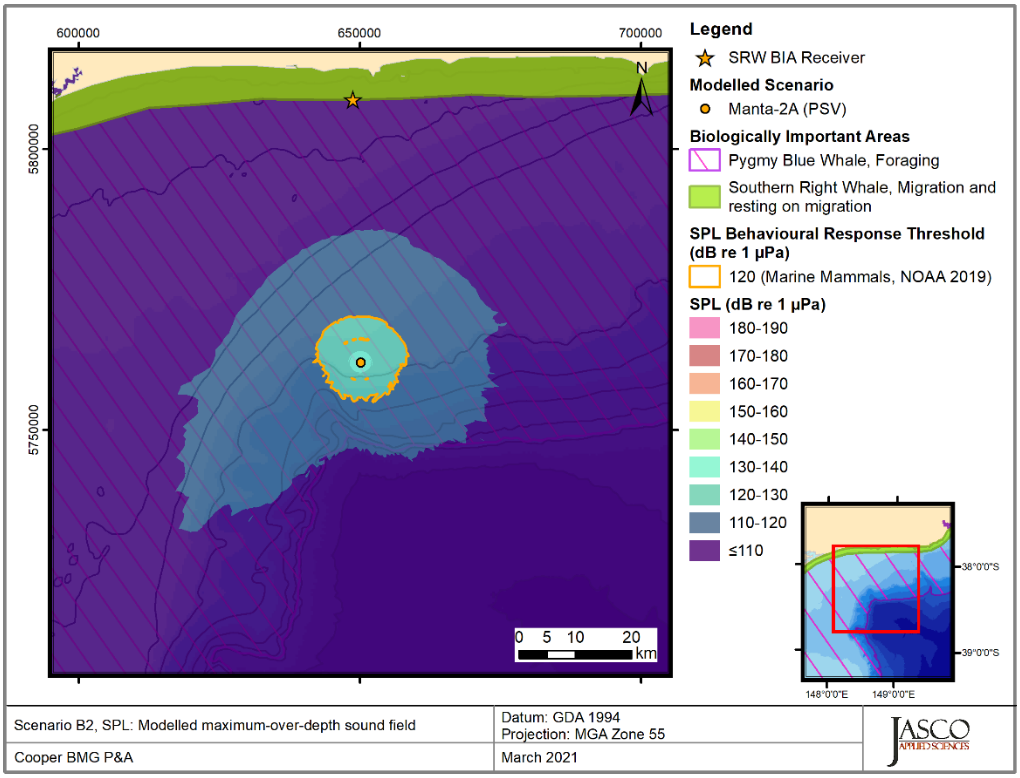


Figure 21. Scenario B2, platform support vessel at Basker-A, SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

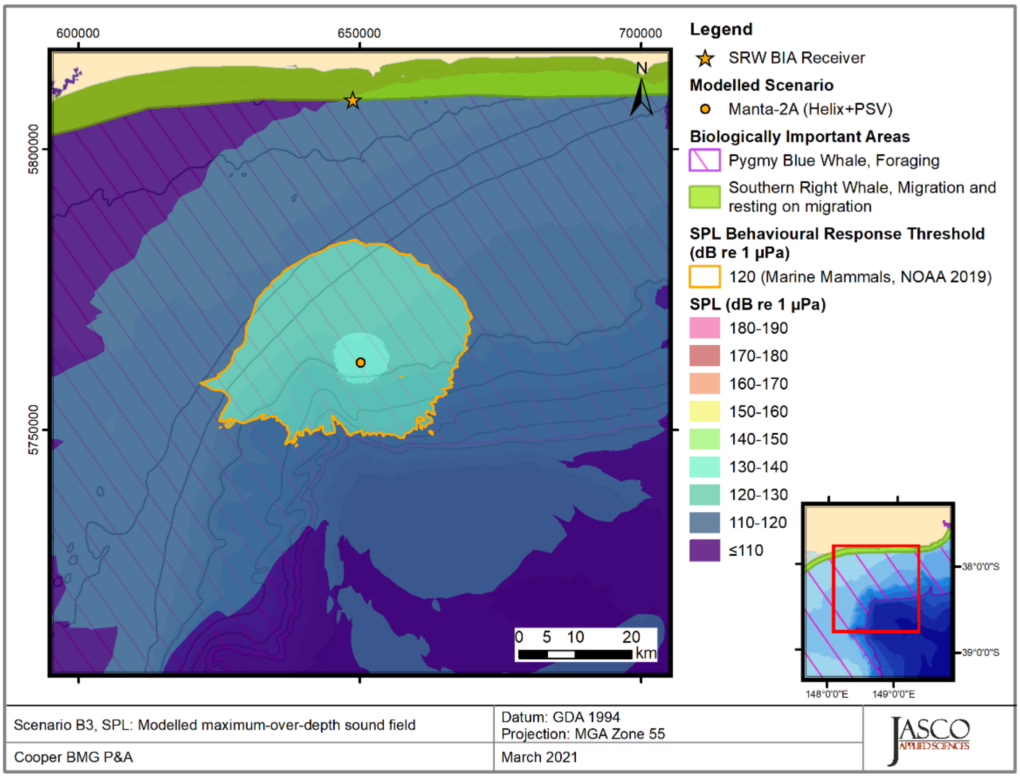


Figure 22. Scenario B3, *Helix Q7000* and platform support vessel at Basker-A, SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

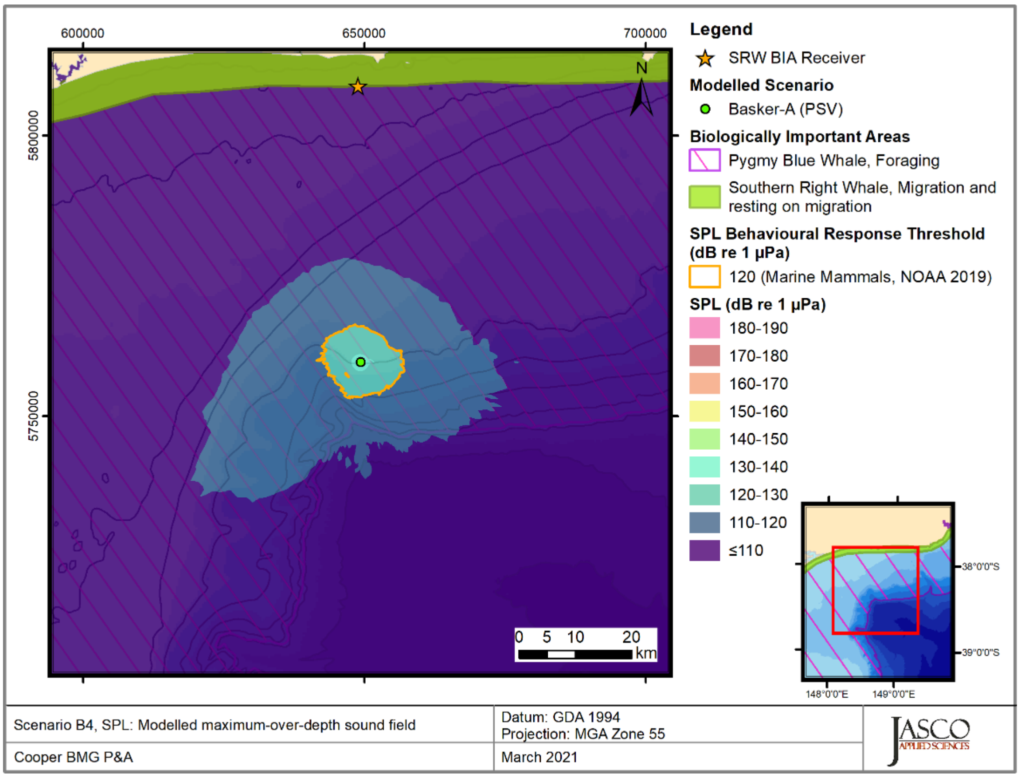


Figure 23. Scenario B4, platform support vessel at Basker-6, SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

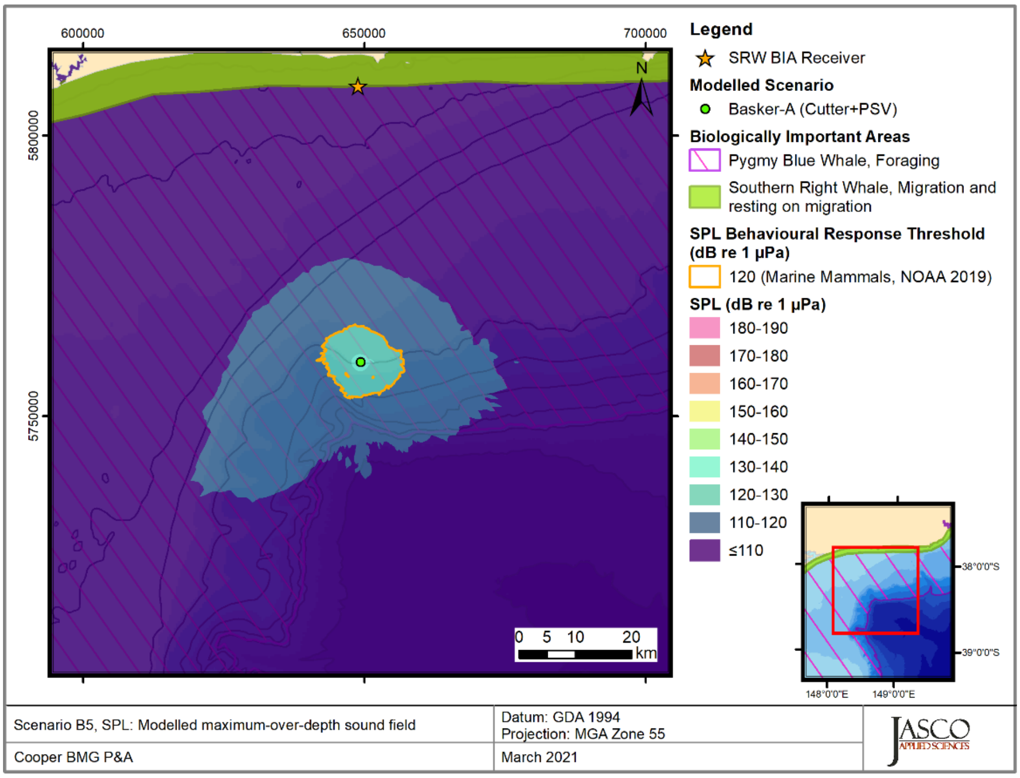


Figure 24. Scenario B5, platform support vessel and ROV cutter at Basker-6, SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

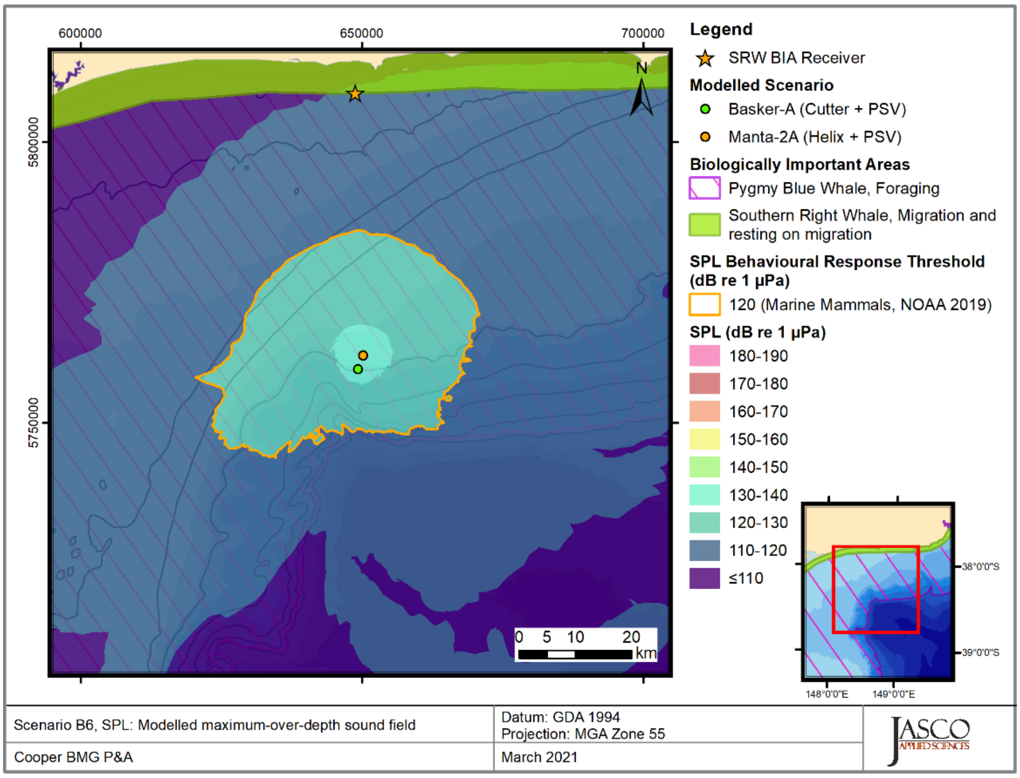


Figure 25. Scenario B6, Helix Q7000 and platform support vessel at Basker-A and ROV Cutter and support vessel at Basker-6, SPL: Sound level contour map, showing unweighted maximum-over-depth SPL results. Isopleth for marine mammal (120 dB re 1 µPa) behavioural criteria is shown as an orange contour line.

4.2.2.2. Accumulated 24-hour Sound Field

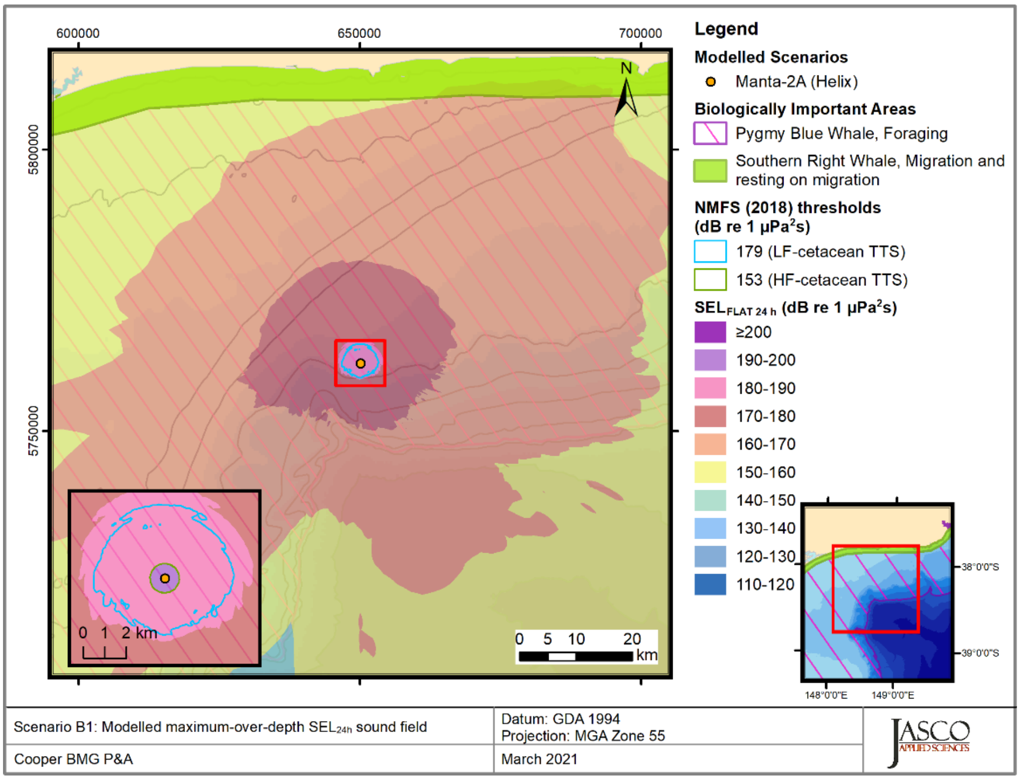


Figure 26. Scenario B1, Helix Q7000 at Basker-A, SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section 4.1 for distances.

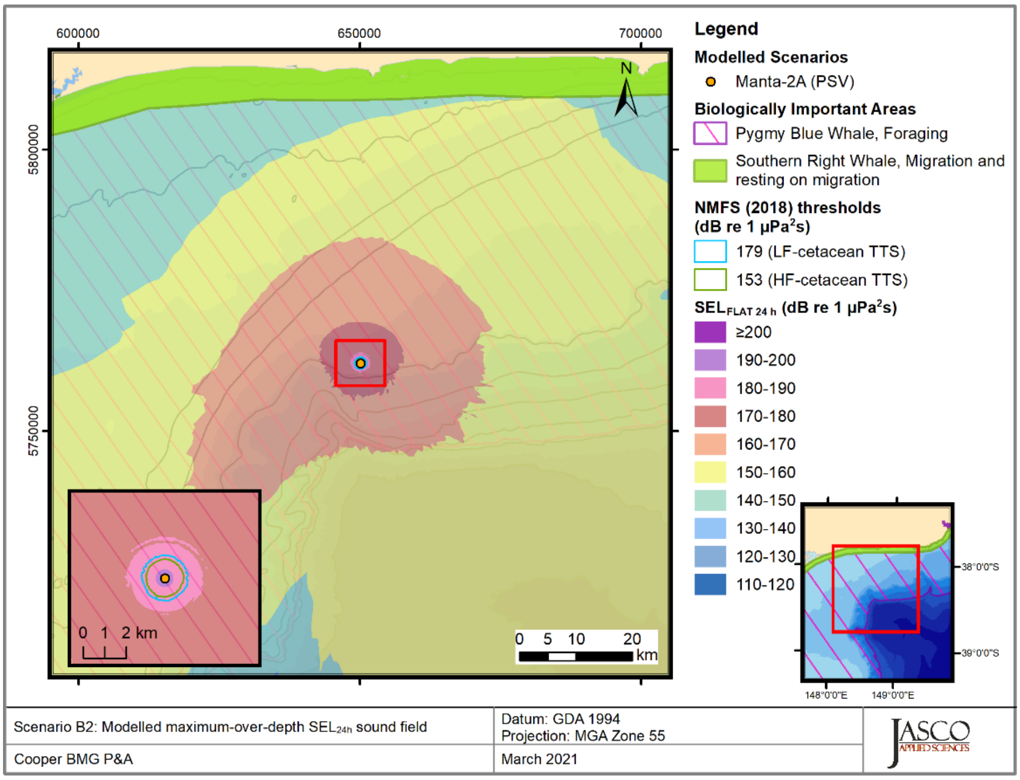


Figure 27. Scenario B2, platform support vessel at Basker-A, SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section 4.1 for distances.

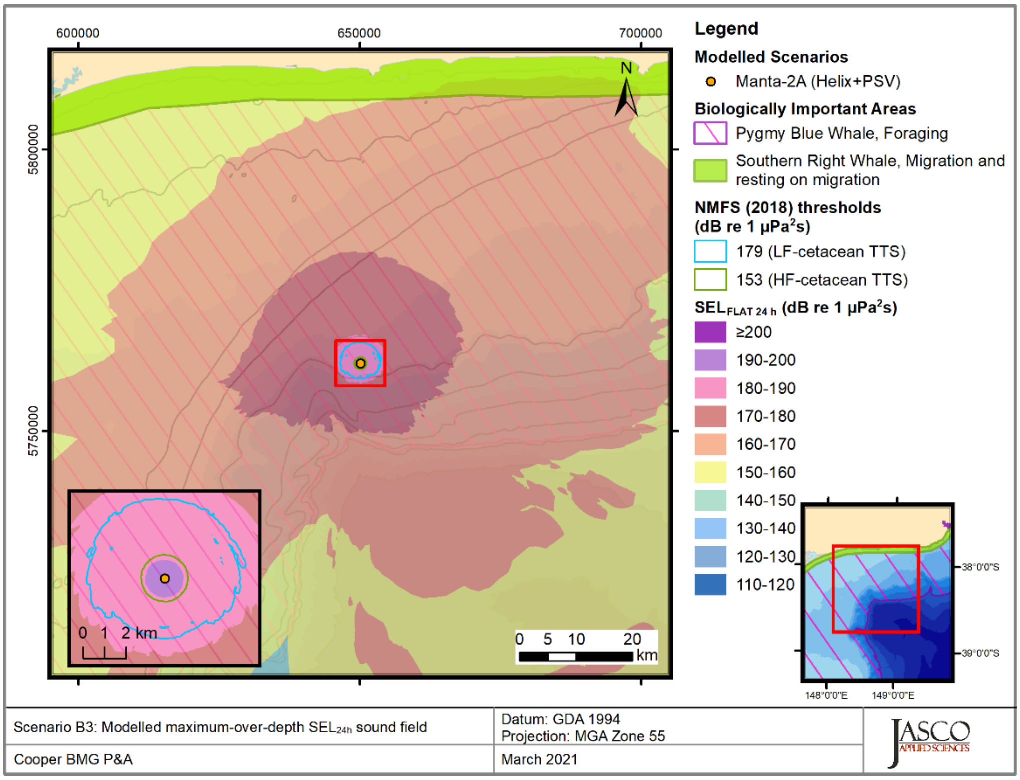


Figure 28. Scenario B3, *Helix Q7000* and platform support vessel at Basker-A, SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section 4.1 for distances.

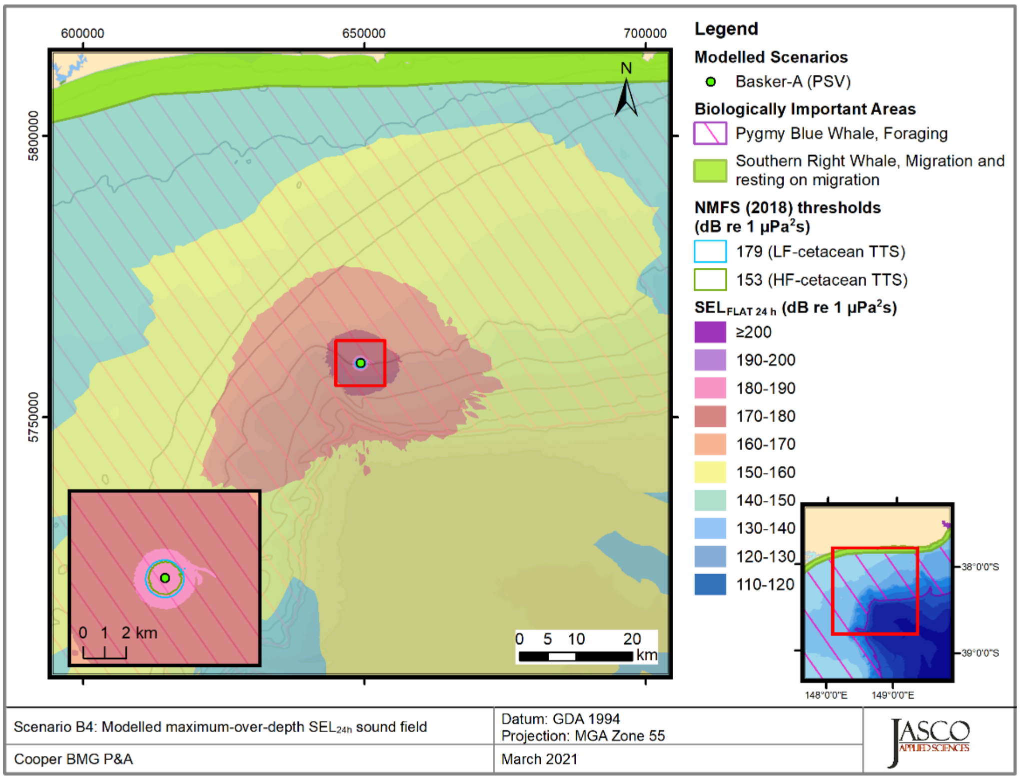


Figure 29. Scenario B4, platform support vessel at Basker-6, SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section 4.1 for distances.

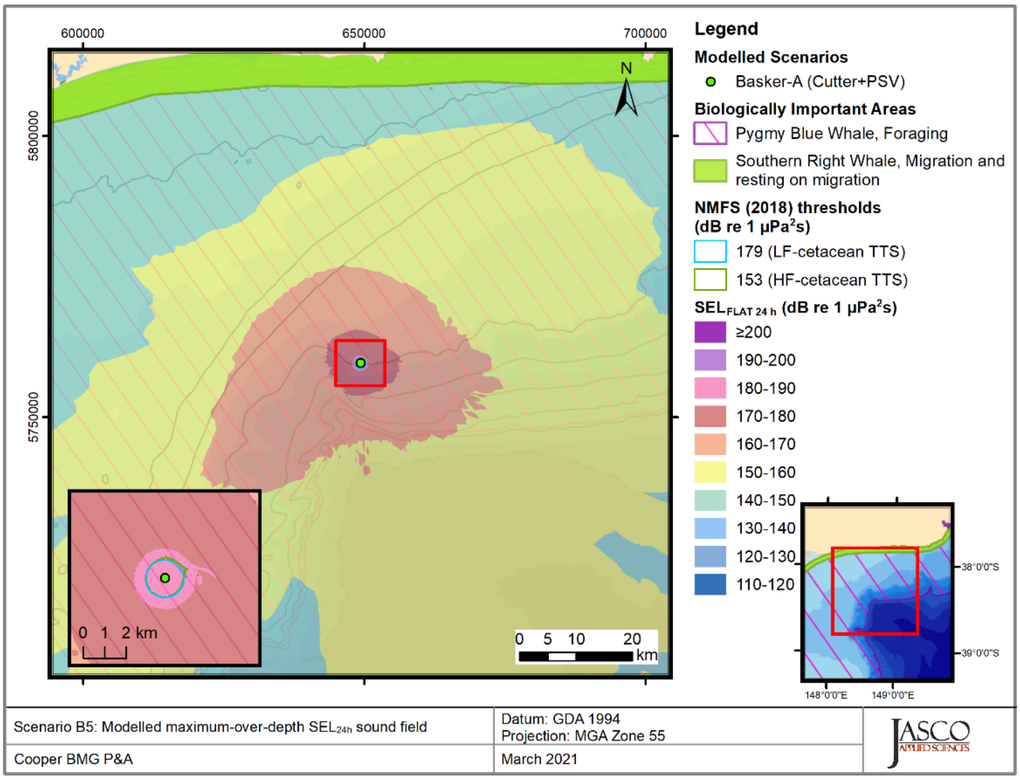


Figure 30. Scenario B5, platform support vessel and ROV cutter at Basker-6, SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section 4.1 for distances.

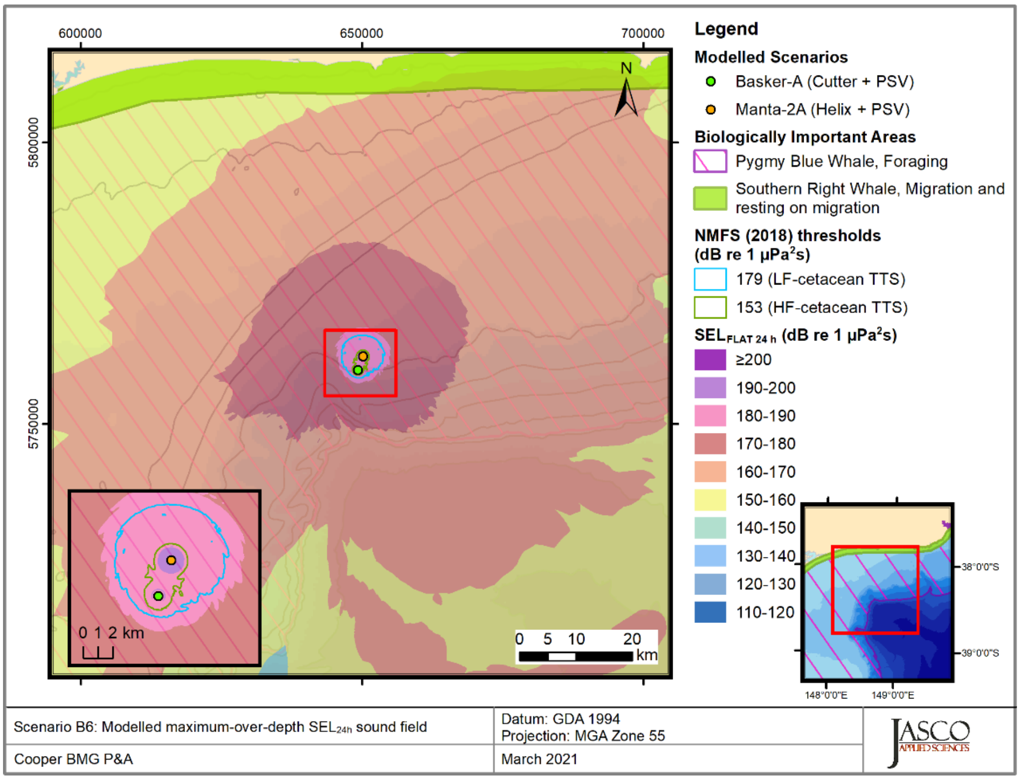


Figure 31. Scenario B6, Helix Q7000 and platform support vessel at Basker-A and ROV Cutter and support vessel at Basker-6, SEL_{24h}: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section 4.1 for distances.

5. Discussion

The sound speed profile was derived from data from the U.S. Naval Oceanographic Office's Generalized Digital Environmental Model V 3.0 (GDEM; Teague et al. 1990, Carnes 2009). The month of June was chosen based on an analysis of the temperature, salinity, and sound speed profiles extracted from this database. The final profile consisted of three representative profiles selected within the modelled area to capture propagation effects associated with shallow and deep water regimes. The considered sound speed profile was primarily downward refracting apart from a slight upward refracting layer, which extended approximately 20 m down from the sea surface. This layer has the potential to trap high frequency energy near the sea surface that would otherwise dissipate more rapidly in range due to propagation, absorption, and seabed losses. The slight upward refracting layer in the sound speed profile only has the potential to effectively trap frequencies above 2100 Hz based on the thickness of the refracting layer (Jensen et al. 2011).

Considering all well locations are situated on the continental shelf break and upper section of the slope, variations in bathymetry generally had the most noticeable effect on the sound field footprints. In this study the isopleths of interest generally were largest to the west of the modelled sites. The bias of isopleths in this direction is likely due to the presence of a sub-marine canyon and associated variations in bathymetry.

For the results tables present in Section 4.1 where a dash is used in place of a horizontal distance, these thresholds may or may not be reached. Due to the discretely sampled 20 m calculation grids of the modelled sound fields, distances to these levels could not be estimated for practicable computational purposes. Some SPL isopleths could be reached at distances between 1 m and the modelled horizontal resolution (20 m); however, distances to injurious accumulated SEL thresholds may not be reached at any range greater than 1 m due the species-specific frequency weighing functions.

Comparing the distances to isopleths for the same modelling scenario, a vessel under DP, between the different modelling scenarios (Scenario A2, A4, B2 and B4) shows that the range to an SPL of 120 dB re 1 µPa decreases as water depth increases, that change between the range at Manta-2A and Basker-6 is equal to a 13% change at the deeper site. The distance to TTS in low-frequency cetaceans follows a similar trend, being furthest at the shallowest site (Manta-2A), 1.09 km, compared to 0.94 km at the deepest site (Basker-6). Considering the combination scenarios, Scenario A6 and B6, the ranges are furthest for Scenario B6, which is related to the sources being at the two shallower site depths, rather than the deeper two.

Table 16. Comparison of distances to sound pressure level (SPL) isopleths for support vessel (PSV or ROV vessel) under DP between modelling locations.

SPL (L_p; dB re 1 µPa)	Manta-2A (132 m) to Basker-A (193 m)		Basker-A (193 m) to Basker-6 (193 m)		Manta-2A (132 m) to Basker-6 (193 m)	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
160	0.0	0.0	0.0	0.0	0.0	0.0
158	0.0	0.0	0.0	0.0	0.0	0.0
150	0.0	0.0	0.0	0.0	0.0	0.0
140	-0.02	-0.03	0.23	0.22	0.21	0.19
130	-0.26	0.37	0.93	0.41	0.67	0.78
120	0.69	1.23	0.49	0.34	1.18	1.57
110	6.7	4.0	2.6	3.6	9.3	7.6

The inclusion of the ROV cutter as an individual source did not influence the extent of ensonification / predicted radii for the relevant scenarios for SPL metrics (A4 and A5 (Table 10), B4 and B5 (Table 11)), and for the SEL metrics, the only radii influenced were that for the high-frequency cetaceans, with ranges increased by 310 and 730 m (Scenario A5 compared to A4 (Table 12) and Scenario B5 compared to B4 (Table 13). The ROV cutter ESL spectra (Figure 6) is quiet in contrast to the vessel (Figure 5), however the majority of energy occurs at 10 kHz. Because of this, the broadband sound levels are not influenced, and thus the ranges associated with the SPL metrics or those for fauna with frequency weighting which incorporates lower frequency energy. However, the ROV cutter does increase the sound levels in the hearing range of high-frequency cetaceans, therefore the ranges to TTS for high-frequency cetaceans is increased, and in the case of Scenario B5 compared to B4, almost doubled, however the resulting ranges are still relatively small (less than 1.57 km).

Glossary

1/3-octave
One third of an octave. Note: A one-third octave is approximately equal to one decidecade (1/3 oct ≈ 1.003 ddec; ISO 2017).

1/3-octave-band
Frequency band whose bandwidth is one one-third octave. Note: The bandwidth of a one-third octave-band increases with increasing centre frequency.

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

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

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

Auditory frequency weighting (auditory weighting function, frequency-weighting function)
The process of band-pass filtering sounds to reduce the importance of inaudible or less-audible frequencies for individual species or groups of species of aquatic mammals (ISO 2017). One example is M-weighting introduced by Southall et al. (2007) to describe "Generalized frequency weightings for various functional hearing groups of marine mammals, allowing for their functional bandwidths and appropriate in characterizing auditory effects of strong sounds".

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

bandwidth
The range of frequencies over which a sound occurs. Broadband refers to a source that produces sound over a broad range of frequencies (e.g., seismic airguns, vessels) whereas narrowband sources produce sounds over a narrow frequency range (e.g., sonar) ([ANSI] American National Standards Institute and [ASA] Acoustical Society of America S1.13-2005 (R2010)).

bar
Unit of pressure equal to 100 kPa, which is approximately equal to the atmospheric pressure on Earth at sea level. 1 bar is equal to 10^5 Pa or 10^{11} µPa.

broadband sound level
The total sound pressure level measured over a specified frequency range. If the frequency range is unspecified, it refers to the entire measured frequency range.

cavitation
A rapid formation and collapse of vapor cavities (i.e., bubbles or voids) in water, most often caused by a rapid change in pressure. Fast-spinning vessel propellers typically cause cavitation, which creates a lot of noise.

cetacean
Any animal in the order Cetacea. These are aquatic, mostly marine mammals and include whales, dolphins, and porpoises.

continuous sound
A sound whose sound pressure level remains above ambient sound during the observation period ([ANSI] American National Standards Institute and [ASA] Acoustical Society of America S1.13-2005 (R2010)). A sound that gradually varies in intensity with time, for example, sound from a marine vessel.

decade
Logarithmic frequency interval whose upper bound is ten times larger than its lower bound (ISO 2006).

decidecade
One tenth of a decade (ISO 2017). Note: An alternative name for decidecade (symbol ddec) is “one-tenth decade”. A decidecade is approximately equal to one third of an octave (1 ddec ≈ 0.3322 oct) and for this reason is sometimes referred to as a “one-third octave”.

decidecade band
Frequency band whose bandwidth is one decidecade. Note: The bandwidth of a decidecade band increases with increasing centre frequency.

decibel (dB)
One-tenth of a bel. Unit of level when the base of the logarithm is the tenth root of ten, and the quantities concerned are proportional to power ([ANSI] American National Standards Institute S1.1-1994 (R2004)).

ensonified
Exposed to sound.

far field
The zone where, to an observer, sound originating from an array of sources (or a spatially distributed source) appears to radiate from a single point. The distance to the acoustic far-field increases with frequency.

fast-average sound pressure level
The time-averaged sound pressure levels calculated over the duration of a pulse (e.g., 90%-energy time window), using the leaky time integrator from Plomp and Bouman (1959) and a time constant of 125 ms. Typically used only for pulsed sounds.

fast Fourier transform (FFT)
A computationally efficiently algorithm for computing the discrete Fourier transform.

frequency
The rate of oscillation of a periodic function measured in cycles-per-unit-time. The reciprocal of the period. Unit: hertz (Hz). Symbol: *f*. 1 Hz is equal to 1 cycle per second.

hearing group
Groups of marine mammal species with similar hearing ranges. Commonly defined functional hearing groups include low-, mid-, and high-frequency cetaceans, pinnipeds in water, and pinnipeds in air.

geoacoustic
Relating to the acoustic properties of the seabed.

hearing threshold
The sound pressure level for any frequency of the hearing group that is barely audible for a given individual in the absence of significant background noise during a specific percentage of experimental trials.

hertz (Hz)
A unit of frequency defined as one cycle per second.

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

intermittent sound
A level of sound that abruptly drops to the background noise level several times during the observation period.

impulsive sound
Sound that is typically brief and intermittent with rapid (within a few seconds) rise time and decay back to ambient levels (NOAA 2013, [ANSI] American National Standards Institute S12.7-1986 (R2006)). For example, seismic airguns and impact pile driving.

low-frequency (LF) cetacean
The functional cetacean hearing group that represents mysticetes (baleen whales) specialised for hearing low frequencies.

masking
Obscuring of sounds of interest by sounds at similar frequencies.

median
The 50th percentile of a statistical distribution.

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

mysticete
Mysticeti, a suborder of cetaceans, use their baleen plates, rather than teeth, to filter food from water. They are not known to echolocate, but they use sound for communication. Members of this group include rorquals (Balaenopteridae), right whales (Balaenidae), and grey whales (*Eschrichtius robustus*).

non-impulsive sound
Sound that is broadband, narrowband or tonal, brief or prolonged, continuous or intermittent, and typically does not have a high peak pressure with rapid rise time (typically only small fluctuations in decibel level) that impulsive signals have ([ANSI] American National Standards Institute and [ASA] Acoustical Society of America S3.20-1995 (R2008)). For example, marine vessels, aircraft, machinery, construction, and vibratory pile driving (NIOSH 1998, NOAA 2015).

octave
The interval between a sound and another sound with double or half the frequency. For example, one octave above 200 Hz is 400 Hz, and one octave below 200 Hz is 100 Hz.

odontocete
The presence of teeth, rather than baleen, characterizes these whales. Members of the Odontoceti are a suborder of cetaceans, a group comprised of whales, dolphins, and porpoises. The skulls of toothed whales are mostly asymmetric, an adaptation for their echolocation. This group includes sperm whales, killer whales, belugas, narwhals, dolphins, and porpoises.

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

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

permanent threshold shift (PTS)
A permanent loss of hearing sensitivity caused by excessive noise exposure. PTS is considered auditory injury.

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

phocid pinnipeds in water (PPW)
The functional pinniped hearing group that represents true/earless seals under water.

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

point source
A source that radiates sound as if from a single point ([ANSI] American National Standards Institute S1.1-1994 (R2004)).

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

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

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

received level (RL)
The sound level measured (or that would be measured) at a defined location.

rms
root-mean-square.

signature
Pressure signal generated by a source.

sound
A time-varying pressure disturbance generated by mechanical vibration waves travelling through a fluid medium such as air or water.

sound exposure
Time integral of squared, instantaneous frequency-weighted sound pressure over a stated time interval or event. Unit: pascal-squared second ($Pa^2 \cdot s$) ([ANSI] American National Standards Institute S1.1-1994 (R2004)).

sound exposure level (SEL)
A cumulative measure related to the sound energy. Unit: dB re 1 µPa²·s. SEL is expressed over the summation period (e.g., per-second SEL [for vessels], per-pulse SEL [for airguns], single-strike SEL [for pile drivers], 24-hour SEL).

sound field
Region containing sound waves ([ANSI] American National Standards Institute S1.1-1994 (R2004)).

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

sound pressure level (SPL)
The decibel ratio of the time-mean-square sound pressure, in a stated frequency band, to the square of the reference sound pressure ([ANSI] American National Standards Institute S1.1-1994 (R2004)).

For sound in water, the reference sound pressure is one micropascal (p_0 = 1 µPa) and the unit for SPL is dB re 1 µPa²:

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

Unless otherwise stated, SPL refers to the root-mean-square (rms) pressure level. See also 90% sound pressure level and fast-average sound pressure level. Non-rectangular time window functions may be applied during calculation of the rms value, in which case the SPL unit should identify the window type.

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

source level (SL)
The sound level measured in the far-field and scaled back to a standard reference distance of 1 metre from the acoustic centre of the source. Unit: dB re 1 µPa·m (pressure level) or dB re 1 µPa²·s·m (exposure level).

spectrum
An acoustic signal represented in terms of its power, energy, mean-square sound pressure, or sound exposure distribution with frequency.

temporary threshold shift (TTS)
Temporary loss of hearing sensitivity caused by excessive noise exposure.

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

Literature Cited

[ANSI] American National Standards Institute. S1.1-1994 (R2004). *American National Standard: Acoustical Terminology*. NY, USA. https://webstore.ansi.org/Standards/ASA/ANSIS11994R2004.

[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.

[ANSI] American National Standards Institute and [ASA] Acoustical Society of America. S3.20-1995 (R2008). *American National Standard: Bioacoustical Terminology*. NY, USA. https://webstore.ansi.org/Standards/ASA/ANSIASAS3201995R2008.

[ANSI] American National Standards Institute. S12.7-1986 (R2006). *American National Standard: Methods for Measurements of Impulsive Noise*. NY, USA. https://webstore.ansi.org/Standards/ASA/ANSIS121986R2006.

[DoC] Department of Commerce (US) and [NOAA] National Oceanic and Atmospheric Administration (US). 2018. Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to Marine Site Characterization Surveys off of Delaware. *Federal Register* 83(110): 26416-26432. https://www.federalregister.gov/d/2018-12225.

[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.

[NIOSH] National Institute for Occupational Safety and Health. 1998. *Criteria for a recommended standard: Occupational noise exposure. Revised Criteria*. Document Number 98-126. US Department of Health and Human Services, NIOSH, Cincinnati, OH, USA. 122 p. https://www.cdc.gov/niosh/docs/98-126/pdfs/98-126.pdf.

[NMFS] National Marine Fisheries Service. 2014. *Marine Mammals: Interim Sound Threshold Guidance* (webpage). National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.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://www.fisheries.noaa.gov/webdam/download/75962998.

[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* (webpage), 27 Sep 2019. https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/esa-section-7-consultation-tools-marine-mammals-west. (Accessed 10 Mar 2020).

[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 Number 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 Number 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.

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.

CTCMARINE. 2011. *ROC Oil AGR - Basker-Manta Gummy Project: Geotechnical Analysis and Trenching Assessment*. Document Number PROJ/J10-262/ENG/001. 16 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://jeb.biologists.org/content/220/16/2878.

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.

Fairweather Science. 2018. *Petition for Incidental Take Regulations for Oil and Gas Activities In Cook Inlet, Alaska*. Prepared by Fairweather Science LLC for Hilcorp Alaska, Harvest Alaska, and Alaska Gasline Development Corporation.

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://apps.dtic.mil/dtic/tr/fulltext/u2/a561707.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.

Gray, L.M. and D.S. Greeley. 1980. Source level model for propeller blade rate radiation for the world's merchant fleet. *Journal of the Acoustical Society of America* 67(2): 516-522. https://doi.org/10.1121/1.383916.

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

Helix Energy Solutions. 2020. *Q7000: DP3 well intervention vessel* (pamphlet). https://www.helixesg.com/downloads/Helix-Well-Ops-Q7000-LTR-02-04-2020-FINAL.pdf.

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 Number P1049-1. 277 p.

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 Number 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 Number 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 Number 56. NOAA Outer Continental Shelf Environmental Assessment Program. Final Reports of Principal Investigators. 393-600 p.

Martin, 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, 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. 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., 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 Number 00443, Version 2.0. Technical report by JASCO Applied Sciences for BP Exploration (Alaska) Inc. http://www.nmfs.noaa.gov/pr/pdfs/permits/bp_openwater_90dayreport_appendices.pdf.

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 Number 001583. Version 1.0. Technical report by JASCO Applied Sciences for RPS Energy Services Pty Ltd.

McPherson, C.R. and B. Martin. 2018. *Characterisation of Polarcus 2380 in^3 Airgun Array*. Document Number 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 Number 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.

Pangerc, T., S. Robinson, P. Theobald, and L. Galley. 2016. Underwater sound measurement data during diamond wire cutting: First description of radiated noise. *Proceedings of Meetings on Acoustics* 27(1): 040012. https://doi.org/10.1121/2.0000322.

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.

Plomp, R. and M.A. Bouman. 1959. Relation between Hearing Threshold and Duration for Tone Pulses. *Journal of the Acoustical Society of America* 31(6): 749-758. https://doi.org/10.1121/1.1907781.

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. http://jeb.biologists.org/content/209/21/4193.abstract.

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.

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.

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 Number 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.

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.

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 Number 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:

$$L_p = 10\log_{10}\left(\frac{1}{T}\int_T g(t)\,p^2(t)\,dt \Big/ p_0^2\right)\ \mathrm{dB} \qquad \text{(A-1)}$$

where $g(t)$ is an optional time weighting function. In many cases, the start time of the integration is marched forward in small time steps to produce a time-varying SPL function.

The sound exposure level (SEL or LE; dB re 1 µPa2·s) is the time-integral of the squared acoustic pressure over a duration (T):

$$L_E = 10\log_{10}\left(\int_T p^2(t)\,dt \Big/ T_0 p_0^2\right)\ \mathrm{dB} \qquad \text{(A-2)}$$

where T_0 is a reference time interval of 1 s. SEL continues to increase with time when non-zero pressure signals are present. It is a dose-type measurement, so the integration time applied must be carefully considered for its relevance to impact to the exposed recipients.

SEL can be calculated over a fixed duration, such as the time of a single event or a period with multiple acoustic events. When applied to pulsed sounds, SEL can be calculated by summing the SEL of the N individual pulses. For a fixed duration, the square pressure is integrated over the duration of interest. For multiple events, the SEL can be computed by summing (in linear units) the SEL of the N individual events:

$$L_{E,N} = 10\log_{10}\left(\sum_{i=1}^{N} 10^{\frac{L_{E,i}}{10}}\right)\ \mathrm{dB}\,. \qquad \text{(A-3)}$$

If applied, the frequency weighting of an acoustic event should be specified, as in the case of weighted SEL (e.g., $L_{E,LFC,24h}$; Appendix A.4). The use of fast, slow, or impulse exponential-time-averaging or other time-related characteristics should also be specified.

A.2. Decidecade Band Analysis

The distribution of a sound's power with frequency is described by the sound's spectrum. The sound spectrum can be split into a series of adjacent frequency bands. Splitting a spectrum into 1 Hz wide bands, called passbands, yields the power spectral density of the sound. This splitting of the spectrum into passbands of a constant width of 1 Hz, however, does not represent how animals perceive sound.

Because animals perceive exponential increases in frequency rather than linear increases, analysing a sound spectrum with passbands that increase exponentially in size better approximates real-world scenarios. In underwater acoustics, a spectrum is commonly split into decidecade bands, which are one tenth of a decade wide. A decidecade is sometimes referred to as a "1/3 octave" because one tenth of a decade is approximately equal to one third of an octave. Each decade represents a factor 10 in sound frequency. Each octave represents a factor 2 in sound frequency. The centre frequency of the ith band, $f_c(i)$, is defined as:

$$f_c(i) = 10^{\frac{i}{10}}\ \text{kHz} \qquad \text{(A-4)}$$

and the low (f_{lo}) and high (f_{hi}) frequency limits of the ith decade band are defined as:

$$f_{lo,i} = 10^{\frac{-1}{20}} f_c(i) \quad \text{and} \quad f_{hi,i} = 10^{\frac{1}{20}} f_c(i) \qquad \text{(A-5)}$$

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).

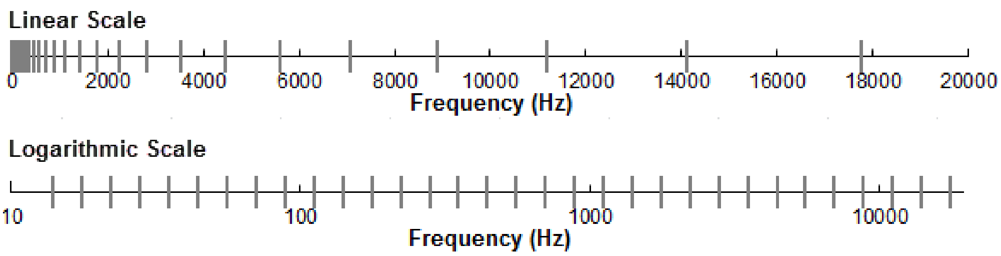


Figure A-1. Decidecade frequency bands (vertical lines) shown on a linear frequency scale and a logarithmic scale.

The sound pressure level in the ith band ($L_{p,i}$) is computed from the spectrum $S(f)$ between $f_{lo,i}$ and $f_{hi,i}$:

$$L_{p,i} = 10\, log_{10} \int_{f_{lo,i}}^{f_{hi,i}} S(f)\, df\ \ \text{dB} \qquad \text{(A-6)}$$

Summing the sound pressure level of all the bands yields the broadband sound pressure level:

$$\text{Broadband SPL} = 10\log_{10} \sum_i 10^{\frac{L_{p,i}}{10}}\ \text{dB} \qquad \text{(A-7)}$$

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.

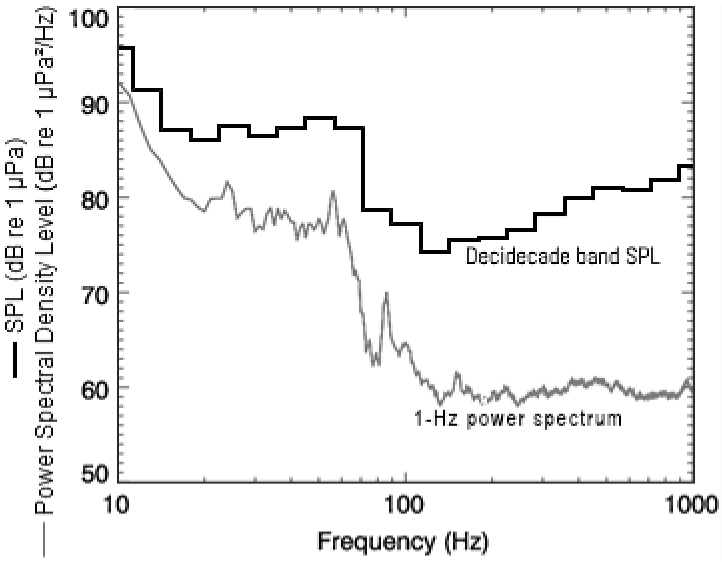


Figure A-2. Sound pressure spectral density levels and the corresponding decidecade band sound pressure levels of example ambient noise shown on a logarithmic frequency scale.Because the decidecade bands are wider with increasing frequency, the 1/3-octave-band SPL is higher than the power spectrum.

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).

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 (NOAA 2018), referring to Malme et al. (1983), Malme et al. (1984), and Malme et al. (1986), which were considered in Southall et al. (2007). Malme et al. (1986) found that playback of drillship noise did not produce clear evidence of disturbance or avoidance for levels below 110 dB re 1 µPa (SPL), possible avoidance occurred for exposure levels approaching 119 dB re 1 µPa. Malme et al. (1984) determined that measurable reactions usually consisted of rather subtle short-term changes in speed and/or heading of the whale(s) under observation. It has been shown that both received level and proximity of the sound source is a contributing factor in eliciting behavioural reactions in humpback whales (Dunlop et al. 2017, Dunlop et al. 2018).

A.4. Marine Mammal Frequency Weighting

The potential for noise to affect animals 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 NMFS (2018).

Hearing group	a	b	f_{lo} (Hz)	f_{hi} (kHz)	K (dB)
Low-frequency cetaceans (baleen whales)	1.0	2	200	19,000	0.13
Mid-frequency cetaceans (dolphins, plus toothed, beaked, and bottlenose whales)	1.6	2	8,800	110,000	1.20
High-frequency cetaceans (true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* and *L. australis*)	1.8	2	12,000	140,000	1.36
Phocid seals in water	1.0	2	1,900	30,000	0.75
Otariid seals in water	2.0	2	940	25,000	0.64

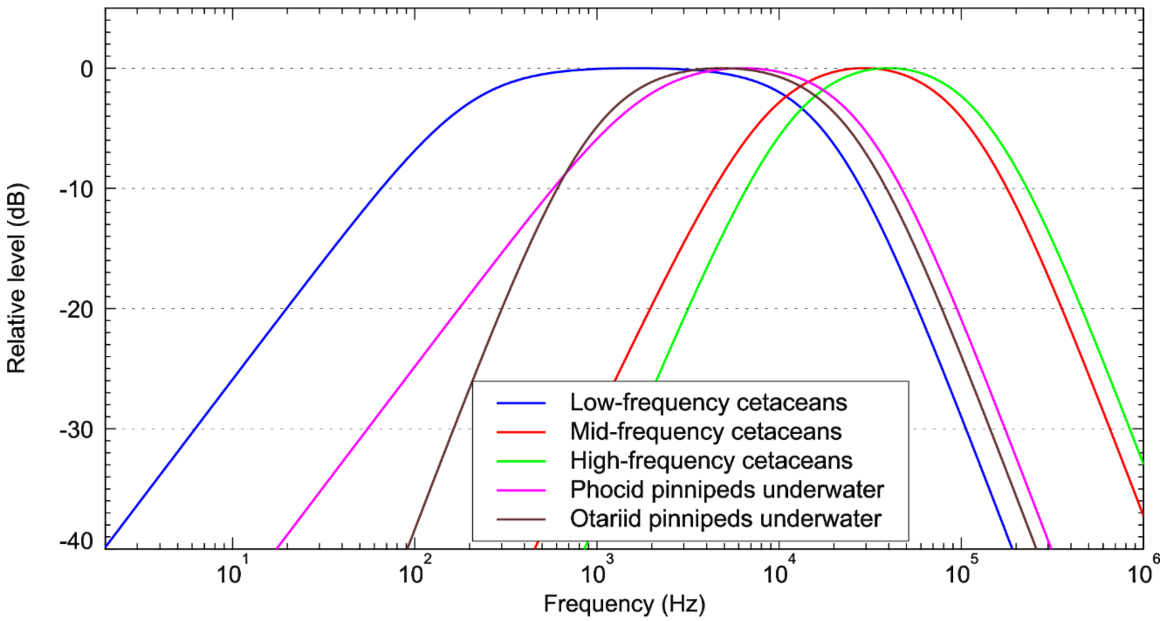


Figure A-3. Auditory weighting functions for functional marine mammal hearing groups as recommended by NMFS (2018).

Appendix B. Methods and Parameters

B.1. Environmental Parameters

B.1.1. 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 100 × 100 m (Figure B-1).

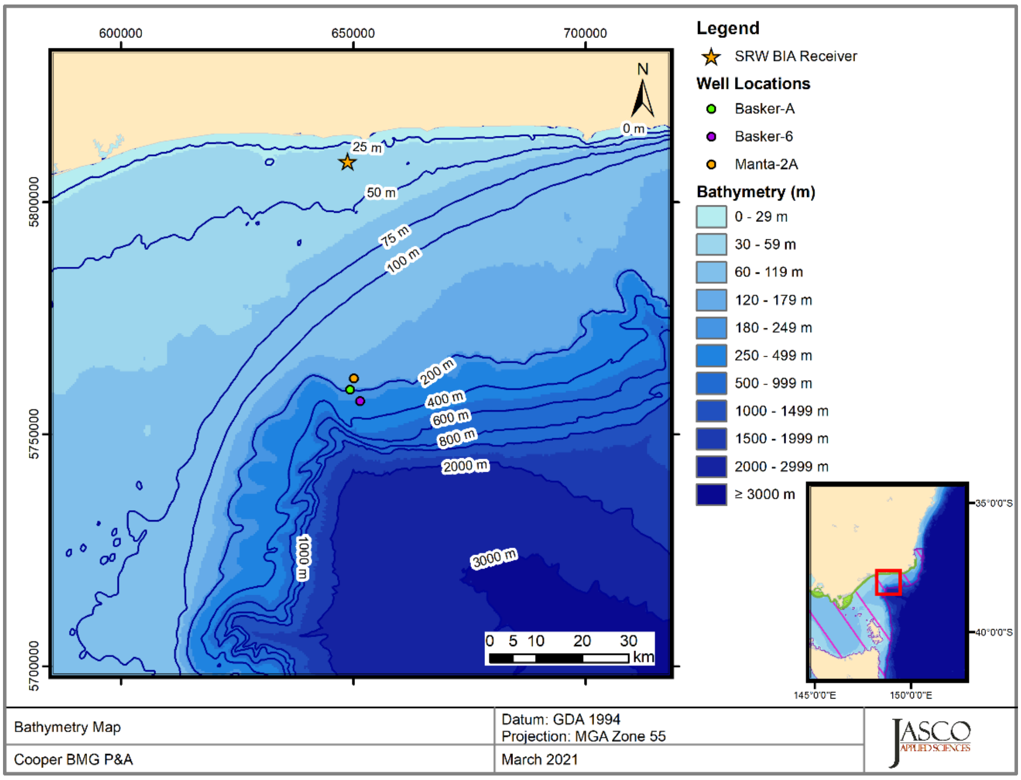


Figure B-1. Bathymetry in the modelled area.

B.1.2. Sound Speed Profile

The sound speed profile in the area was derived from temperature and salinity profiles from the 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 at distances less than 40 km around the modelled site. The June sound speed profile is expected to be most favourable to longer-range sound propagation across the entire year. As such, June was selected for sound propagation modelling to ensure precautionary estimates of distances to received sound level thresholds. Figure B-2 shows the resulting profile, which was used as input to the sound propagation modelling.

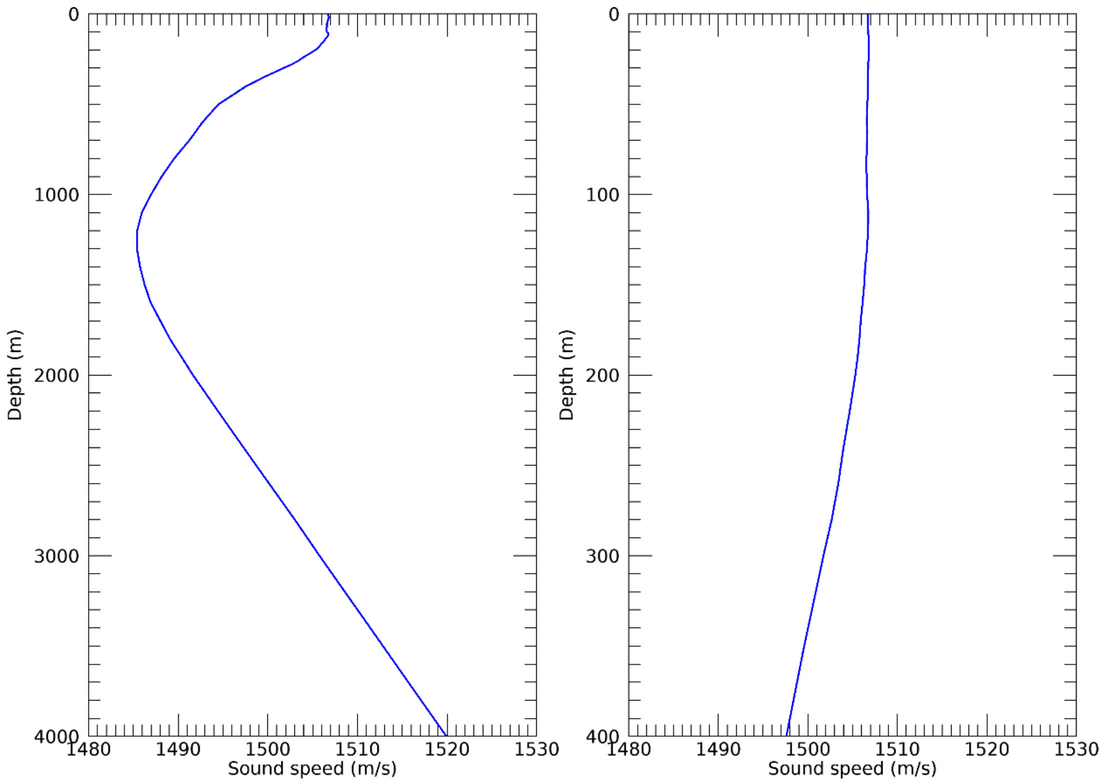


Figure B-2. The modelling sound speed profile corresponding to June: full profile (left) and top 400 m (right) Profiles are calculated from temperature and salinity profiles from *Generalized Digital Environmental Model* V 3.0 (GDEM; Teague et al. 1990, Carnes 2009).

Geoacoustics

A single representative geoacoustic profile was used for all modelled sites based on core logs and geologic studies conducted in the study area (CTCMARINE 2011). The seabed nominally consists of a 30 m thick package of interbedded silt, sand, and sandy silt layers.

The geoacoustic profile determines how energy is reflected from the seabed, as well as how is transmitted and absorbed into the sediment layers. Geoacoustic parameters were derived from sedimentary grain size measurements from CTCMARINE (2011). These measurements provided data to 30 m below the seafloor. After 30 m a simple profile was constructed assuming increasingly consolidated sediment (Table B-1). The geoacoustic properties were calculated using the sediment grain-shearing model of Buckingham (2005). Table B-1 presents the geoacoustic profile for all modelled sites.

Table B-1. Geoacoustic profile for all modelled sites. Each parameter varies linearly within the stated range.

Depth below seafloor (m)	Predicted lithology	Density (g/cm³)	Compressional wave		Shear wave	
			Speed (m/s)	Attenuation (dB/λ)	Speed (m/s)	Attenuation (dB/λ)
0–5	Very fine sand	2.02	1727.8	0.570		
5–10	Silt	1.99	1725.6	0.633		
10–15	Very fine sand	2.01	1779.9	0.773		
15–20		2.03	1826.6	0.892	250	3.65
20–25		2.01	1819.5	0.900		
25–30	Silt	1.97	1780.0	0.851		
30–100		1.97	1909.1	1.217		

B.2. 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:

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

where L_{100} is the spectrum level at 100 Hz, u is the propeller tip speed (m/s), and B is the number of propeller blades. Equation B-1 gives the total energy produced by the propeller cavitation at frequencies between 100 Hz and 10 kHz. This equation is valid for a propeller tip speed between 15 and 50 m/s. The spectrum is assumed to be flat below 100 Hz. Its level is assumed to fall off at a rate of −6 dB per octave above 100 Hz (Figure B-3).

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:

$$\mathrm{SL}_B = 163 + 40\log D + 30\log N + 10\log B + 20\log f + 10\log(A_c/A_D)\,, \tag{B-2}$$

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

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

$$\mathrm{SL}_{\mathrm{total}} = 10\log_{10}\sum_i 10^{\frac{SL_i}{10}}, \tag{B-3}$$

where $\mathrm{SL}_{1,\ldots,N}$ 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:

$$\mathrm{SL}_N = \mathrm{SL} + 10\log N \tag{B-4}$$

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

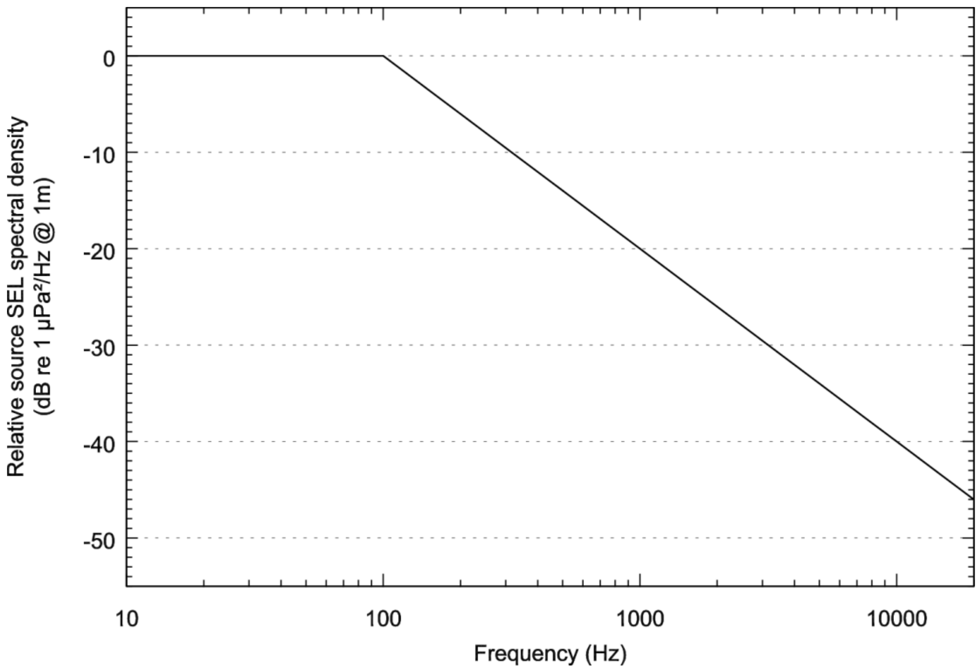


Figure B-3. Estimated sound spectrum from cavitating propeller. (Leggat et al. 1981).

B.3. Sound Propagation Models

B.3.1. 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 µPa^2·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 µPa^2·s by:

$$\mathrm{RL} = \mathrm{SL} - \mathrm{PL}. \quad \text{(B-5)}$$

B.3.2. 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-4).

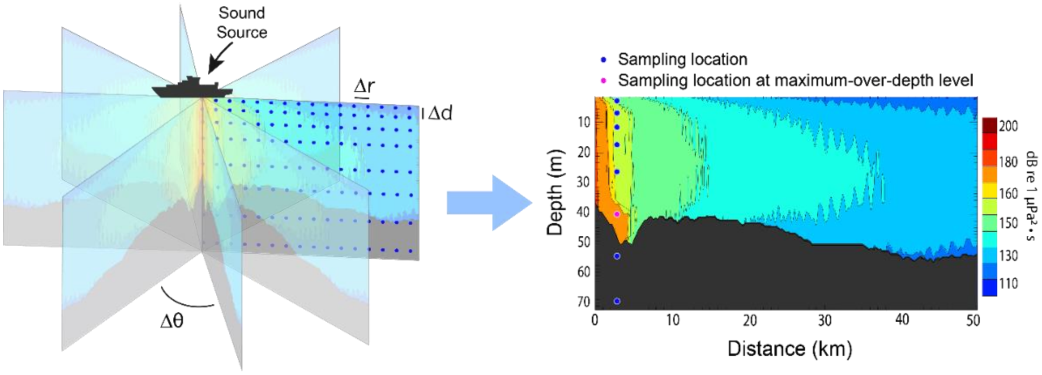


Figure B-4. The N×2-D and maximum-over-depth modelling approach used by MONM.

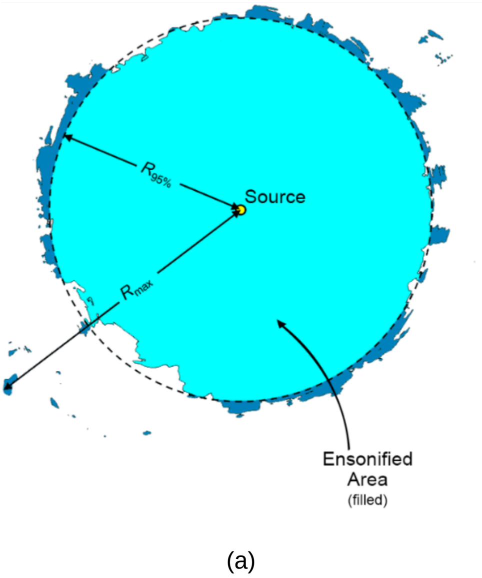
MONM treats frequency dependence by computing acoustic propagation loss at the centre frequencies of decidecade bands. Sufficiently many decidecade frequency-bands, starting at 10 Hz, are modelled to include most of the acoustic energy emitted by the source. At each centre frequency, the propagation 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.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.



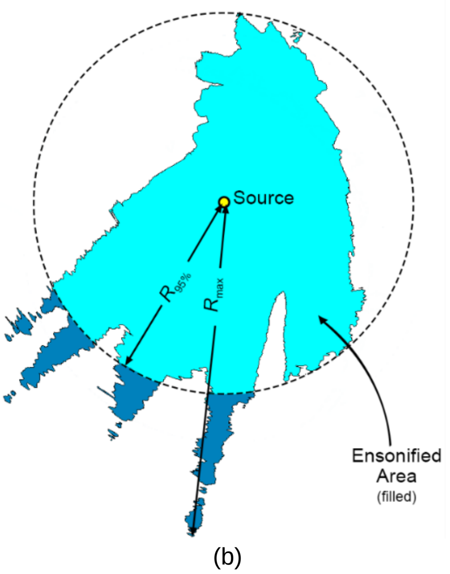


Figure B-5. Sample areas ensonified to an arbitrary sound level with R_{max} and $R_{95\%}$ ranges shown for two different scenarios. (a) Largely symmetric sound level contour with small protrusions. (b) Strongly asymmetric sound level contour with long protrusions. Light blue indicates the ensonified areas bounded by $R_{95\%}$; darker blue indicates the areas outside this boundary which determine R_{max}.

B.5. 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 C. Additional Results

Additional maximum-over-depth accumulated sound field results considering an accumulation time of 8 h are presented below. The twelve modelled scenarios (described in Section 1.1) are presented as tables and, where the distances are long enough, as contour maps showing distance to various sound levels.

C.1. Tabulated Results

Table C-1. *Scenario A:* Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{8h} PTS and TTS thresholds based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelled resolution (20 m). Scenario descriptions are given in Table 4.

Hearing group	Frequency-weighted SEL_{8h} threshold ($L_{E,24h}$; dB re 1 µPa^2·s)	Scenario A1: Helix ops		Scenario A2: PSV under DP		Scenario A3: Helix ops with PSV under DP		Scenario A4: ROV vessel under DP		Scenario A5: ROV vessel & cutter tool		Scenario A6: All sources	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
PTS													
LF cetaceans	199	0.06	0.0099	0.03	0.0036	0.06	0.0133	0.03	0.0036	0.03	0.0036	0.07	0.017
MF cetaceans	198	–	–	–	–	–	–	–	–	–	–	–	–
HF cetaceans	173	0.03	0.0036	0.03	0.0036	0.05	0.0085	0.03	0.0036	0.03	0.0036	0.05	0.011
Otariid seals	219	–	–	–	–	–	–	–	–	–	–	–	–
Sea turtles	220	–	–	–	–	–	–	–	–	–	–	0.02	0.001
TTS													
LF cetaceans	179	1.05	2.811	0.55	0.6533	1.66	4.227	0.30	0.2715	0.30	0.2734	1.69	5.115
MF cetaceans	178	0.02	0.0020	0.03	0.0036	0.03	0.0036	0.03	0.0036	0.03	0.0036	0.04	0.008
HF cetaceans	153	0.30	0.2809	0.37	0.4185	0.58	0.7823	0.36	0.4117	0.43	0.5437	0.59	1.402
Otariid seals	199	–	–	–	–	–	–	–	–	–	–	0.03	0.001
Sea turtles	200	0.05	0.0085	0.03	0.0036	0.06	0.0099	0.03	0.0036	0.03	0.0036	0.06	0.014

Table C-2. Scenario B: Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds for marine mammals based on NMFS (2018) and Finneran et al. (2017) from the most appropriate location for considered sources per scenario, and ensonified area (km^2). A dash indicates the level was not reached within the limits of the modelled resolution (20 m). Scenario descriptions are given in Table 4.

Hearing group	Frequency-weighted SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)	Scenario B1: Helix ops		Scenario B2: PSV under DP		Scenario B3: Helix ops with PSV under DP		Scenario B4: ROV vessel under DP		Scenario B5: ROV vessel & cutter tool		Scenario B6: All Sources	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
PTS													
LF cetaceans	199	0.06	0.0099	0.03	0.0036	0.06	0.0117	0.03	0.0036	0.03	0.0036	0.06	0.016
MF cetaceans	198	–	–	–	–	–	–	–	–	–	–	–	-
HF cetaceans	173	0.03	0.0036	0.03	0.0036	0.05	0.0085	0.03	0.0036	0.03	0.0036	0.04	0.011
Otariid seals	219	–	–	–	–	–	–	–	–	–	–	–	-
Sea turtles	220	–	–	–	–	–	–	–	–	–	–	–	–
TTS													
LF cetaceans	179	1.30	4.426	0.53	0.8825	1.53	6.379	0.55	0.6533	0.55	0.6590	1.70	8.867
MF cetaceans	178	0.02	0.0020	0.03	0.0036	0.03	0.0036	0.03	0.0036	0.03	0.0036	0.03	0.008
HF cetaceans	153	0.31	0.2961	0.46	0.4902	0.61	1.101	0.37	0.4185	0.52	0.6533	0.54	1.824
Otariid seals	199	–	–	–	–	–	–	–	–	–	–	0.02	0.002
Sea turtles	200	0.05	0.0085	0.03	0.0036	0.06	0.0099	0.03	0.0036	0.03	0.0036	0.04	0.015

C.2. Cumulative Sound Field Maps

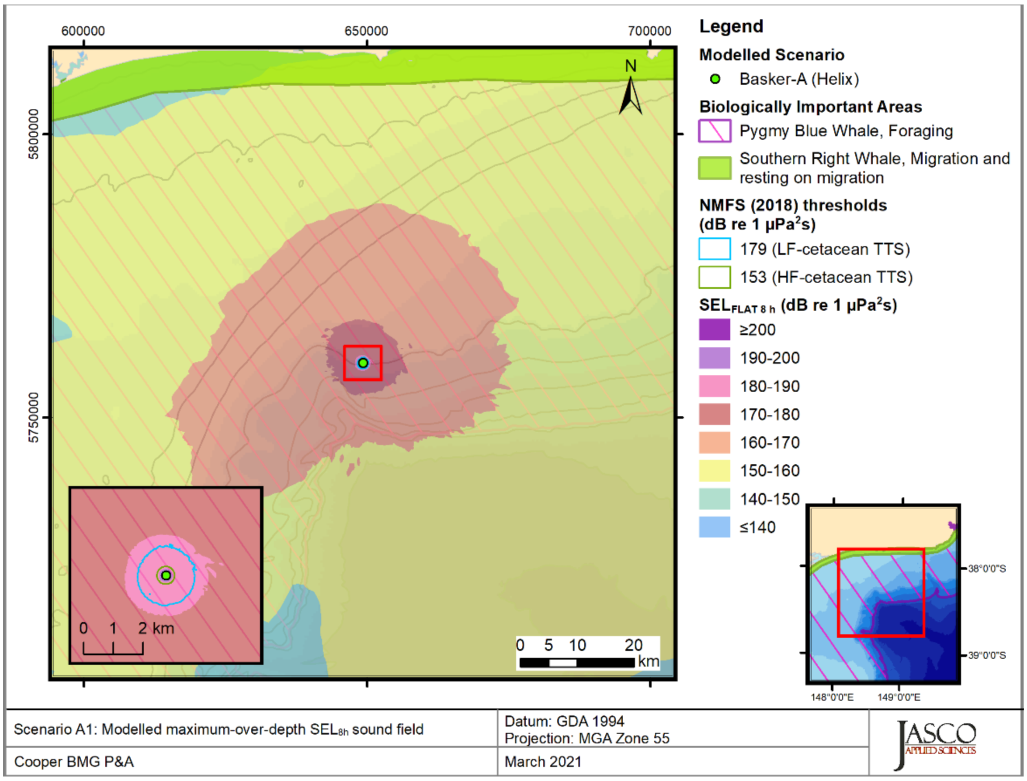


Figure C-1. Scenario A1, Helix Q7000 at Basker-A, SEL_{8h}: Sound level contour map showing unweighted maximum-over-depth SEL_{8h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section C.1 for distances.

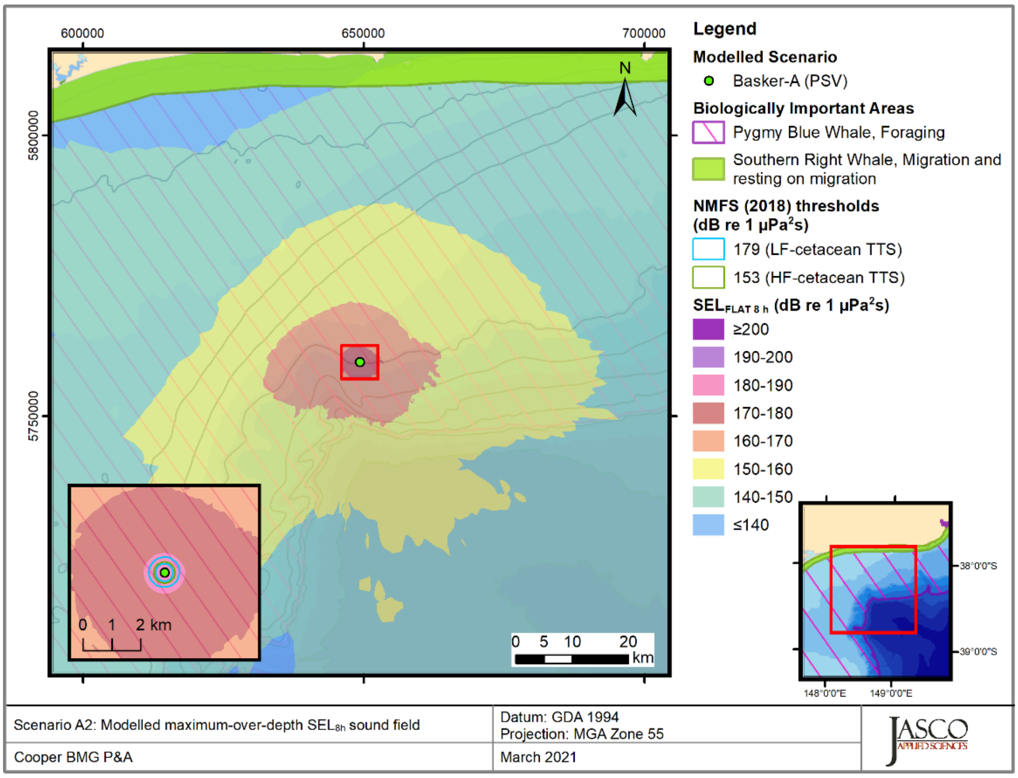


Figure C-2. Scenario A2, platform support vessel at Basker-A, SEL_{8h}: Sound level contour map showing unweighted maximum-over-depth SEL_{8h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section C.1 for distances.

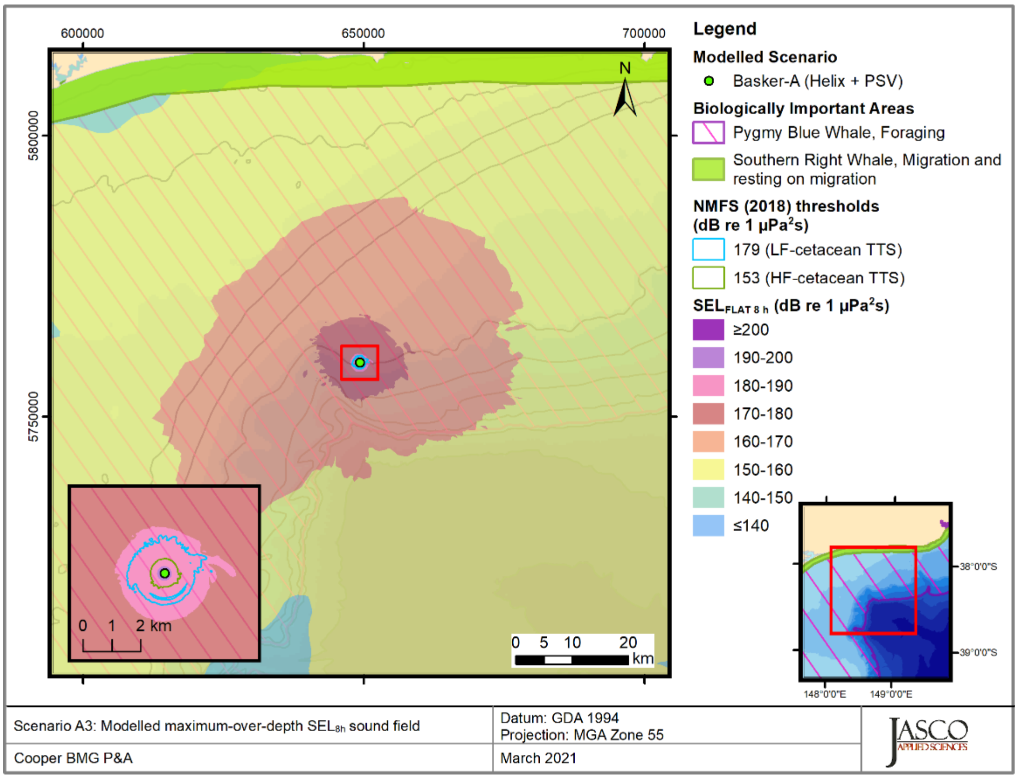


Figure C-3. Scenario A3, *Helix Q7000* and platform support vessel at Basker-A, SEL_{8h}: Sound level contour map showing unweighted maximum-over-depth SEL_{8h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section C.1 for distances.

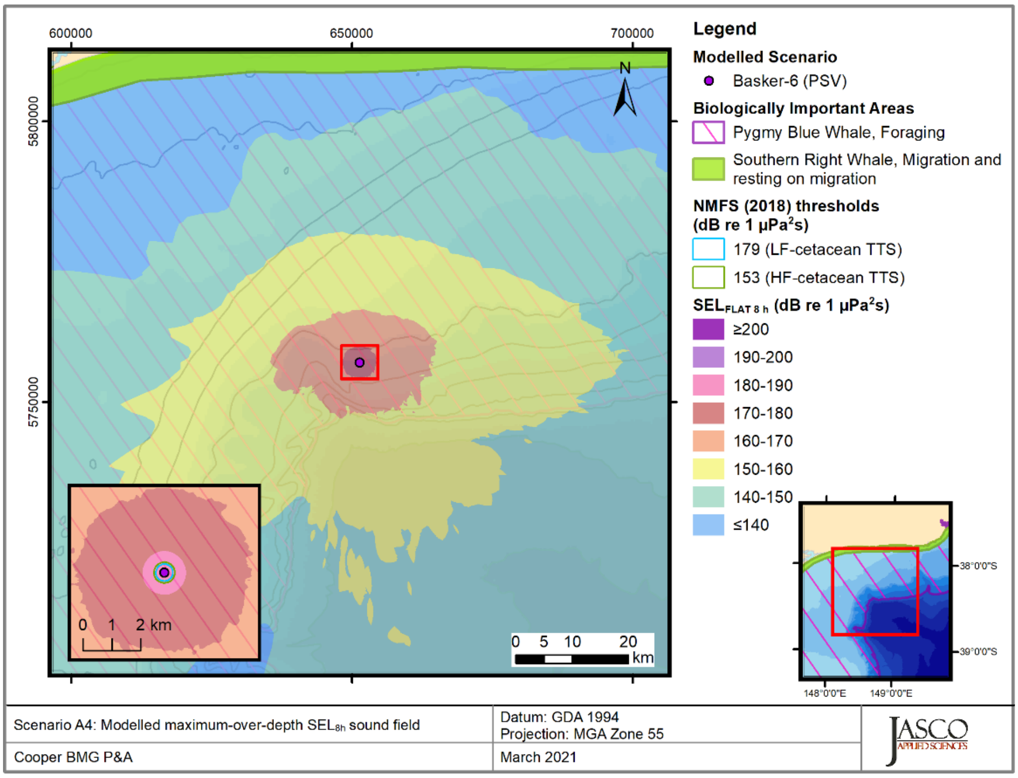


Figure C-4. Scenario A4, platform support vessel at Basker-6, SEL_{8h}: Sound level contour map showing unweighted maximum-over-depth SEL_{8h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section C.1 for distances.

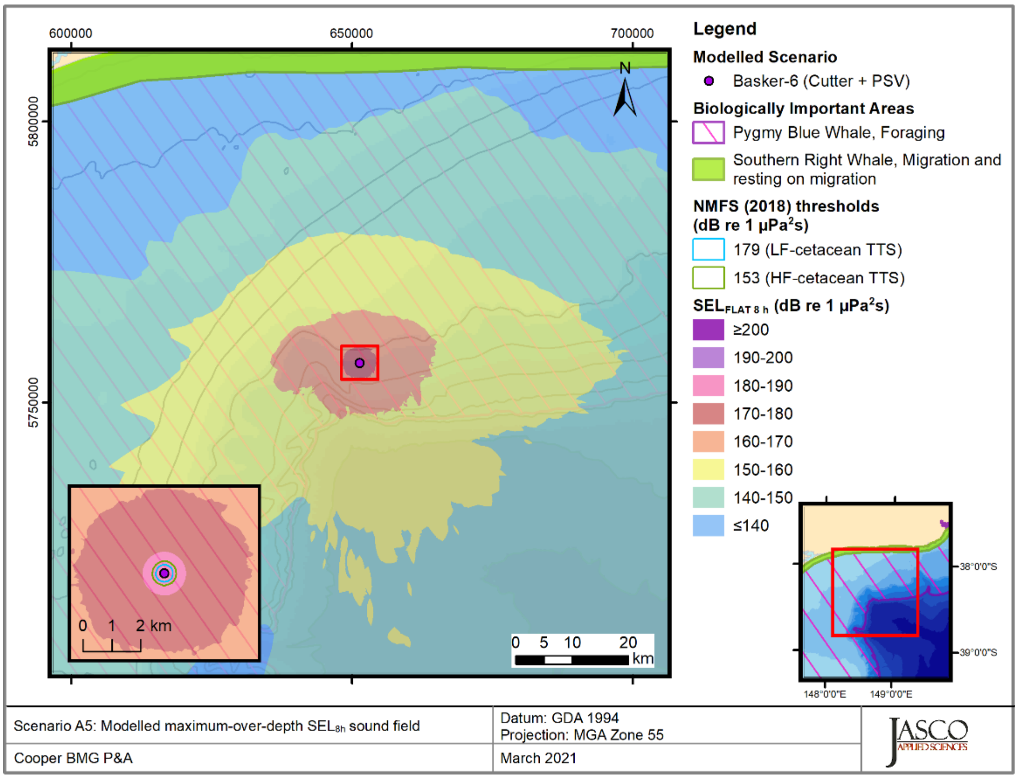


Figure C-5. Scenario A5, platform support vessel and ROV cutter at Basker-6, SEL_{8h}: Sound level contour map showing unweighted maximum-over-depth SEL_{8h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section C.1 for distances.

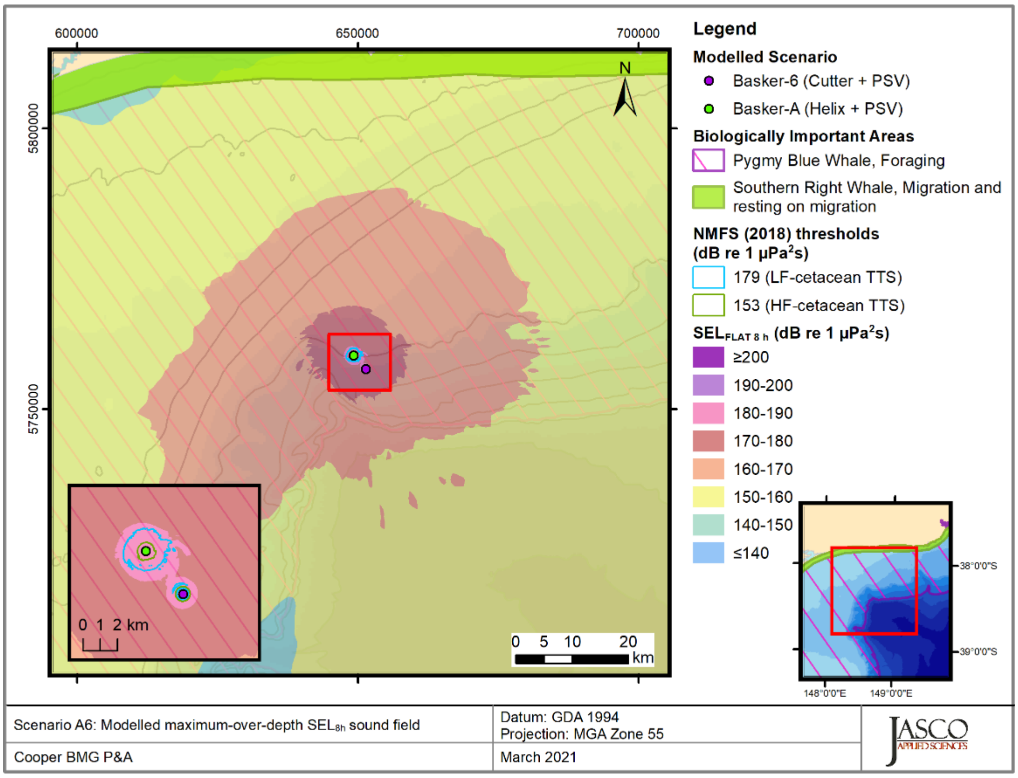


Figure C-6. Scenario A6, Helix Q7000 and platform support vessel at Basker-A and ROV Cutter and support vessel at Basker-6, SEL_{8h}: Sound level contour map showing unweighted maximum-over-depth SEL_{8h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS 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 C.1 for distances.

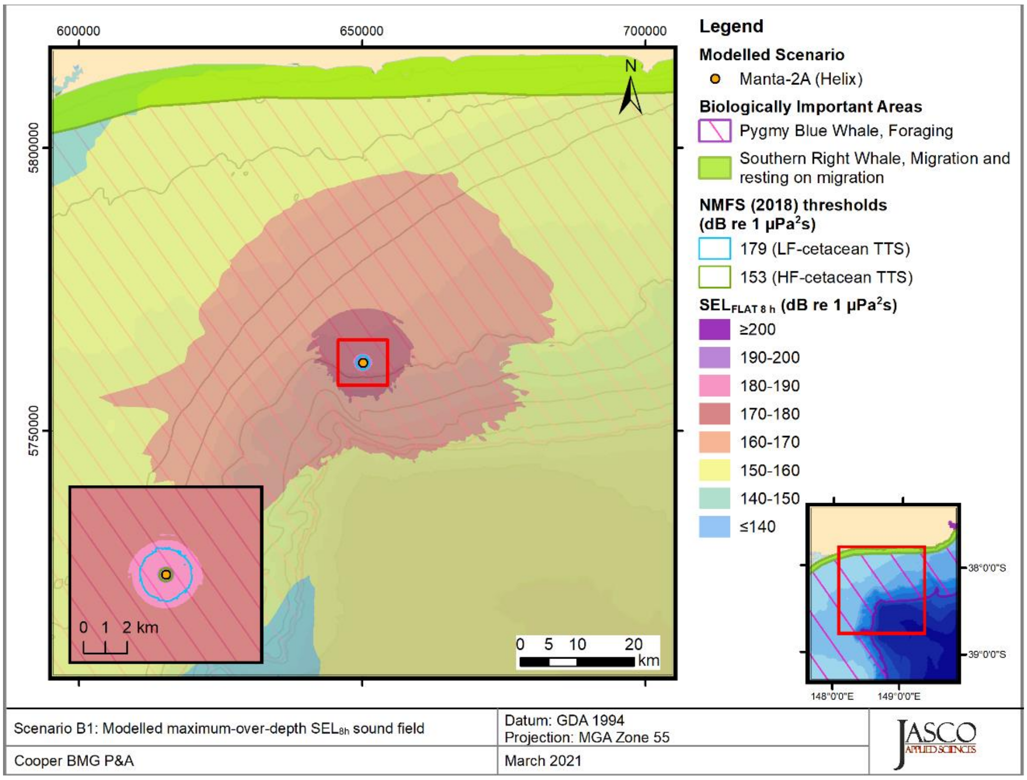


Figure C-7. Scenario B1, Helix Q7000 at Basker-A, SEL_{8h}: Sound level contour map showing unweighted maximum-over-depth SEL_{8h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section C.1 for distances.

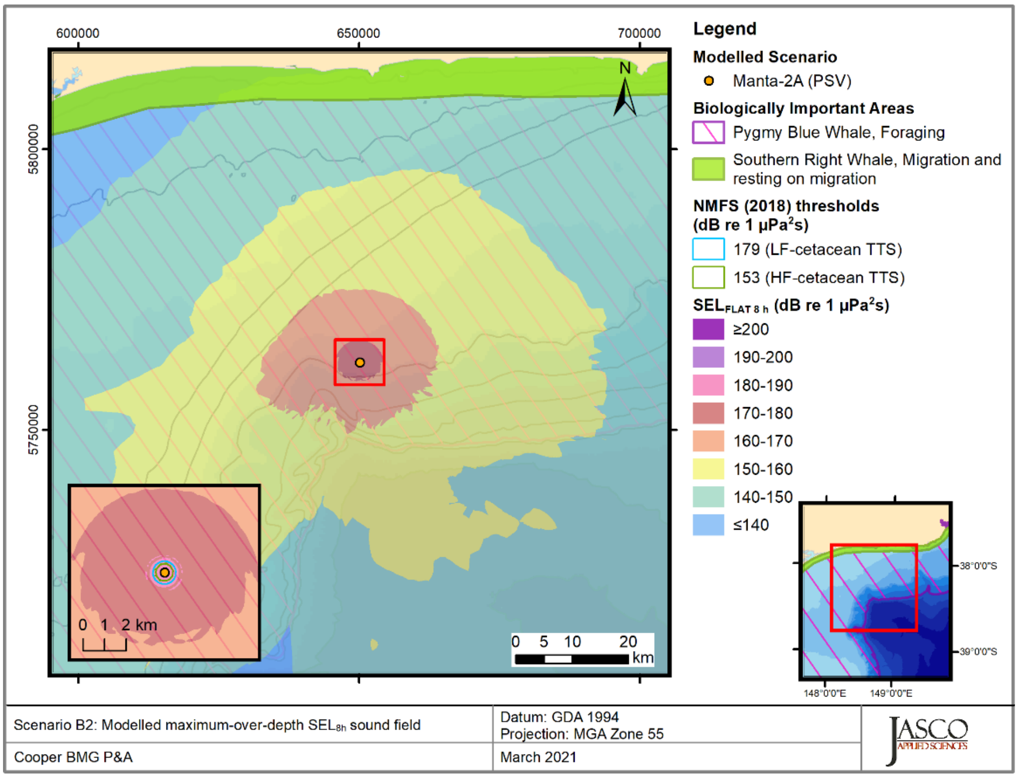


Figure C-8. Scenario B2, platform support vessel at Basker-A, SEL_{8h}: Sound level contour map showing unweighted maximum-over-depth SEL_{8h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section C.1 for distances.

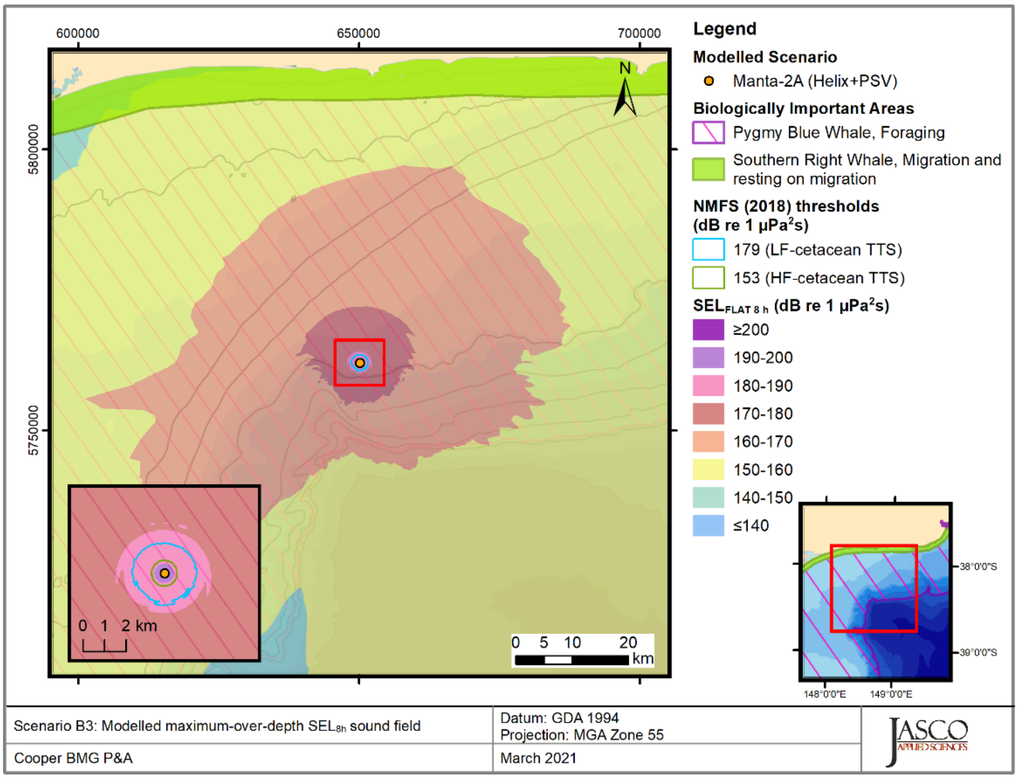


Figure C-9. Scenario B3, *Helix Q7000* and platform support vessel at Basker-A, SEL_{8h}: Sound level contour map showing unweighted maximum-over-depth SEL_{8h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section C.1 for distances.

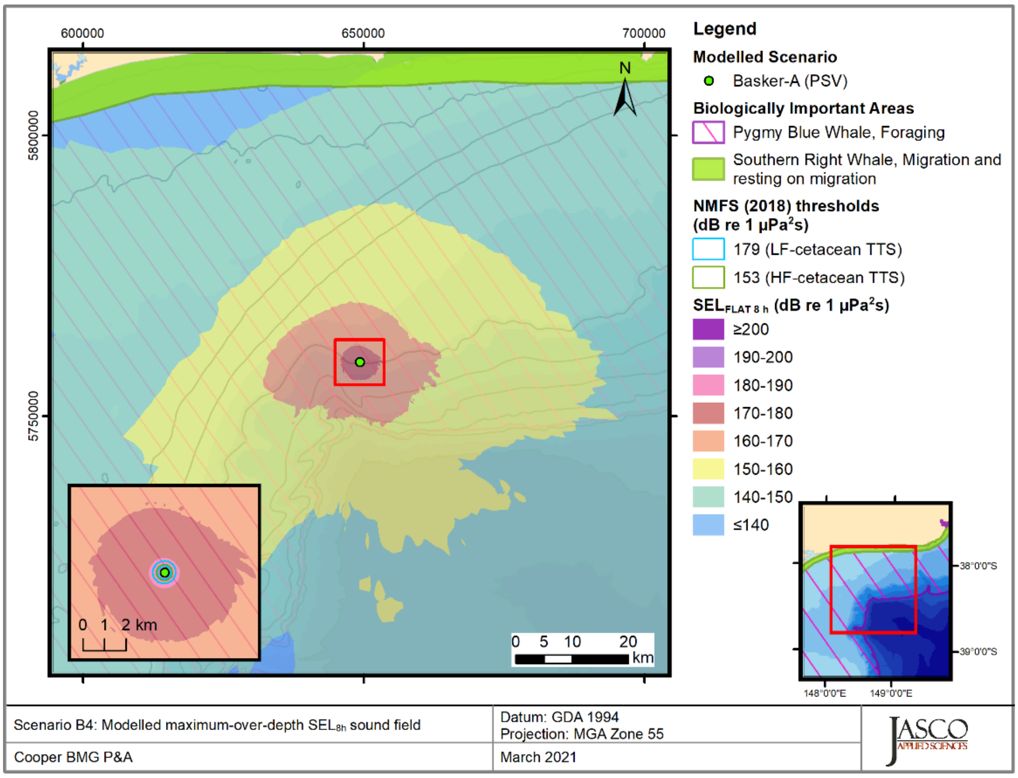


Figure C-10. Scenario B4, platform support vessel at Basker-6, SEL_{8h}: Sound level contour map showing unweighted maximum-over-depth SEL_{8h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section C.1 for distances.

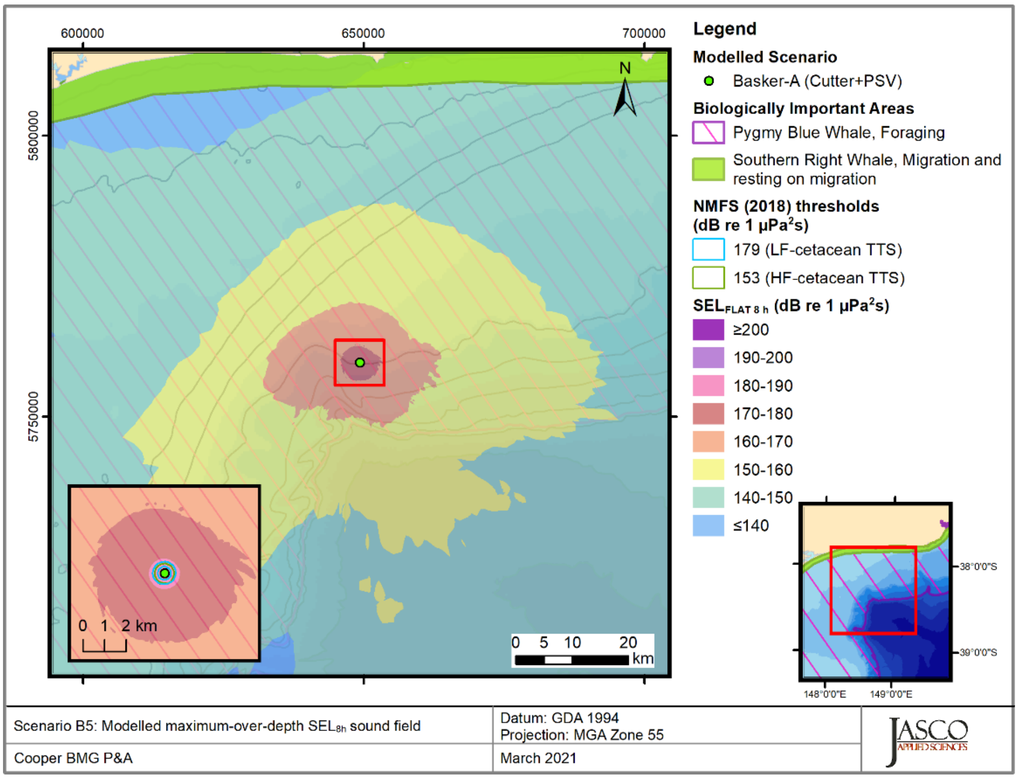


Figure C-11. Scenario B5, platform support vessel and ROV cutter at Basker-6, SEL_{8h}: Sound level contour map showing unweighted maximum-over-depth SEL_{8h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS were either not reached or were small enough such that they could not be displayed on a map. Refer to the radii tables in Section C.1 for distances.

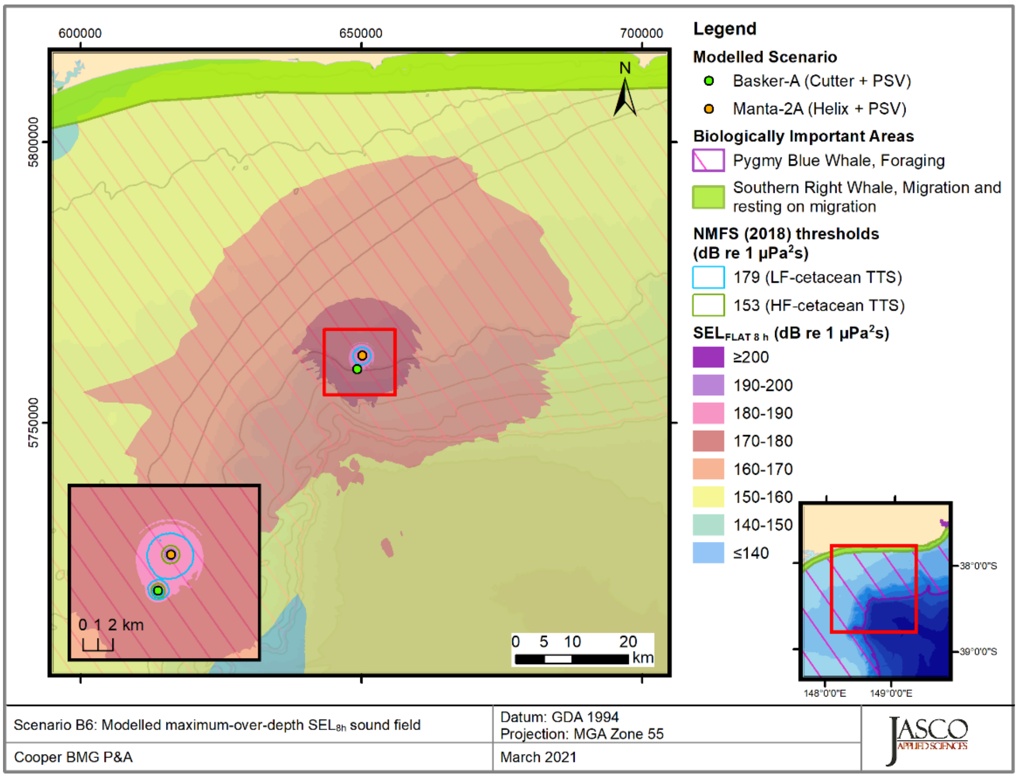


Figure C-12. Scenario B6, Helix Q7000 and platform support vessel at Basker-A and ROV Cutter and support vessel at Basker-6, SEL_{8h}: Sound level contour map showing unweighted maximum-over-depth SEL_{8h} results, along with isopleths for TTS thresholds. Thresholds for PTS and some thresholds for TTS 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 C.1 for distances.

Appendix 6 - Oil Spill Modelling Report

BASKER MANTA GUMMY WELL ABANDONMENT

Oil Spill Modelling

MAQ0951J
Basker Manta Gummy Well Abandonment Oil Spill Modelling
Rev 2
18 February 2021

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Document status

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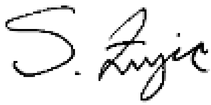
Dr. Sasha Zigic  22 February 2021

Prepared by:

RPS

Jeremie Bernard
Senior Coastal Engineer

Suite E1, Level 4, 140 Bundall Road
Bundall QLD 4217

T +61 7 5574 1112
E Jeremie.Bernard@rpsgroup.com

Prepared for:

Cooper Energy Ltd

Joe Morris
Environment Consultant

Level 15, 123 St. Georges Terrace,
Brookfield Place Tower 2,
Perth WA 6000

T +61 466 628 737
E joem@cooperenergy.com.au

Contents

Tables

Figures

Appendices

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
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
Biodegradation	Decomposition of organic material by microorganism
BMG fields	Collectively refers to Basker, Manta and Gummy fields
Bonn Agreement	An agreement for cooperation in dealing with pollution of the North Sea by oil and other harmful substances, 1983, includes: Governments of the Kingdom of Belgium, the Kingdom of Denmark, the French Republic, the Federal Republic of Germany, the Republic of Ireland, the Kingdom of the Netherlands, the Kingdom of Norway, the Kingdom of Sweden, the United Kingdom of Great Britain and Northern Ireland and the European Union.
BP	Boiling point
BTEX	Benzene, toluene, ethylbenzene, and xylenes
B2	Basker-2 Well
°C	degree Celsius (unit of temperature)
CFSR	Climate Forecast System Reanalysis
CIRES	Cooperative Institute for Research in Environmental Sciences
CNES	The National Centre for Space Studies (France)
Cooper Energy	Cooper Energy Limited
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.
Dissolved hydrocarbons	Hydrocarbon droplets which are dissolved in water.
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.
Entrained hydrocarbons	Hydrocarbon droplets that are suspended into the water column, though not dissolved.
EP	Environmental Plan
Evaporation	The process whereby components of the oil mixture are transferred from the sea-surface to the atmosphere as vapours.
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.
IBRA	Interim Biogeographic Regionalisation of Australia
IMCRA	Integrated Marine and Coastal Regionalisation of Australia
IOA	Index of Agreement. Statistical measure of model performance
Isopycnal layer	Water layer characterised by the same density
ITOPF	International Tanker Owner Pollution Federation
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)
LC_{50}	Median lethal dose required for mortality of 50% of a tested population after a specified exposure duration.
LGA	Local government area
m	Meter (unit of length)
m/s	Meter per Second (unit of speed)
m^3	Cubic meter (unit of volume)
MAHs	Monoaromatic hydrocarbons
MAE	Mean Absolute Error. Statistical measure of model performance
MP	Marine Park
MR	Marine Reserve
M2A	Manta-2a Well
N	Number of observations
NASA	National Aeronautics and Space Administration
NCEP	National Centres for Environmental Prediction
nm	Nautical mile
NOAA	National Oceanic and Atmospheric Administration
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NR	Nature Reserve
NRC	National Research Council
O	Observed variable (surface elevation)
OILMAP	Oil spill model system
OPEP	Oil Pollution Emergency Plan
P	Model-predicted variable (surface elevation)
PAHs	Polynuclear aromatic hydrocarbons
Plume execution depth (trapping depth)	Depth at which the plume density has reached equilibrium with the surrounding sea water. The trapping depth is used to set up the far-field model SIMAP.
ppb	parts per billion (concentration)

PP	Protection priorities
Pour point	The pour point of a liquid is the temperature below which the liquid loses its flow characteristics.
PSU	Practical salinity units
Ramsar site	A site listed under the Ramsar Convention on wetlands which is an international intergovernmental treaty that provides the framework for the conservation and wise use of wetlands and their resources.
RSB	Reefs, shoals and banks
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 accumulation	Arrival of oil at or near shorelines at on-water concentrations equal to or exceeding defined threshold concentrations. Shoreline contact is judged for floating oil arriving within a 1 km buffer zone from any shoreline as a conservative measure
SIMAP	Spill Impact Mapping and Analysis Program. 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, 2018). 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.
SRTM30_PLUS	Shuttle Radar Topography Mission Plus
State waters	Low water mark seaward for three nautical miles
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 area that maybe affected (EMBA) and also indicates which particular 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 for the Risk EMBA will enclose 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 Risk EMBA contours derived from stochastic modelling indicate the outcomes expected from a single spill event (NOPSEMA, 2018). 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.
Summer	October to the following April
TRP	Tactical Response Planning
TOPEX/Poseidon	A joint satellite mission between NASA and CNES to map ocean surface topography using an array of satellites equipped with detailed altimeters
US EPA	United States Environmental Protection Agency
Weathered oil	Oil that no longer contains volatile or soluble components
WOA13	The World Ocean Atlas 2013
Winter	May to September
X_{model}	Model predicted variable (surface elevation)

X_{obs}	Observed variable (surface elevation)
z-level coordinates	Vertical coordinates (depth)

EXECUTIVE SUMMARY

Cooper Energy Limited (Cooper Energy) is the titleholder of Petroleum Retention Leases VIC/RL13, VIC/RL 14 and VIC/RL 15 in the Gippsland Basin. VIC/RL13 includes the Basker Manta Gummy subsea oil development (referred to as BMG in this document). The development is located approximately 50 km south of the Gippsland Coast, offshore Victoria.

From 2022 Cooper Energy plans to decommission the existing BMG facilities. These facilities consist of seven (7) subsea wells, a manifold, and a network of flowlines and umbilicals. All associated surface and mid-water production facilities were removed from the field in 2011. The field has been in a non-production phase since then. Decommissioning of the subsea facilities will begin with the plug and abandonment of the subsea wells.

To support the development of Environment Plan (EP) and Oil Pollution Emergency Plan (OPEP) to be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for consideration and approval, comprehensive oil spill modelling was undertaken. The modelled cases represent the worst-case spill scenarios (determined by Cooper Energy) inclusive of the abandonment of BMG wells and vessel-based activities during broader decommissioning scope at BMG. The following hypothetical spill scenarios have been modelled:

- **Scenario 1**: Loss of well control – Subsea release of 77,339 m^3 of Basker 6ST1 crude over 120 days at Basker-2 well, and;

- **Scenario 2**: Vessel collision – surface release of 500 m^3 of marine diesel oil over 5 hours at Manta-2A well.

For Scenario 1, the potential risk of exposure to the surrounding waters and oil accumulation to shorelines was assessed for annual conditions. The risk of exposure for Scenario 2 was considered during; (i) summer (October to the following April), (ii) winter (May to September) due to the shorter spill duration.

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 release. The modelling does not take into consideration any of the spill prevention, mitigation and response capabilities that would be implemented in response to the spill. Therefore, the modelling results represent the maximum extent that the released hydrocarbon may influence.

Methodology

The modelling study was carried out in several stages. Firstly, a ten-year wind and current dataset (2008–2017) 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 (or probabilistic) approach, which involved running 100 randomly selected single trajectory simulations for Scenario 1 and 100 simulations per season for Scenario 2 (200 simulations in total), 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.

Thresholds

The thresholds adopted for floating, shoreline, and in-water (entrained and dissolved) oil are in accordance with the recommended NOPSEMA (2019) thresholds and are referred to in this document as follows:

Low thresholds: 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).

Oil Properties

The oil type used to represent the loss of well control (Scenario 1) was a composite crude (referred to in this report as Basker 6ST1 crude). Basker 6ST1 was derived from a combination of worst-case physical properties that characterised the Basker 2 and Basker 6ST1 crude oils. A detailed summary of Basker 2 and Basker 6ST1 oil data is available in COE (2020).

Basker 6ST1 crude has a density of 829.8 kg/m^3 (API of 45.2), a dynamic viscosity of 2.8 cP (at 25 °C) and a high pour point of 15 °C (when compared to ambient water temperature). This oil is categorised as a group II oil (light-persistent) based on categorisation and classification derived from AMSA (2015a) guidelines. The classification is based on the specific gravity of hydrocarbons in combination with relevant boiling point ranges. It is important to note that this crude oil contains approximately 40.3% persistent compounds characterised by a high pour point (above ambient water temperature) and a wax content of 27.7%. This portion of the crude will likely solidify over time to form small waxy flakes as it loses the light end hydrocarbons acting as solvent to the heavier compounds.

A marine diesel oil (MDO) was used to represent the vessel collision (Scenario 2). MDO is a light-persistent fuel oil used in the maritime industry. It has a density of 829.1 kg/m^3 (API of 37.6) and a low pour point (-14°C). The low viscosity (4 cP) indicates that this oil will spread quickly when released and will form a thin to low thickness film on the sea surface, increasing the rate of evaporation. This oil contains approximately 5% (by mass) of hydrocarbon compounds (or residuals) that will not evaporate at atmospheric temperatures and will likely persist in the environment. The oil is categorised as a group II oil (light-persistent) based on categorisation and classification derived from AMSA (2015a) guidelines.

Summary of the Stochastic Assessment Results

Scenario 1: 77,338 m^3 Subsea Release of Basker 6ST1 Crude

- The maximum distance from the release location to the low (≥ 1 g/m^2), moderate (≥ 10 g/m^2) and high (≥ 50 g/m^2) exposure thresholds for floating oil was 1,540 km northeast, 386 km northeast and 140 km east northeast, respectively.

- A total of 65 Biologically Important Areas (BIAs) were predicted to be exposed to floating oil at or above the low threshold during annualised conditions. Aside from the 11 BIAs that the release location resides within, the highest probability of low, moderate and high floating oil exposure was predicted at the Southern Right Whale - Migration BIA with 100%, 100% and 72%, respectively. This same receptor also recorded the minimum time before floating oil exposure at the low, moderate and high thresholds with 0.04 days (1 hour), 0.04 days (1 hour) and 0.13 days (3 hours), respectively. It is important to note that the Southern Right Whale - Migration BIA boundary lies approximately 1.9 km northeast of the release location (B2 well).

- The probability of accumulation on any shoreline at, or above, the low threshold (10-100 g/m^2) was 100% and the minimum time before shoreline accumulation was approximately 3.42 days. The maximum volume of oil ashore was 1,975 m^3, which represent about 2.5% of the total volume of oil released.

- In the surface (0-10 m) depth layer, a total of 34 BIAs were predicted to be exposed to dissolved hydrocarbons at or above the high threshold during the annualised assessment. Aside from the 11 BIAs that the release location resides within, the highest probabilities of exposure to low, moderate and high dissolved hydrocarbons were predicted as 95%, 95% and 29% for the Southern Right Whale – Migration BIA.

- In the surface (0-10 m) depth layer, a total of 54 BIAs were predicted to be exposed to entrained oil at or above the low and high thresholds during the annualised assessment. Aside from the 11 BIAs that the release location resides within, the highest probability of high entrained exposure was 95%, predicted at 8 BIAs (Humpback Whale – Foraging, Indo-Pacific/Spotted Bottlenose Dolphin – Breeding, Little Penguin – Foraging, Short-tailed Shearwater – Foraging, Southern Right Whale – Migration, Wedge-tailed Shearwater – Foraging, White Shark – Foraging, White-faced Storm-petrel – Foraging).

Scenario 2: 500 m^3 Surface Release of Marine Diesel Oil

- The maximum distance from the release location to the low (≥ 1 g/m^2), moderate (≥ 10 g/m^2) and high (≥ 50 g/m^2) exposure thresholds was 194 km east (summer), 132 km east northeast (winter) and 11 km north northwest (summer), respectively.

- A total of 19 and 21 BIAs were predicted to be exposed to floating oil at or above the low threshold during summer and winter conditions, respectively. Aside from the 12 BIAs that the release location resides within, the highest probability of low floating oil exposure and the minimum time before low floating oil exposure was predicted at the White-faced Storm-petrel - Foraging BIA with 55% and 56% during summer and winter conditions respectively and 0.25 days (6 hours) and 0.21 days (5.0 hours) minimum time, respectively.

- The probability of accumulation on any shoreline at, or above, the low threshold (10-100 g/m^2) was 4%, and 8% in summer and winter months, respectively. The minimum time before shoreline contact was approximately 1.9 days (~46 hours) and the maximum volume of oil ashore was 64.8 m^3, both predicted during winter conditions.

- In the surface (0-10 m) depth layer, a total of 12 BIAs were predicted to be exposed to dissolved hydrocarbons at or above the low and moderate thresholds during summer and winter conditions, and the greatest probabilities of 72% and 36% and 69% and 50% respectively. Aside from the 12 BIAs that the release location resides within, all the other BIAs recorded probabilities of less than 10% except the White-faced Storm-petrel – Foraging BIA which recorded a 17%. No receptors were exposed at or above the high exposure threshold for either season.

- In the surface (0-10 m) depth layer, a total of 12 BIAs were predicted to be exposed to entrained oil at or above the low and high thresholds during summer and winter conditions, and the highest probabilities were 94% and 89% and 98% and 89% respectively. Aside from the 12 BIAs that the release location resides within, 13 and 12 additional BIAs recorded probabilities of exposure to entrained hydrocarbons at the high threshold during summer and winters conditions, respectively. The greatest probabilities of high exposure during summer and winter conditions were predicted at the White-faced Storm-petrel – Foraging BIA with 36% and 37%, respectively.

1 INTRODUCTION

1.1 Background

Cooper Energy Limited (Cooper Energy) is the titleholder of Petroleum Retention Leases VIC/RL13 (Basker Field), VIC/RL 14 (Manta Field) and VIC/RL 15 (Gummy Field) in the Gippsland Basin. These permits (referred to as BMG in this document) are located approximately 50 km south of the Gippsland Coast, offshore Victoria.

From 2022 Cooper Energy plans to decommission the existing BMG facilities. These facilities consist of seven (7) subsea wells, a manifold, and a network of flowlines and umbilicals. All associated surface and mid-water production facilities were removed from the field in 2011. The field has been in a non-production phase since then. Decommissioning of the subsea facilities will begin with the plug and abandonment of the subsea wells.

To support the development of Environment Plan (EP) and Oil Pollution Emergency Plan (OPEP) to be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for consideration and approval, a comprehensive oil spill modelling was undertaken. The modelled cases represent the worst-case spill scenarios (determined by Cooper Energy) inclusive of the abandonment of BMG wells and vessel-based activities during broader decommissioning scope at BMG. The following hypothetical spill scenarios have been modelled:

- **Scenario 1**: Loss of well control – Subsea release of 77,339 m^3 of Basker 6ST1 crude over 120 days; at Basker-2 Well (refer to COE (2020) for the determination of the worst-case flow rate and oil properties), and;
- **Scenario 2**: Vessel collision – surface release of 500 m^3 of marine diesel oil over 5 hours at Manta-2A Well.

The release locations used for the oil spill assessment are presented in Table 1-1 and illustrated in Figure 1-1.

The potential risk of exposure to the surrounding waters and oil accumulation to shorelines was assessed for annual conditions for Scenario 1 and for two distinct seasons for Scenario 2; (i) summer (October to the following April), (ii) winter (May to September). Scenario 2 was assessed on a seasonal basis due to the shorter nature of the spill and hence subject to seasonal trends of weather and oceanographic conditions.

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 release. The modelling does not take into consideration any of the spill prevention, mitigation and response capabilities that would be implemented in response to the spill. Therefore, the modelling results represent the maximum extent that the released hydrocarbon may influence.

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

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

Table 1-1 Coordinates of the release locations used in the oil spill modelling study.

Scenario	Location	Latitude	Longitude	Depth (mLAT)
1	Basker-2 Well (B2)	38° 17' 58.5" S	148° 42' 24.7" E	153

2	Manta-2A Well (M2A)	38° 16’ 39.8” S	148° 42’ 58.4” E	135

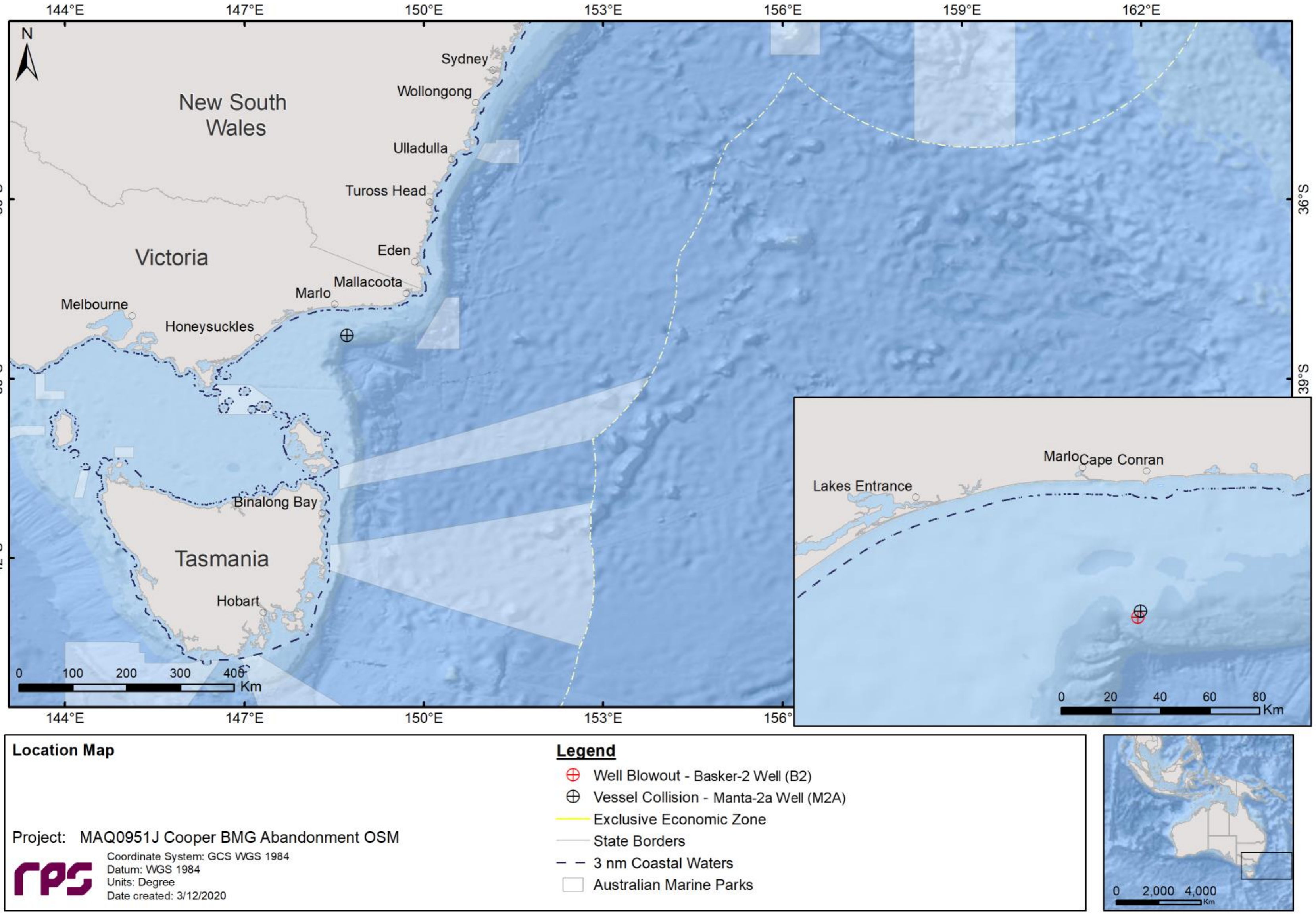


Figure 1-1 Map of the release locations used in the oil spill modelling study.

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, 100-250 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.

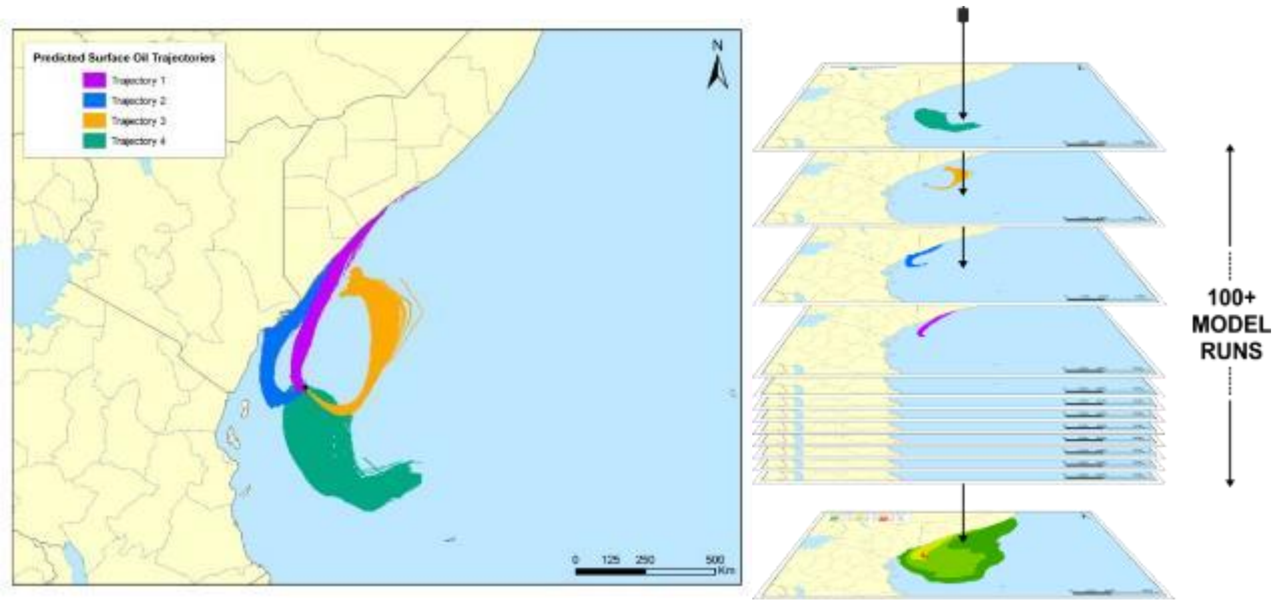


Figure 1-2 Examples of four individual spill trajectories (four replicate simulations) predicted by SIMAP for a spill scenario. The frequency of contact with given locations is used to calculate the probability of impacts during a spill. Essentially, all model runs are overlain (shown as the stacked 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 a single hypothetical oil spill simulation subject to a single set of wind and current 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 modelling results is generally the "worst cast" single run selected and serves as the basis for developing the plans and equipment needs for a realistic spill response. The "worst case" deterministic simulations can be selected on several basis such as minimum time to shoreline, largest swept area, maximum volume ashore and longest length oil accumulation on the shorelines.

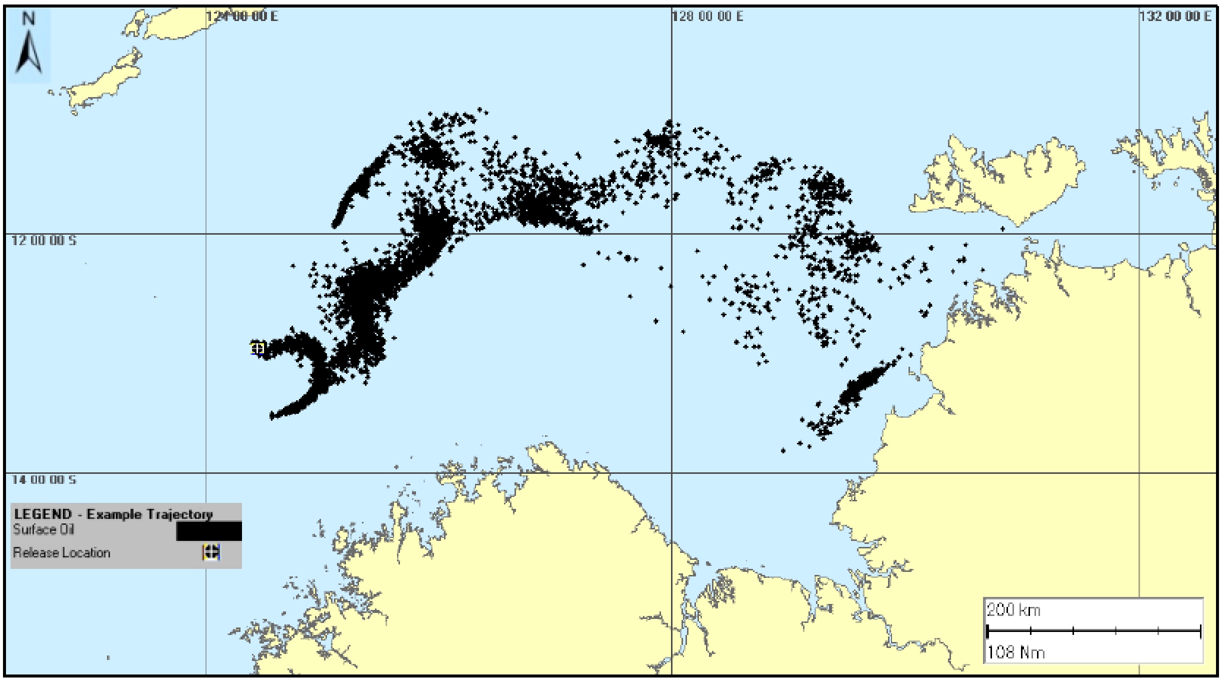


Figure 1-3 Example of an individual spill trajectory predicted by SIMAP for a spill scenario. Note, this image represents surface oil as spillets and do not take any thresholds into consideration.

2 SCOPE OF WORK

The scope of work included the following components:

- Generate 10 years (2008 to 2017 (inclusive)) wind and current data. The three-dimensional current data includes the combined influence of ocean and tidal currents;
- Use 10 years of high-resolution wind, aggregated current data and oil characteristics as input into the 3-dimensional oil spill model to represent the movement, spreading, entrainment and weathering of the oil over time;
- Use SIMAP's stochastic model to calculate exposure to surrounding waters (sea surface and water column) and shorelines. This will involve running 100 randomly selected single trajectory simulations for Scenario 1 and 100 simulation per season for Scenario 2, with each simulation having the same spill information (spill volume, duration and composition of hydrocarbons) but varying start times. This will ensure that each spill trajectory is subjected to unique wind and current conditions.
- The results from the 100 spill trajectories (for the scenario or per season) were combined to determine the probability of exposure to the sea surface and water column, in addition to potential oil accumulation to shorelines (for a defined low, moderate and high threshold) for each season and scenario.
- In addition to the stochastic modelling, “worst case” deterministic runs were identified for each scenario based on the following criteria:

  a. largest volume of oil ashore;

  b. longest length of shoreline contacted above 100 g/m^2;

  c. minimum time before shoreline contact above 10 g/m^2; and

  d. largest swept area of floating oil above 10 g/m^2 (visible sea surface oil).

  e. largest entrained oil swept area above 10 ppb.

  f. largest dissolved hydrocarbon swept area above 10 ppb.

3 CALCULATION OF EXPOSURE RISK

The stochastic model within SIMAP performs a large number of simulations for a given spill site, randomly varying the spill time for each simulation. Hence, the transport and weathering of each simulation will be subject to a different sample of wind and current conditions.

This stochastic sampling approach provides an objective measure of the possible outcomes of a spill, because environmental conditions will be selected at a rate that is proportional to the frequency that these conditions occur over the study region. More simulations will tend to use the most commonly occurring conditions, while conditions that are more unusual will be represented less frequently.

During each simulation, the SIMAP model records the location (by latitude, longitude and depth) of each of the particles (representing a given mass of oil) on or in the water column, at regular time steps. For any particles that contact a shoreline, the model records the accumulation of oil mass that arrives on each section of shoreline over time, less any mass that is lost to evaporation and/or subsequent removal by current and wind forces.

The collective records from all simulations are then analysed by dividing the study region into a three-dimensional grid. For oil particles that are classified as being at the water surface (floating oil), the sum of the mass in all oil particles (including accounting for spreading and dispersion effects) located within a grid cell, divided by the area of the cell provides estimates of the concentration of oil in that grid cell, at each time step. For entrained and dissolved hydrocarbons particles, concentrations are calculated at each time step by summing the mass of particles within a grid cell and dividing by the volume of the grid cell.

The concentrations of oil calculated for each grid cell, at each time step, are then analysed to determine whether concentration estimates exceed defined threshold concentrations over time.

Risks are then summarised as follows:

- The probability of exposure to a location is calculated by dividing the number of spill simulations where any contact occurred above a specified threshold at that location by the total number of replicate spill simulations. For example, if contact occurred at a location (above a specified threshold) during 21 out of 100 simulations, a probability of exposure of 21% is indicated.
- The minimum potential time to a shoreline location is calculated by the shortest time over which oil at a concentration above a threshold was calculated to travel from the source to the location in any of the replicate simulations.
- The maximum potential concentration of oil predicted for each shoreline section is the greatest mass per m^2 of shoreline calculated to strand at any location within that section during any of the replicate simulations.
- Similar treatments were undertaken for entrained and dissolved hydrocarbon exposures.

Thus, the minimum time to shoreline and the maximum potential concentration estimates indicate the worst potential outcome of the modelled spill scenario for each section of shoreline. However, the average over the replicates presents an average of the potential outcomes, in terms of oil that could strand.

Note also that results quoted for sections of shoreline are derived for any individual location within that section, as a conservative estimate. Locations will represent shoreline lengths of the order of ~1 km, while sections or regions will represent shorelines spanning tens to hundreds of kilometres and we do not imply that the maximum potential concentrations quoted will occur over the full extent of each section. We therefore warn against multiplying the maximum concentration estimates by the full area of the section because this will greatly overestimate the total volume expected on that section.

4 INPUTS TO THE RISK ASSESSMENT

4.1.1 Current Data

4.1.1.1 Background

The Gippsland Basin lies within the eastern portion of the Bass Strait, which is a sea straight separating Tasmania from the southern Australian mainland. The strait is a relatively shallow area of the continental shelf, connecting the southeast Indian Ocean with the Tasman Sea. The Bass Strait region has a reputation for high winds and strong tidal currents (Jones, 1980). Currents within the strait are primarily driven by tides, winds and density driven flows. During winter the South Australian current moves dense, salty water eastward from the Great Australian Bight into the western margin of the Bass Strait (Sandery and Kampf, 2007). 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 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 and Bye, 2007). Figure 4-2 displays seasonal current trends within the Bass Strait. During winter there is a strong eastward water flow due to the strengthening of the South Australian Current (fed by the Leeuwin Current in the Northwest Shelf), which bifurcates with one extension moving though the Bass Strait, and another forming the Zeehan Current off western Tasmania (Sandery and Kampf, 2007). During summer, water flow reverses off Tasmania, King Island and the Otway Basin travelling eastward, as the coastal current develops due to south-easterly winds.

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

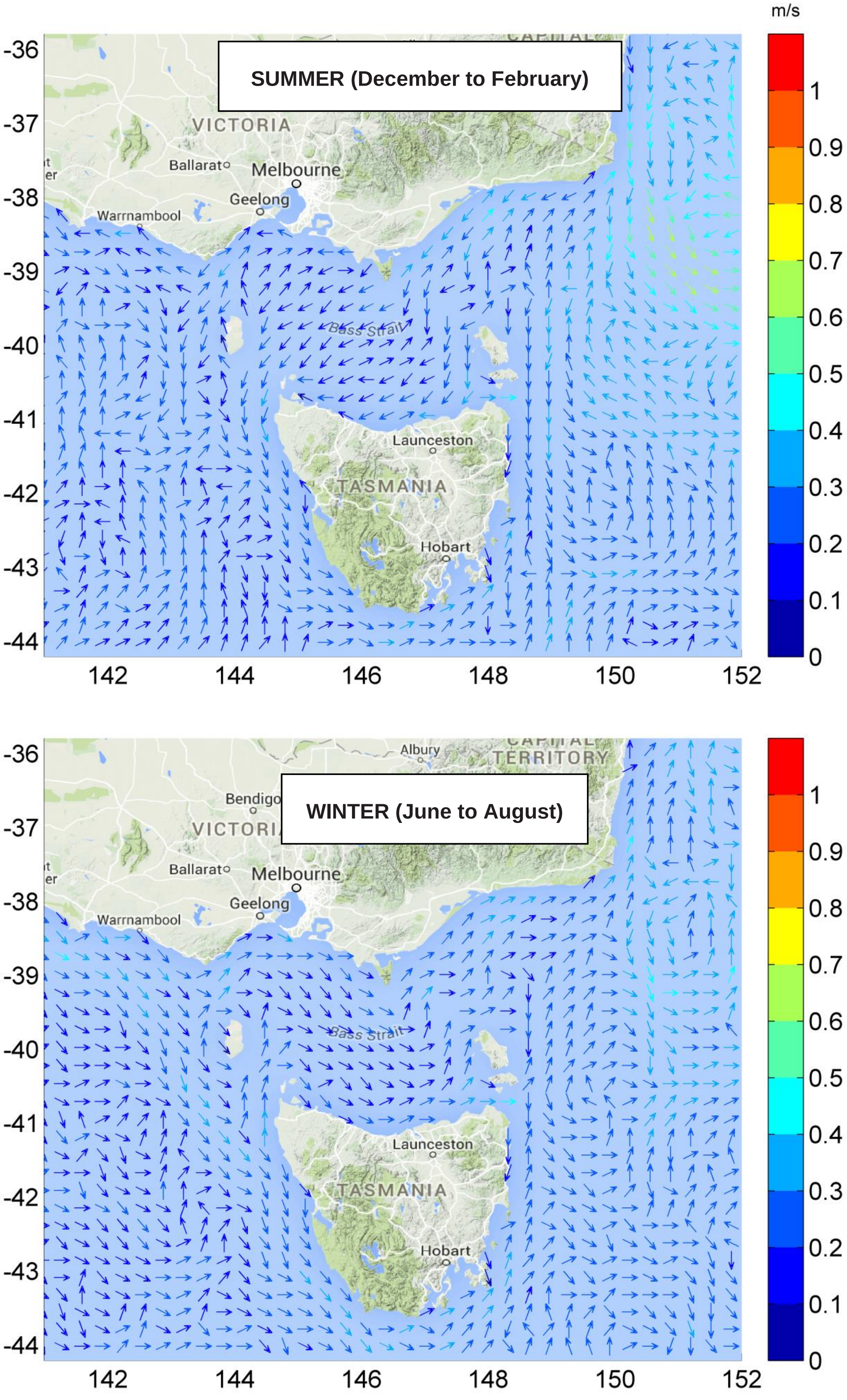


Figure 4-1 HYCOM averaged seasonal surface drift currents during summer and winter.

4.1.1.2 Ocean Circulation Model

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

For this study, the HYCOM hindcast currents were obtained for the years 2008 to 2017 (inclusive).

4.1.1.3 Tidal Circulation Model

4.1.1.3.1 Description of Tidal Model: HYDROMAP

Tidal current data was generated using RPS's advanced ocean/coastal model, HYDROMAP. The HYDROMAP model has been thoroughly tested and verified through field measurements throughout the world for over 30 years (Isaji & Spaulding, 1984; Isaji, et al., 2001; Zigic, et al., 2003). HYDROMAP tidal current data has been used as input to forecast (in the future) and hindcast (in the past) pollutant spills in Australian waters and forms part of the Australian National Oil Spill Emergency Response System operated by AMSA (Australian Maritime Safety Authority).

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

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

4.1.1.3.2 Model Grid Setup

The tidal model domain has been sub-gridded to a resolution of 500 m for shallow and coastal regions, starting from an offshore (or deep water) resolution of 8 km. The finer grids were allocated in a step-wise fashion to more accurately resolve flows along the coastline, around islands and over regions with more complex bathymetry. Figure 4-2 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 4-3). 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).

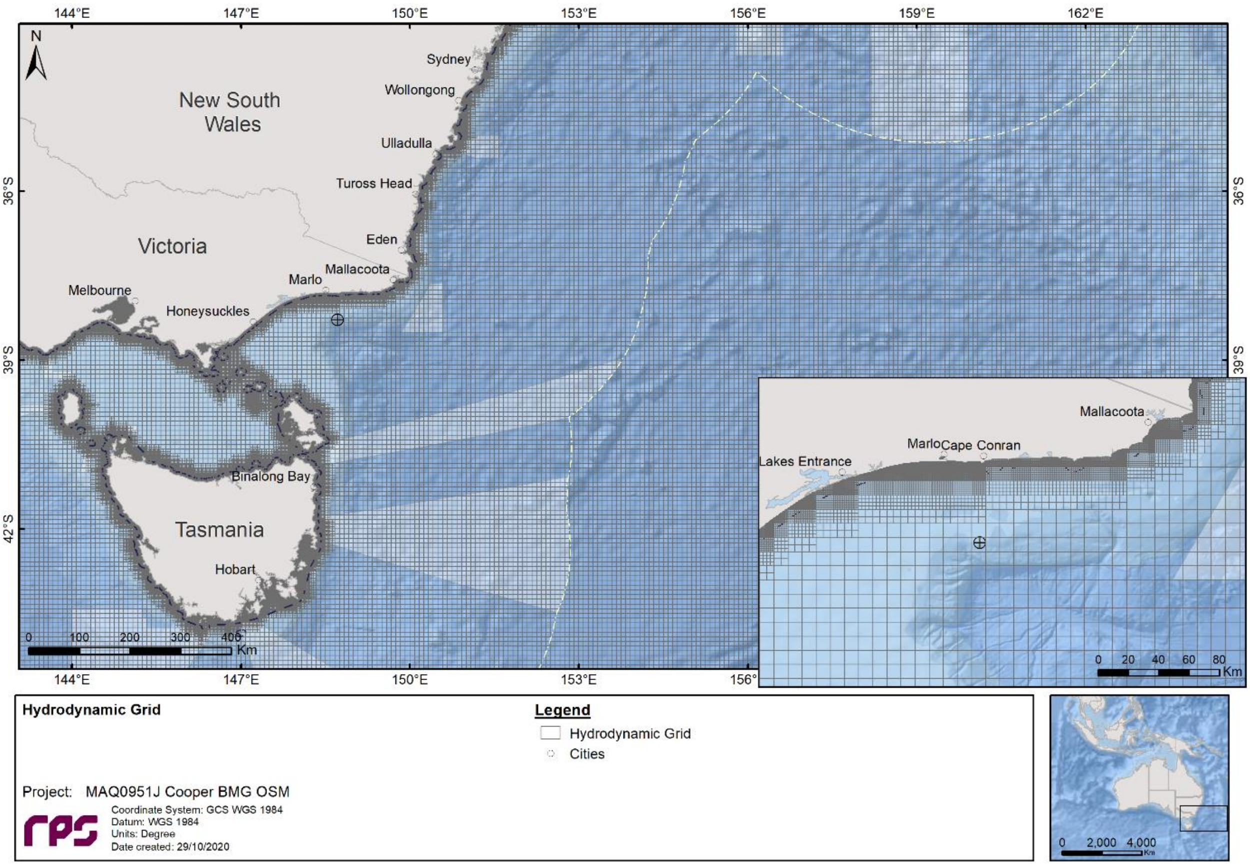


Figure 4-2 Map showing the regions of sub-gridding for the study area.

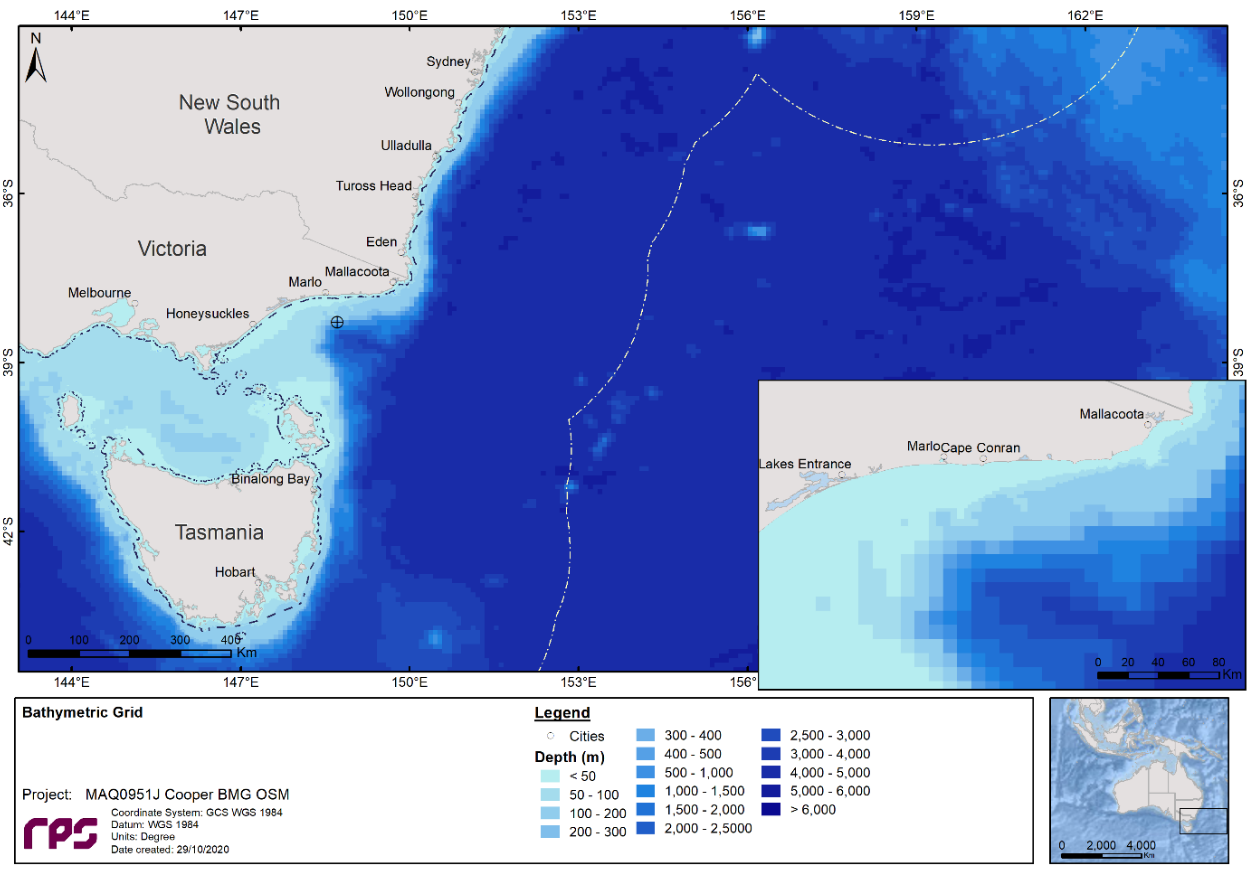


Figure 4-3 Bathymetry defined throughout the tidal model domain.

4.1.1.3.3 Model Boundary Conditions

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

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

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

4.1.1.3.4 Tidal Elevation Validation

To ensure that tidal predictions were accurate, predicted surface elevations were compared to data observed at several locations (see Table 4-1).

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

The MAE (Eq.1) is 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} = Obsrved surface elevation

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

Figure 4-5and Figure 4-6 illustrate a comparison of the predicted and observed surface elevations for each location for January 2014. As shown on the graph, the model accurately reproduced the phase and amplitudes throughout the spring and neap tidal cycles.

Table 4-1 Statistical comparison between the observed and predicted surface elevations.

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

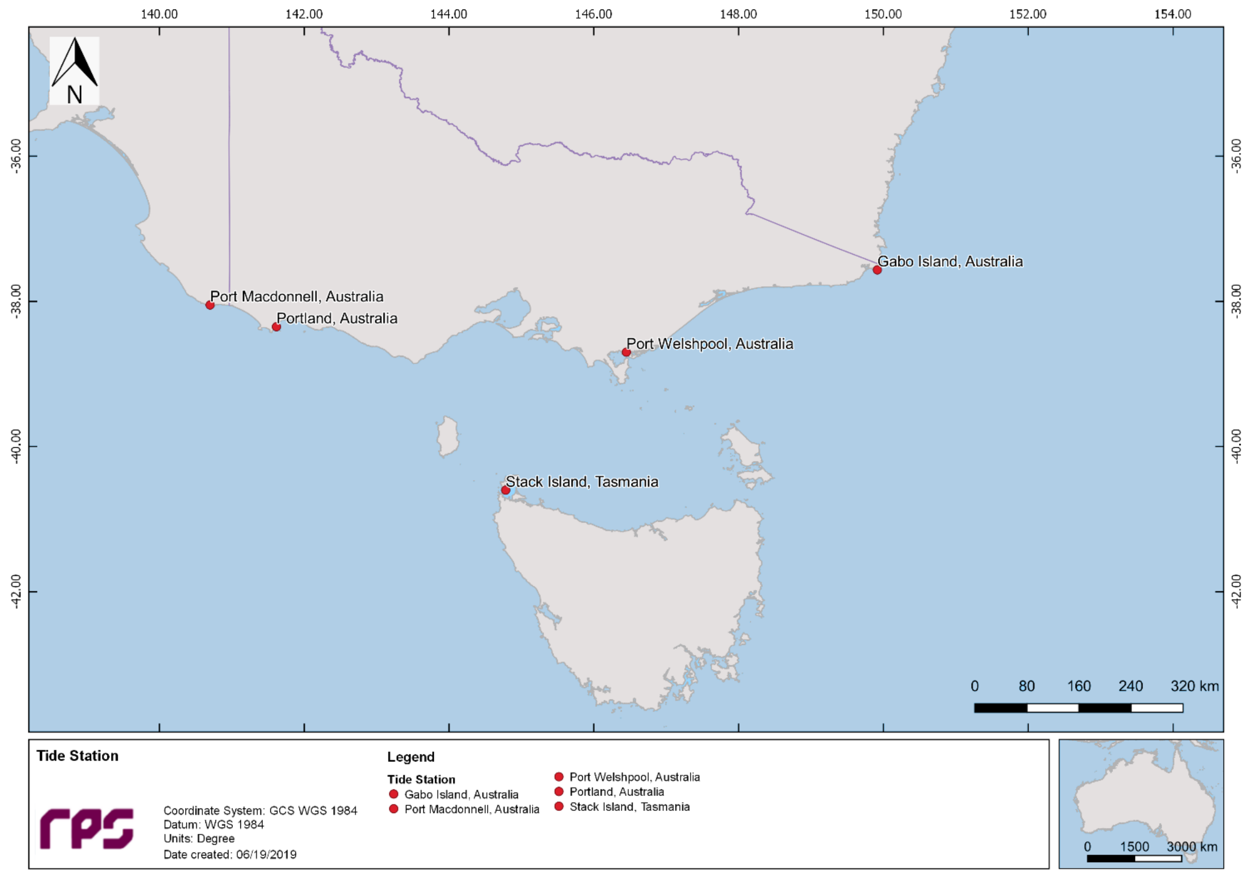


Figure 4-4 Tide stations used to validate surface elevations within the model.

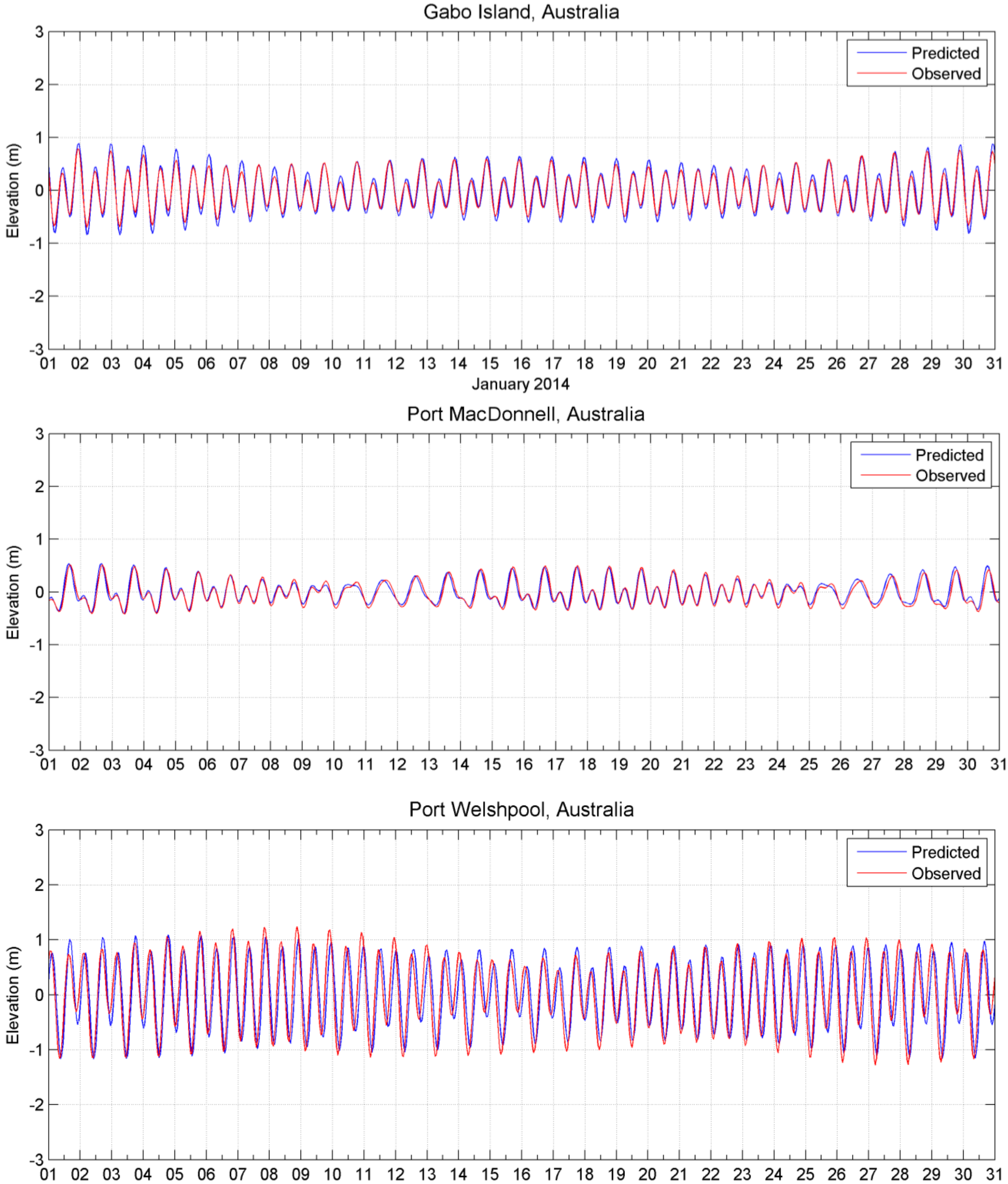


Figure 4-5 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevations.

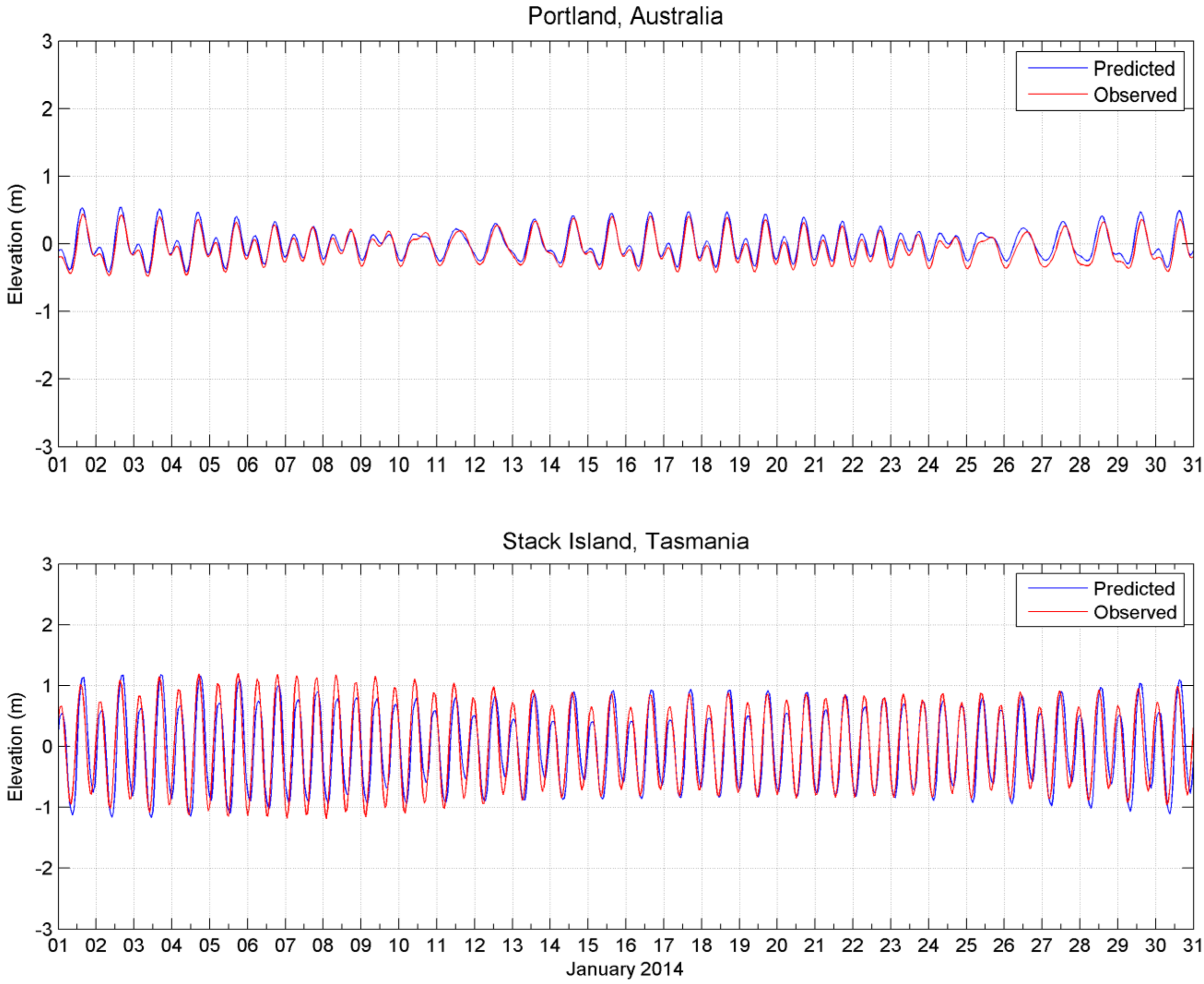


Figure 4-6 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevations.

4.1.1.4 Currents nearby the Release Locations

Table 4-2 to Table 4-5 display the predicted average and maximum current speed near Scenario 1 (B2) and Scenario 2 (M2A) release locations, at the surface and throughout the water column (i.e. 10 m, 20 m and 50 m), respectively. Figure 4-7 to Figure 4-14 illustrate the monthly and total current rose distributions (2008-2017 inclusive) for each depth layer, respectively, derived by combining the large-scale ocean current data (HYCOM) and tidal data (HYDROMAP) near the release locations.

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

The surface currents generally flow in northeast to southwest axis with different intensities depending on the month. The average current speed ranged between 0.18 m/s and 0.24 m/s while maximum current speeds ranged between 0.59 m/s (December) and 0.96 m/s (March).

Table 4-2 Predicted monthly average and maximum surface current speeds close to the B2 and M2A release locations. Data derived by combining the HYCOM ocean data and HYDROMAP high resolution tidal data from 2008-2017 (inclusive).

Season	Month	Average current speed (m/s)	Maximum current speed (m/s)	General direction (towards)
Summer	January	0.22	0.82	Northeast
	February	0.22	0.82	Northeast
	March	0.21	0.96	Northeast
	April	0.19	0.79	Northeast
Winter	May	0.24	0.90	Northeast
	June	0.21	0.81	Variable
	July	0.18	0.87	Variable
	August	0.21	0.82	Variable
	September	0.21	0.81	Variable
Summer	October	0.18	0.69	Northeast
	November	0.20	0.85	Northeast
	December	0.21	0.59	Northeast
	Minimum	0.18	0.59	
	Maximum	0.24	0.96	

Table 4-3 Predicted monthly average and maximum current speeds close to the B2 and M2A release locations, at 10 m below sea surface. Data derived by combining the HYCOM ocean data and HYDROMAP high resolution tidal data from 2008-2017 (inclusive).

Season	Month	Average current speed (m/s)	Maximum current speed (m/s)	General direction (towards)
Summer	January	0.16	0.70	Northeast
	February	0.17	0.65	Northeast
	March	0.16	0.71	Northeast
	April	0.15	0.51	Northeast
Winter	May	0.17	0.66	Northeast
	June	0.15	0.67	Variable
	July	0.13	0.51	Variable
	August	0.16	0.76	Variable
	September	0.15	0.54	Variable
Summer	October	0.12	0.46	Northeast
	November	0.14	0.53	Northeast
	December	0.15	0.45	Northeast
	Minimum	0.12	0.45	
	Maximum	0.17	0.76	

Table 4-4 Predicted monthly average and maximum current speeds close to the B2 and M2A release locations, at 20 m below sea surface. Data derived by combining the HYCOM ocean data and HYDROMAP high resolution tidal data from 2008-2017 (inclusive).

Season	Month	Average current speed (m/s)	Maximum current speed (m/s)	General direction (towards)
Summer	January	0.15	0.62	Northeast
	February	0.16	0.60	Northeast
	March	0.15	0.65	Northeast
	April	0.14	0.44	Northeast
Winter	May	0.16	0.60	Northeast
	June	0.14	0.67	Variable
	July	0.12	0.46	Variable
	August	0.15	0.72	Variable
	September	0.15	0.50	Variable
Summer	October	0.12	0.47	Northeast
	November	0.13	0.46	Northeast
	December	0.14	0.44	Northeast
	Minimum	0.12	0.44	
	Maximum	0.16	0.72	

Table 4-5 Predicted monthly average and maximum current speeds close to the B2 and M2A release locations, at 50 m below sea surface. Data derived by combining the HYCOM ocean data and HYDROMAP high resolution tidal data from 2008-2017 (inclusive).

Season	Month	Average current speed (m/s)	Maximum current speed (m/s)	General direction (towards)
Summer	January	0.14	0.60	Northeast
	February	0.13	0.39	Northeast
	March	0.13	0.50	Northeast
	April	0.14	0.45	Northeast
Winter	May	0.15	0.52	Northeast
	June	0.12	0.65	Variable
	July	0.10	0.40	Variable
	August	0.13	0.46	Variable
	September	0.13	0.47	Variable
Summer	October	0.10	0.47	Northeast
	November	0.11	0.38	Northeast
	December	0.13	0.38	Northeast
	Minimum	0.10	0.38	
	Maximum	0.15	0.65	

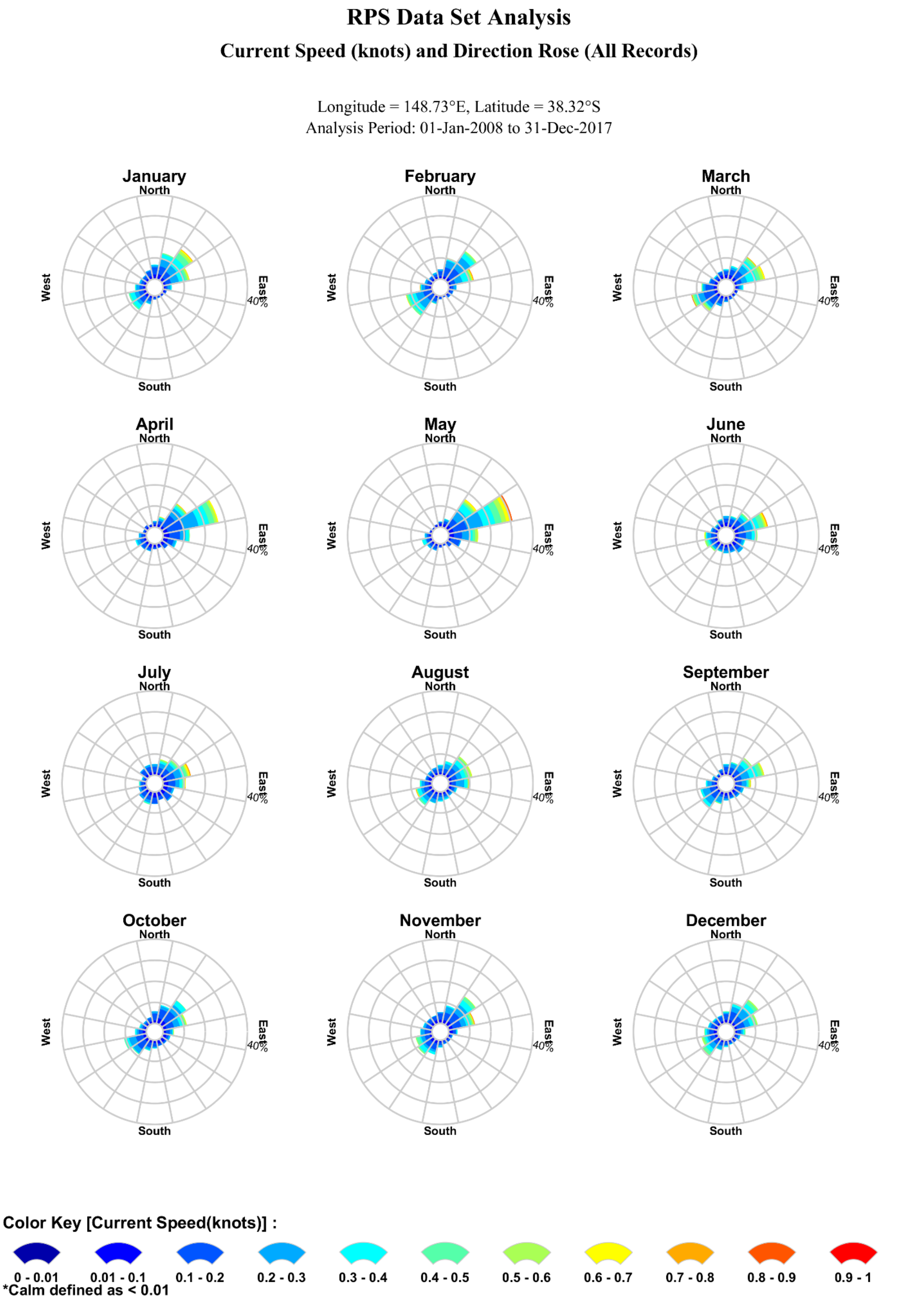


Figure 4-7 Monthly surface current rose plots near the B2 and M2A release locations (derived by combining the HYDROMAP and HYCOM ocean currents for 2008-2017; inclusive).

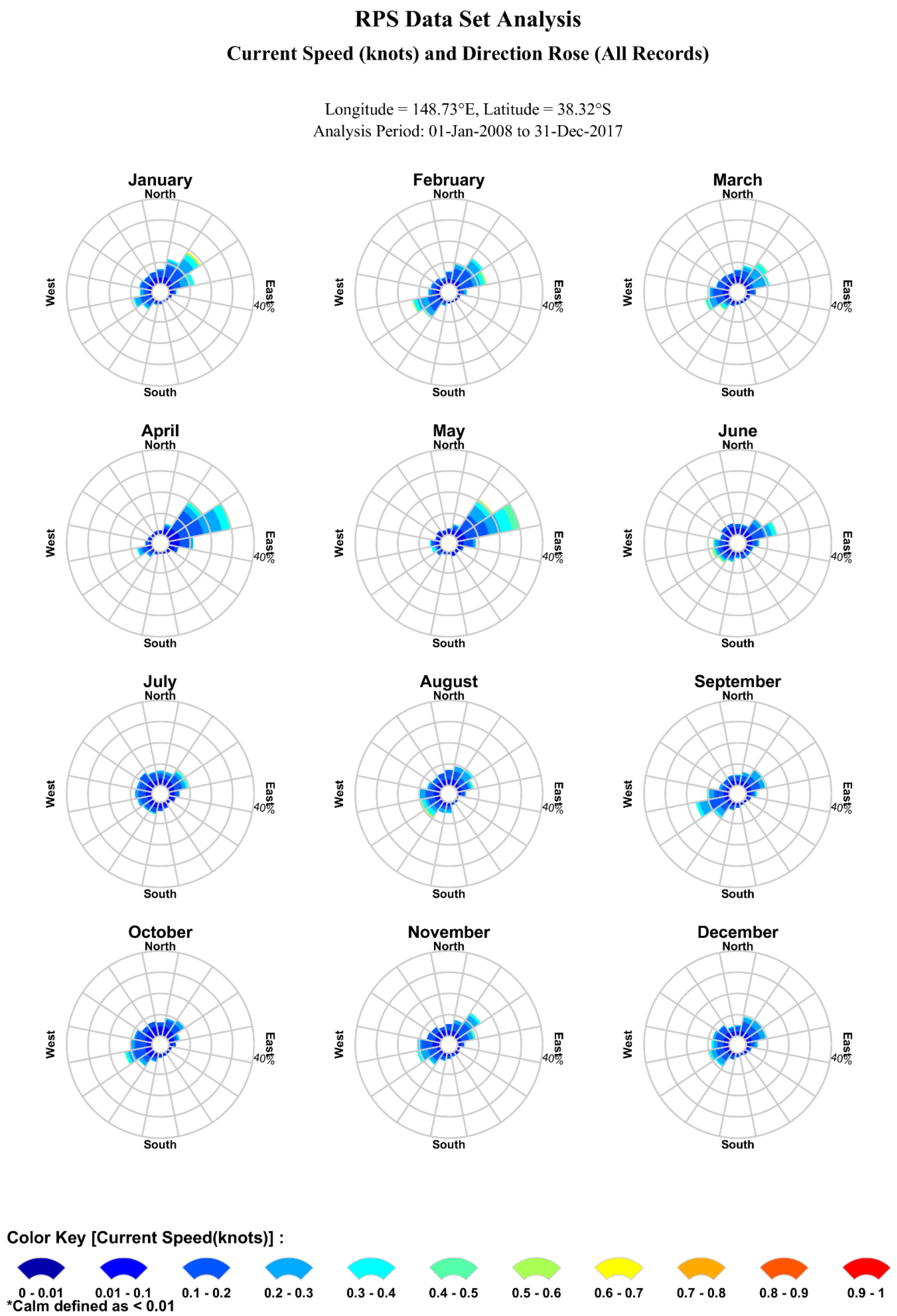


Figure 4-8 Monthly current rose plots near the B2 and M2A release locations, in the 10 m depth layer (derived by combining the HYDROMAP and HYCOM ocean currents for 2008-2017; inclusive).

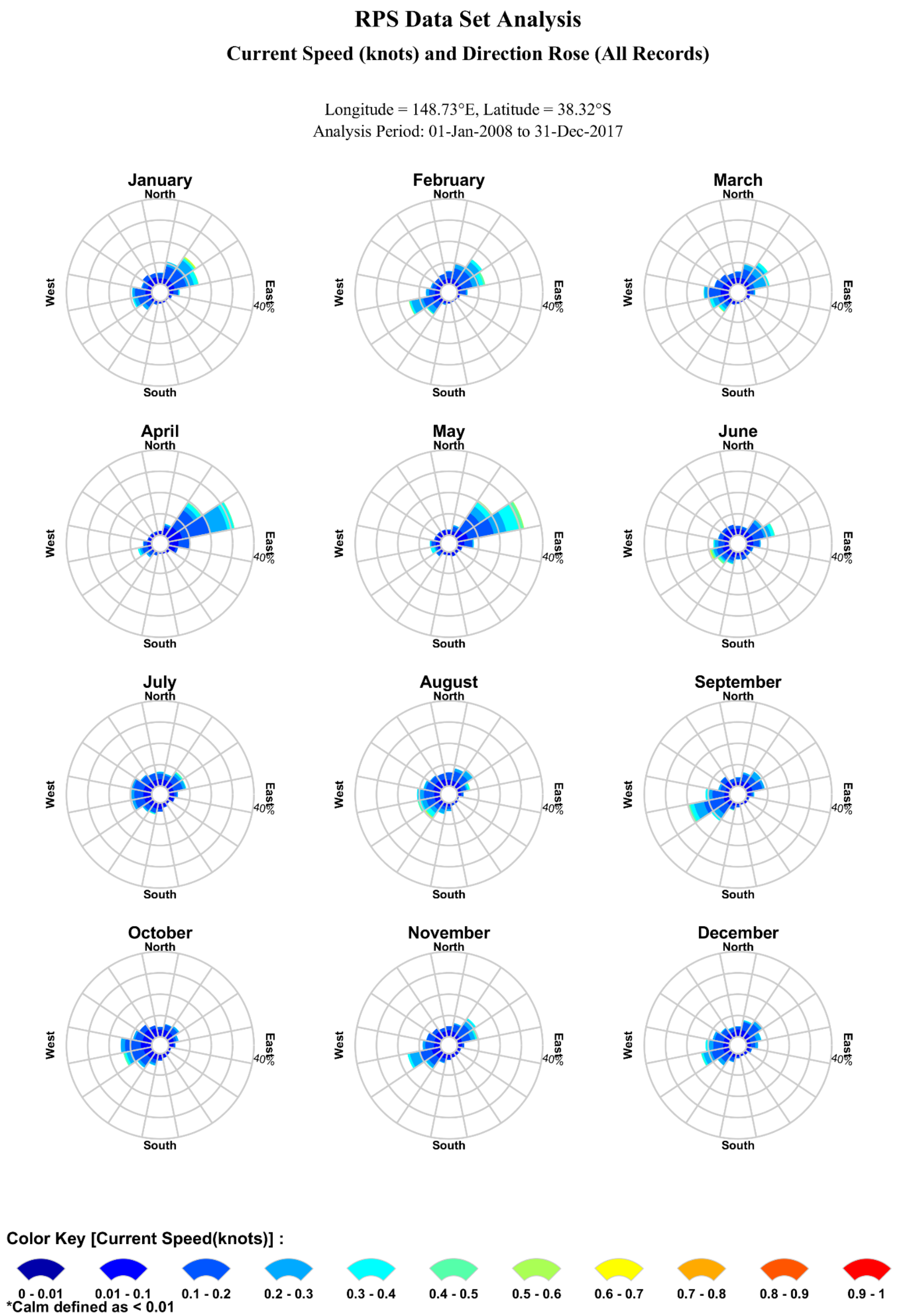


Figure 4-9 Monthly current rose plots near the B2 and M2A release locations, in the 20 m depth layer (derived by combining the HYDROMAP and HYCOM ocean currents for 2008-2017; inclusive).

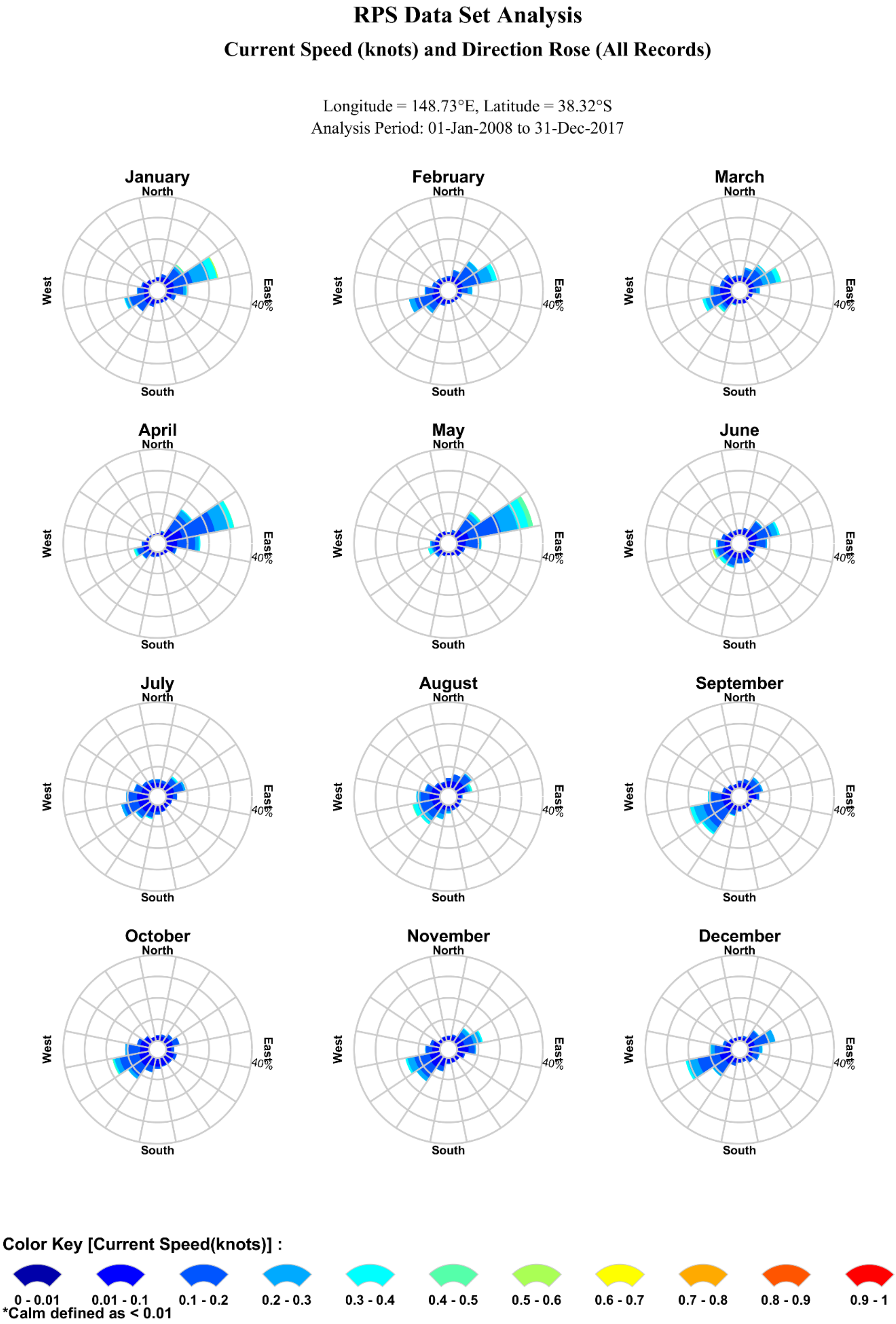


Figure 4-10 Monthly current rose plots near the B2 and M2A release locations, in the 50 m depth layer below sea surface (derived by combining the HYDROMAP and HYCOM ocean currents for 2008-2017; inclusive).

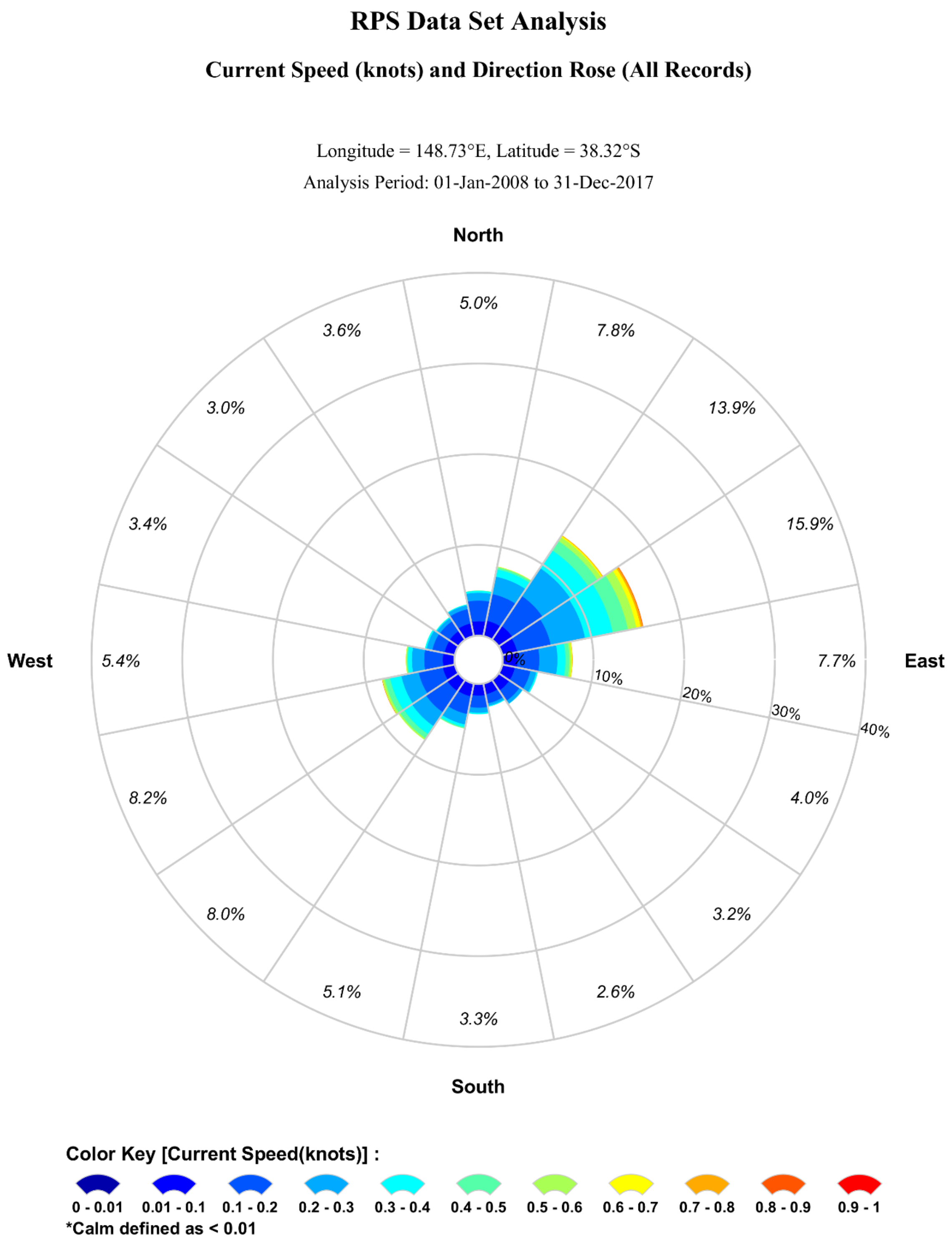


Figure 4-11 Total surface rose plots near the B2 and M2A release locations (derived by combining the HYDROMAP and HYCOM ocean currents for 2008-2017; inclusive).

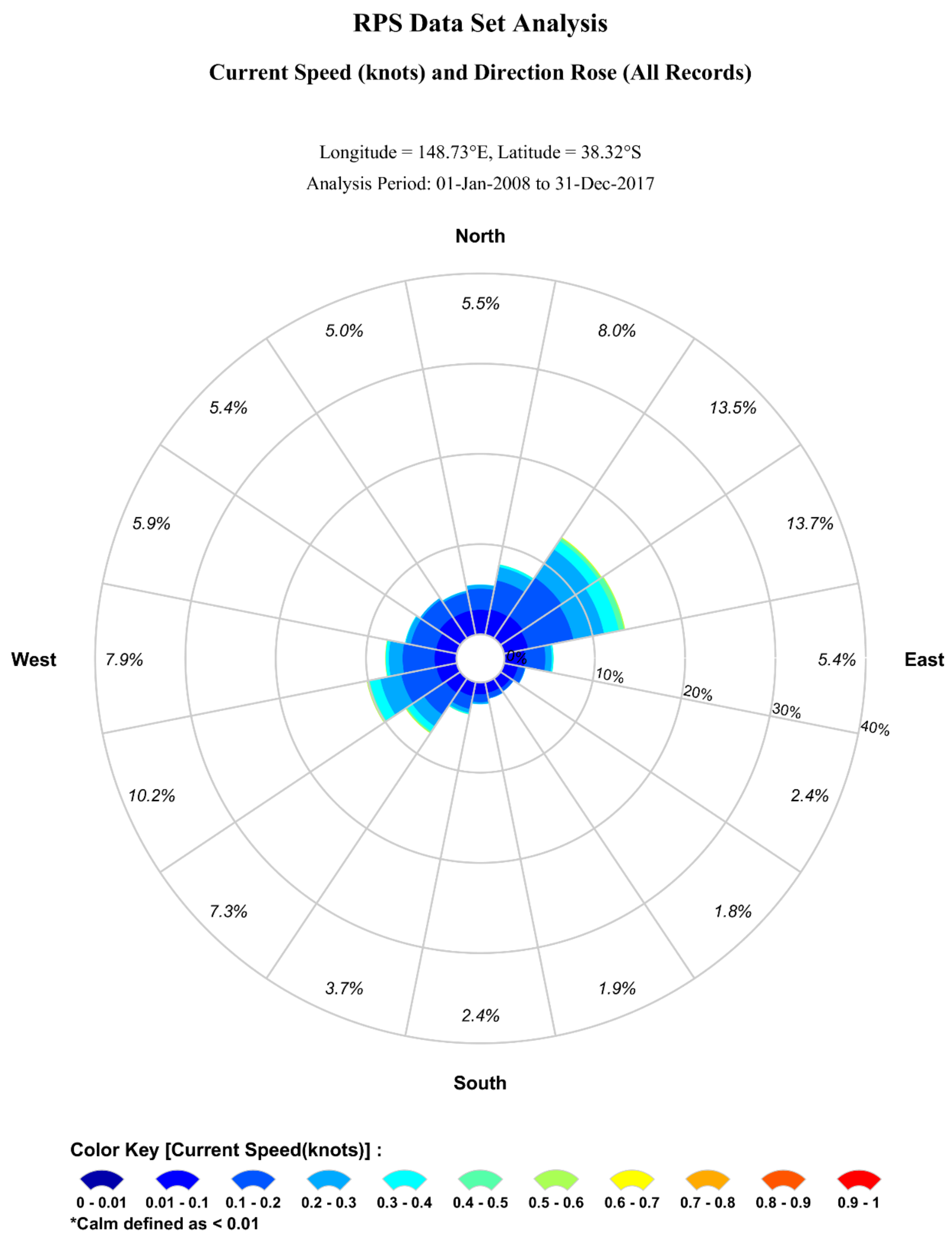


Figure 4-12 Total rose plots near the B2 and M2A release locations, in the 10 m depth layer (derived by combining the HYDROMAP and HYCOM ocean currents for 2008-2017; inclusive).

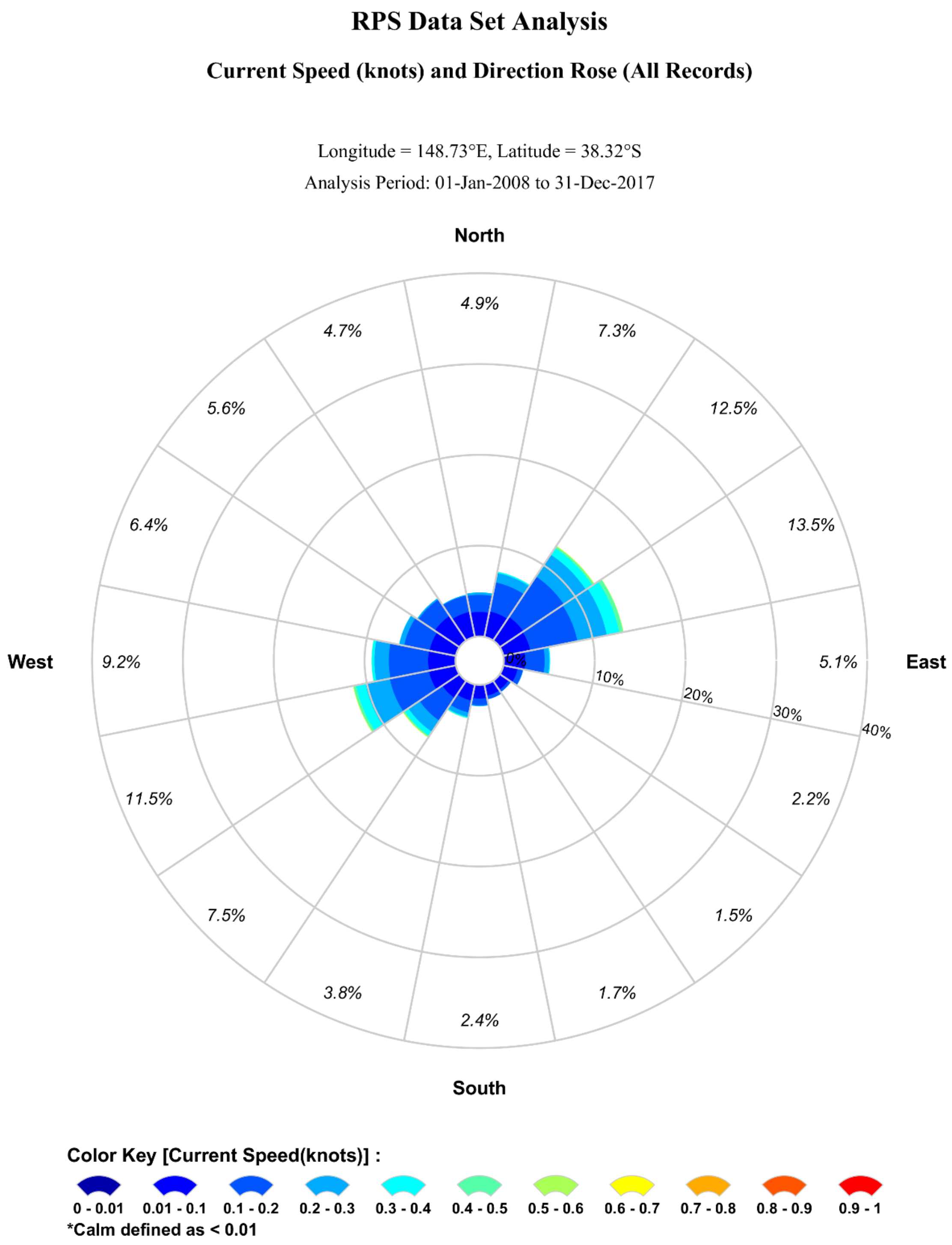


Figure 4-13 Total rose plots near the B2 and M2A release locations, in the 20 m depth layer (derived by combining the HYDROMAP and HYCOM ocean currents for 2008-2017; inclusive).

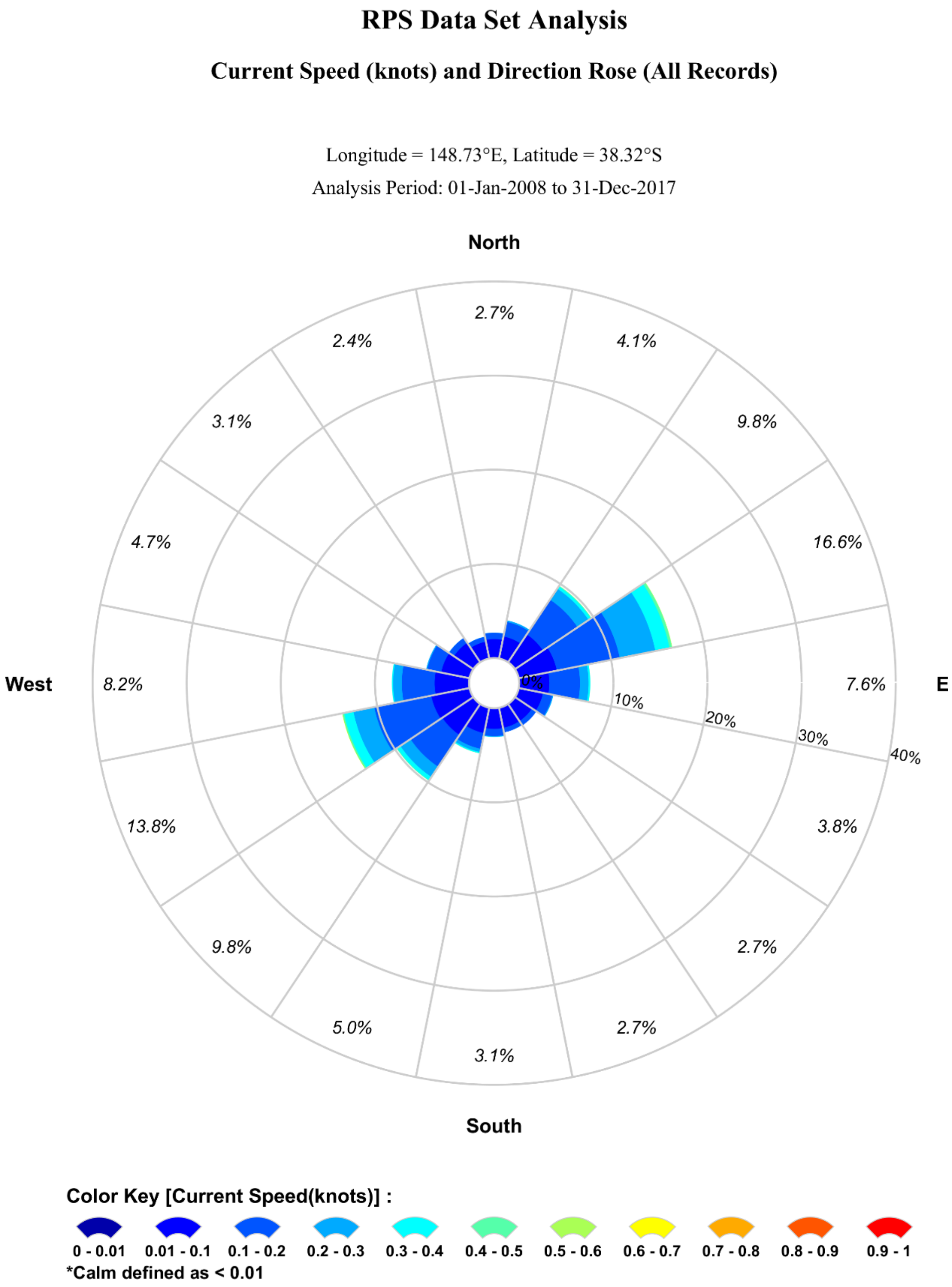


Figure 4-14 Total rose plots near the B2 and M2A release locations, in the 50 m depth layer (derived by combining the HYDROMAP and HYCOM ocean currents for 2008-2017; inclusive).

4.1.2 Wind Data

High resolution wind data from 2008 to 2017 (inclusive) was sourced from the National Centre for Environmental Prediction (NCEP) Climate Forecast System Reanalysis (CFSR; see Saha et al., 2010). The CFSR wind model includes observations from many data sources; surface observations, upper-atmosphere air balloon observations, aircraft observations and satellite observations. The model is capable of accurately representing the interaction between the earth's oceans, land and atmosphere. The gridded wind data output is available at ¼ of a degree resolution (~33 km) and 1-hourly time intervals. Figure 4.1 shows the spatial resolution of the wind field used as input into the oil spill model.

Table 4-6 shows the monthly average and maximum winds derived from the CFSR node located near the B2 and M2A release locations. Figure 4-16 and Figure 4-17 illustrate the monthly and total wind rose distributions for the selected CFSR wind node, respectively.

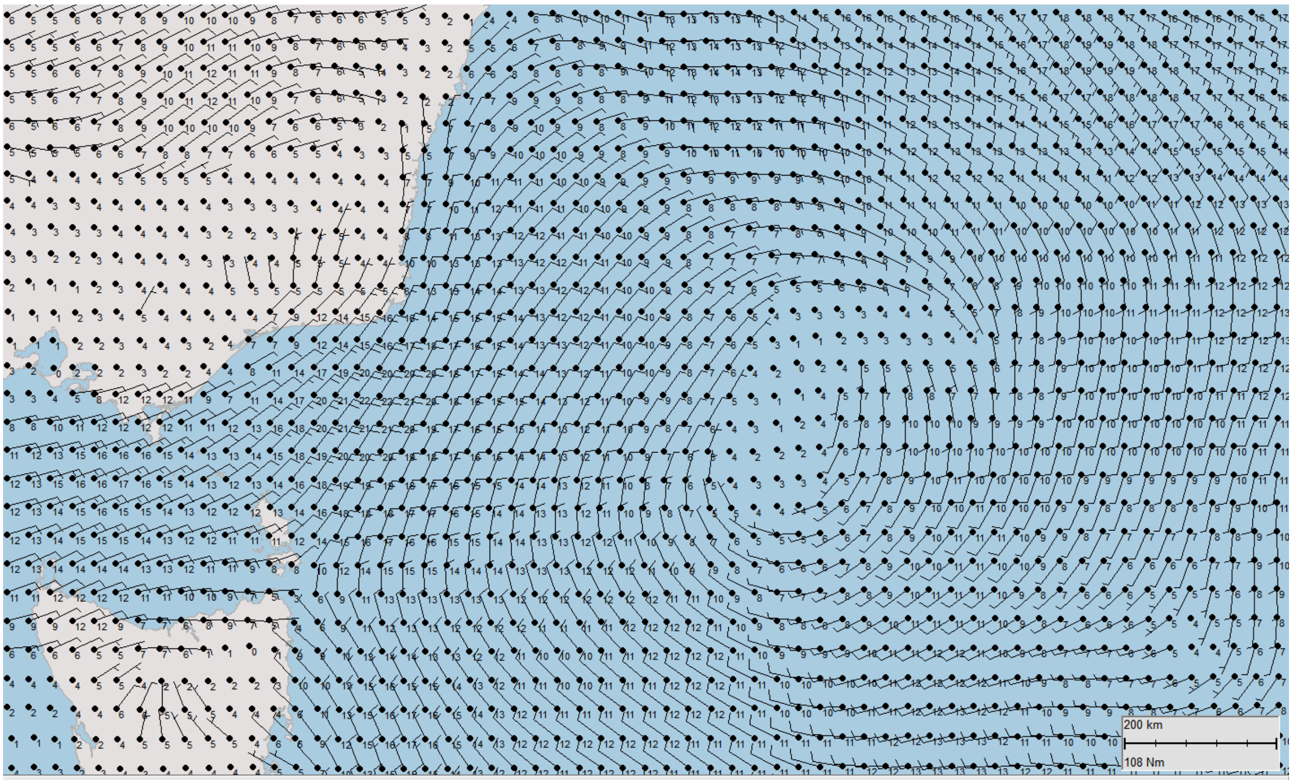


Figure 4-15 Spatial resolution of the CFSR modelled wind data used as input into the oil spill model.

Note that the atmospheric convention for defining wind direction, that is, the direction the wind blows from, is used to reference wind direction throughout this report. Each branch of the rose represents wind coming from that direction, with north to the top of the diagram. Sixteen directions are used. The branches are divided into segments of different colour, which represent wind speed ranges from that direction. Speed ranges of 5 knot intervals, are 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.

The model wind data demonstrated that this region typically experiences moderate to strong winds all year round and although the monthly average wind speeds remain under 16 knots, winds can at times blow over 52 knots at the release location. Winds in the region typically blow from the southwest during the summer months and west-southwest during the winter months.

Table 4-6 Predicted average and maximum winds for the wind node closest to the B2 and M2A release locations. Data derived from CFSR hindcast model 2008 to 2017 (inclusive).

Season	Month	Average wind (knots)	Maximum wind (knots)	General direction (from)
Summer	January	15	42	Southwest
	February	15	42	Southwest
	March	14	47	Southwest
	April	14	47	Southwest
Winter	May	16	44	West
	June	16	50	West
	July	16	47	West
	August	16	44	West
	September	16	51	West
Summer	October	15	40	Southwest
	November	15	48	Southwest
	December	15	52	Southwest
	Minimum	**14**	**40**	
	Maximum	**16**	**52**	

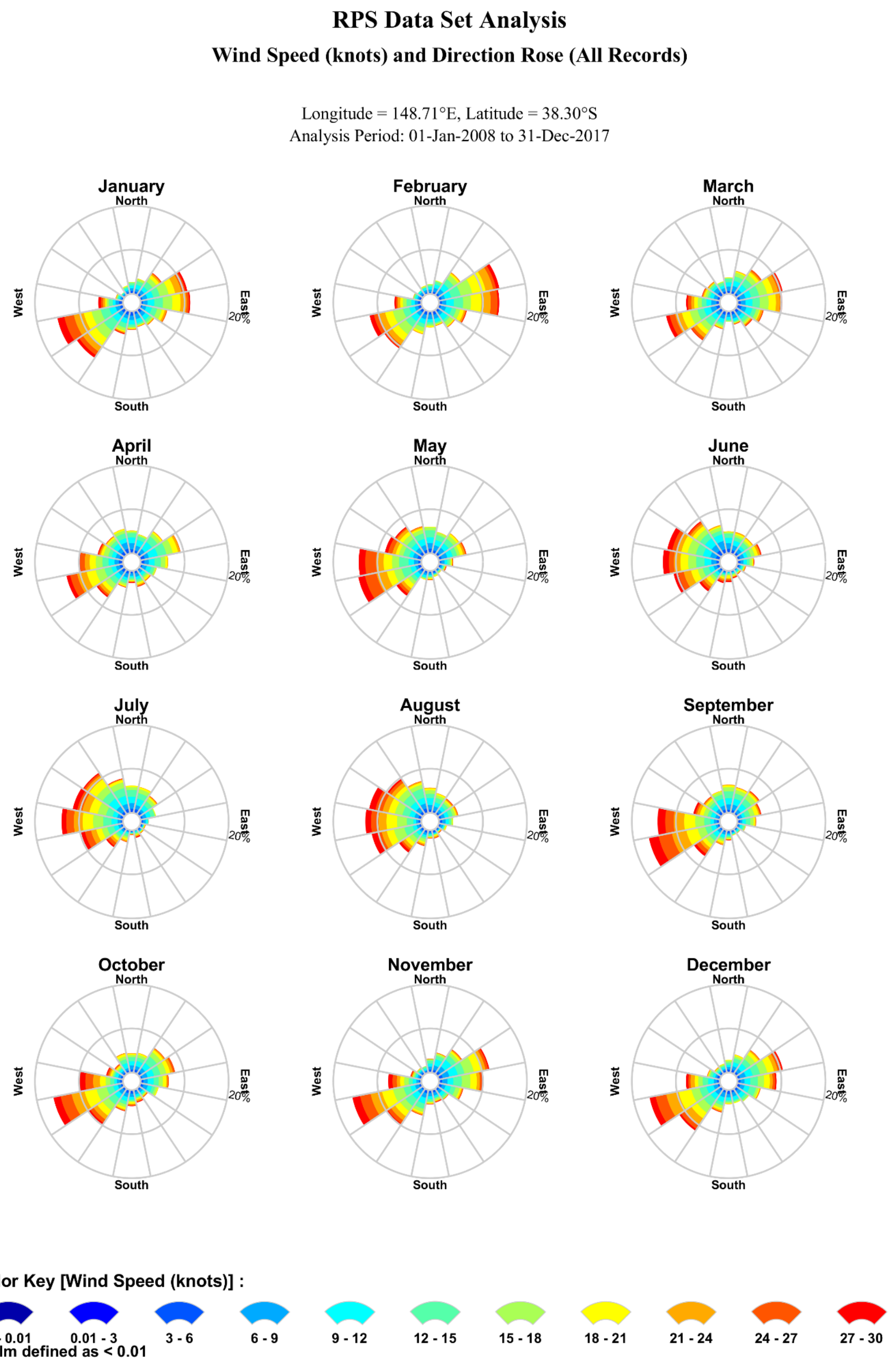


Figure 4-16 Monthly wind rose distributions derived from CFSR model from 2008 to 2017 (inclusive), for the wind node closest to the B2 and M2A release locations.

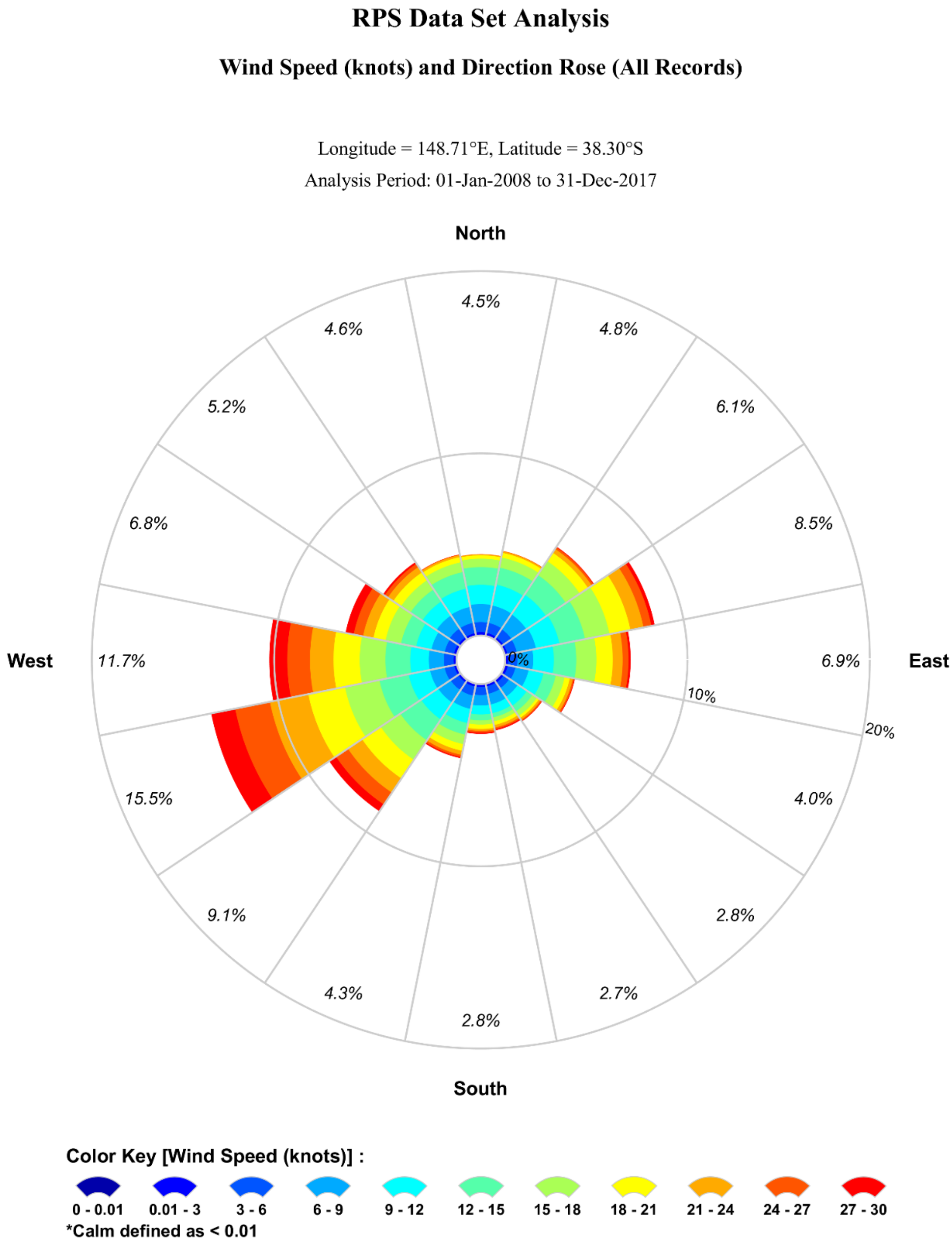


Figure 4-17 Total wind rose distribution derived from the CFSR model from 2008 to 2017 (inclusive), for the wind node closest to the B2 and M2A release locations.

4.1.3 Water Temperature and Salinity Data

The monthly depth-varying water temperature and salinity profiles at 5 m intervals nearest to the release locations was obtained from the World Ocean Atlas 2013 database produced by the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Information (formerly the National Oceanographic Data Centre) (see Levitus et al., 2013) (refer to Figure 4-18). The data is used in the oil spill model to inform the weathering, movement and evaporative loss of hydrocarbon spills in the surface and subsurface layers.

Table 4-7 details the monthly average sea surface temperatures and salinity (from the 0-5 m depth layer) nearest to the B2 and M2A release locations. Monthly average sea surface temperatures were shown to range from 14.1°C (September) to 20.5°C (March). Salinity remained consistent throughout the year between 35.4-35.6 psu.

Table 4-7 Monthly average sea surface temperature and salinity near the B2 and M2A release locations in the 0-5 m depth layer.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Temperature (°C)	19.0	20.2	20.5	19.0	17.3	16.6	14.3	14.6	14.1	15.0	16.6	17.6
Salinity (psu)	35.5	35.5	35.6	35.6	35.4	35.5	35.5	35.5	35.4	35.5	35.4	35.4

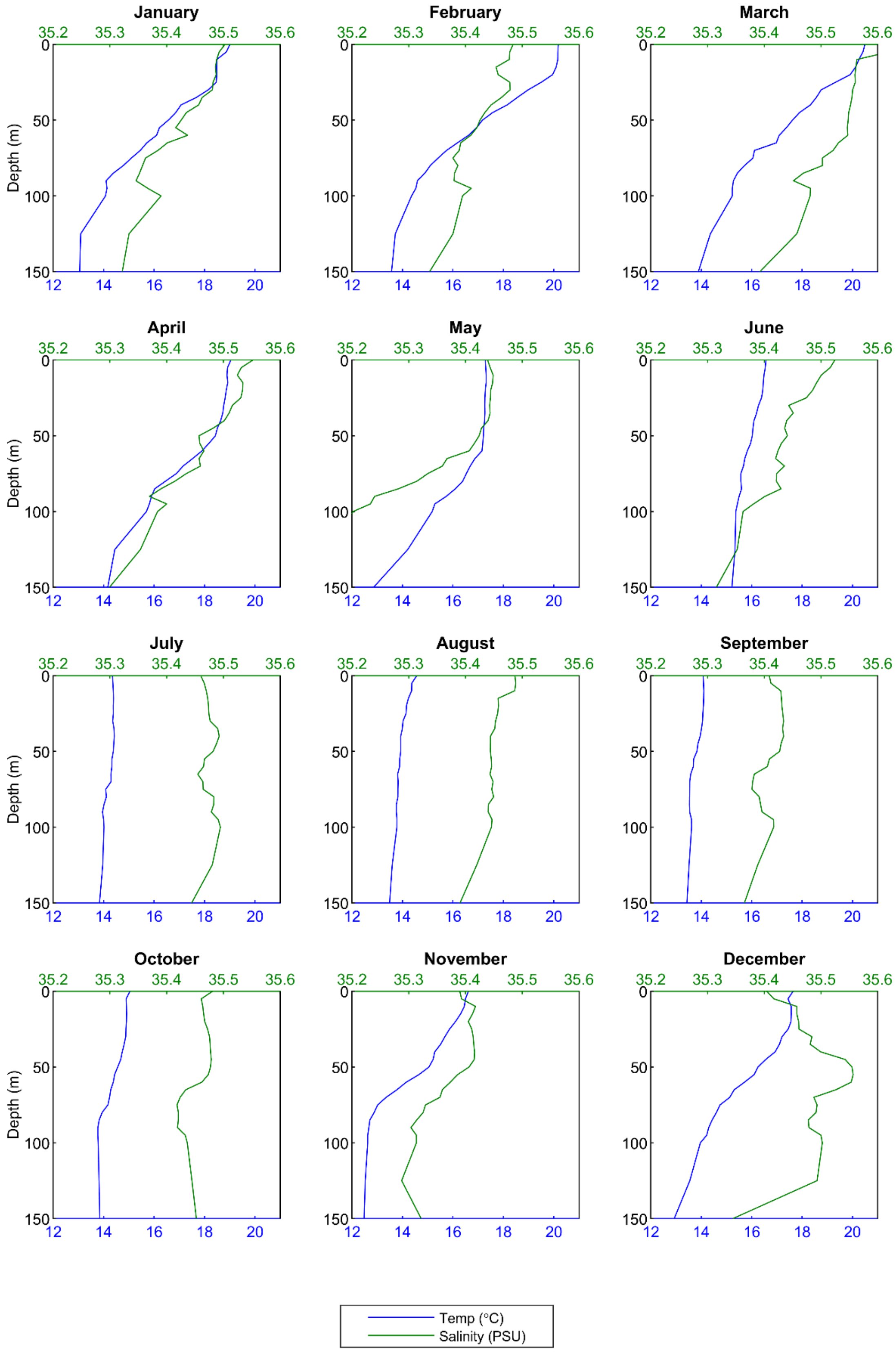


Figure 4-18 Monthly temperature and salinity profiles throughout the water column near the B2 and M2A release locations.

5 NEAR-FIELD MODEL – OILMAP DEEP

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

The model simulates the plume rise dynamics in two phases, the initial jet phase and the buoyant plume phase. The initial jet phase governs the plume dynamics directly above the subsurface release location and is predominately driven by the exit velocity. During this phase, the hydrocarbon 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 condensate droplets.

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

Table 5-1 presents the input parameters for the OILMAP-DEEP model and key results related to the near-field plume dynamics. The near-field modelling of the Basker 6 LOWC scenario predicted the plume would reach the surface relatively quickly with no potential trapping at depth. The oil droplets would range from 2,739 µm to 11,831 µm,.

Figure 5-1 illustrates the various stages of an example blowout plume. Note a depleting release rate was used as input into the model, starting with 14,598 bbl/day (2,320 m^3) on day 1 and decreasing to 2,385 bbl/day (379 m^3) on day 120.

Table 5-1 Physical characteristics of the subsea releases and key results for the near-field model OILMAP-DEEP.

Input Variable	Value
Scenario	Scenario 1
Well name	Basker 6
Water depth (m)	153
Tubing diameter (inch) [m]	4.5 [0.11]
Oil rate (stb/day)	Maximum rate: 14,598 bbl (2,320 m^3) Minimum rate: 2,385 bbl (379 m^3)
Water rate (stb/day)	Average: 3,980 bbl (633 m^3)
Gas rate (scf/day)	Maximum rate: 8,000,000 Minimum rate: 1,900,000
Gas to oil ratio (scf/bbl)	Maximum: 548 Minimum: 237
Reservoir temperature (°C)	114
Release pressure (psia)	4,060
Key Results	
Plume execution depth (m BMSL)	0 (surface)
Droplet sizes (µm)	2,739-11,831

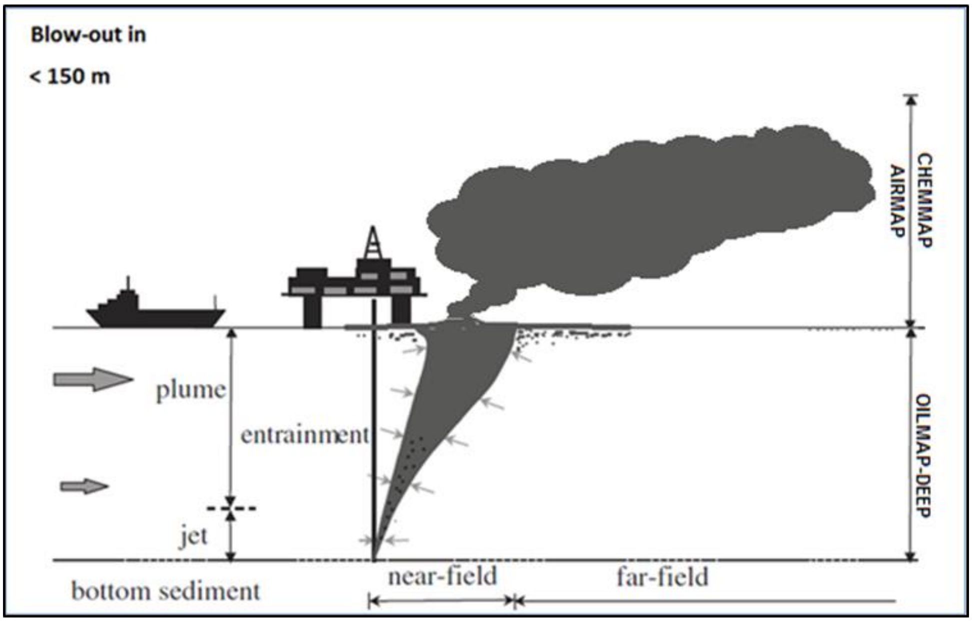


Figure 5-1 Example of a blowout plume illustrating the various stages of the plume in the water column (Source: Applied Science Associates, 2011).

6 OIL SPILL MODEL – SIMAP

The spill modelling was carried out using a purpose-developed oil spill trajectory and fates model, SIMAP (Spill Impact Mapping and Analysis Program). This model is designed to simulate the transport and weathering processes that affect the outcomes of hydrocarbon spills to the sea, accounting for the specific oil type, spill scenario, and prevailing wind and current circulation patterns.

SIMAP is the evolution of the United States Environmental Protection Agency (US EPA) Natural Resource Damage Assessment model (French & Rines, 1997; French, 1998; French et al., 1999) and is designed to simulate the fate and effects of spilled oils and fuels for both the surface slick and the three-dimensional plume that is generated in the water column. SIMAP includes algorithms to account for both physical transport and weathering processes. The latter are important for accounting for the partitioning of the spilled mass over time between the water surface (surface slick), water column (entrained oil and dissolved compounds), atmosphere (evaporated compounds) and land (stranded oil). The model also accounts for the interaction between weathering and transport processes.

The physical algorithms calculate transport and spreading by physical forces, including surface tension, gravity and wind and current forces for both surface slicks and oil within the water column. The fates algorithms calculate all the weathering processes known to be important for oil spilled to marine waters. These include droplet and slick formation, entrainment by wave action, emulsification, dissolution of soluble components, sedimentation, evaporation, bacterial and photo-chemical decay and shoreline interactions. These algorithms account for the specific oil type being considered.

Entrainment is the physical process where globules of oil are transported from the sea surface into the water column by wind and wave-induced turbulence or be generated subsea by a pressurised discharge at depth. It has been observed that entrained oil is broken into droplets of varying sizes. Small droplets spread and diffuse into the water column, while larger ones rise rapidly back to the surface (Delvigne & Sweeney, 1988; Delvigne, 1991).

Dissolution is the process by which soluble hydrocarbons enter the water from a surface slick or from entrained droplets. The lower molecular weight hydrocarbons tend to be both more volatile and more soluble than those of higher molecular weight.

The formation of water-in-oil emulsions, or mousse, which is termed ‘emulsification’, depends on oil composition and sea state. Emulsified oil can contain as much as 80% water in the form of micrometre-sized droplets dispersed within a continuous phase of oil (Daling & Brandvik, 1991; Bobra, 1991; Daling et al., 1997; Fingas, 1995; 1997).

Evaporation can result in the transfer of large proportions of spilled oil from the sea surface to the atmosphere, depending on the type of oil (Gundlach & Boehm, 1981).

Evaporation rates vary over space and time dependent on the prevailing sea temperatures, wind and current speeds, the surface area of the slick and entrained droplets that are exposed to the atmosphere as well as the state of weathering of the oil. Evaporation rates will decrease over time, depending on the calculated rate of loss of the more volatile compounds. By this process, the model can differentiate between the fates of different oil types.

Decay (degradation) of hydrocarbons may occur as the result of photolysis, which is a chemical process energised by ultraviolet light form the sun, and by biological breakdown, termed biodegradation. Many types of marine organisms ingest, metabolise and utilise oil as a carbon source, producing carbon dioxide and water as by-products.

Many types of marine organisms ingest, metabolise and utilise oil as a carbon source, producing carbon dioxide and water as by-products. The biodegradable portion of various crude oils range from 11 to 90% (NRC, 1985, 1989).

Entrainment, dissolution and emulsification rates are correlated to wave energy, which is accounted for by estimating wave heights from the sustained wind speed, direction and fetch (i.e. distance downwind from land barriers) at different locations in the domain. Dissolution rates are dependent upon the proportion of soluble, short-chained hydrocarbon compounds, and the surface area at the oil/water interface of slicks.

Dissolution rates are also strongly affected by the level of turbulence. For example, dissolution rates will be relatively high at the site of the release for a deep-sea discharge at high pressure.

In contrast, the release of hydrocarbons onto the water surface will not generate high concentrations of soluble compounds. However, subsequent exposure of the surface slick to breaking waves will enhance entrainment of oil into the upper water column as oil droplets, which will enhance dissolution of the soluble components. Because the compounds that have high solubility also have high volatility, the processes of evaporation and dissolution will be in dynamic competition with the balance dictated by the nature of the release and the weather conditions that affect the oil after release. The SIMAP weathering algorithms include terms to represent these dynamic processes. Technical descriptions of the algorithms used in SIMAP and validations against real spill events are provided in French (1998), French et al. (1999) and French-McCay (2004).

Input specifications for oil types include density, viscosity, pour-point, distillation curve (volume of oil distilled off versus temperature) and the aromatic/aliphatic component ratios within given boiling point ranges. The model calculates a distribution of the oil by mass into the following components:

- Surface-bound or floating oil
- Entrained oil (non-dissolved hydrocarbons droplets that are physically entrained by wave action)
- Dissolved hydrocarbons (principally the aromatic and short-chained aliphatic compounds)
- Evaporated hydrocarbons
- Sedimented hydrocarbons
- Decayed hydrocarbons.

6.1 Hydrocarbon Properties

Table 6-1 and Table 6-2 present the physical properties and boiling point ranges of Basker 6ST1 crude oil used for the loss of well control (Scenario 1) and marine diesel oil (MDO) used for the vessel collision (Scenario 2).

Table 6-1 Physical properties of oil types used in this study.

Characteristic	Basker 6ST1 Crude	Marine Diesel Oil (MDO)
Density (kg/m^3)	829.8 (at 15 °C)	829.1 (at 25 °C)
API	45.2	37.6
Dynamic viscosity (cP)	2.8 (at 40 °C)	4 (at 25 °C)
Pour point (°C)	15	-14
Wax content (%)	27.7	-
Hydrocarbon property category	Group II	Group II
Hydrocarbon property classification	Light – Persistent	Light – Persistent

Table 6-2 Boiling point ranges of the oil types used in this study.

Characteristics	Non-Persistent			Persistent
	Volatile (%)	*Semi-volatile (%)*	*Low-volatility (%)*	*Residual (%)*
Boiling point (°C)	*<180*	*180-265*	*265-380*	*>380*
Basker 6ST1 crude	19.4	19.5	20.8	40.3
MDO	6.0	34.6	54.4	5.0

6.1.1 Basker 6ST1 Crude

The oil type used to represent the loss of well control (Scenario 1) was a composite crude (referred to in this report as Basker 6ST1 crude). Basker 6ST1 was derived from a combination of worst-case physical properties that characterised the Basker 2 and Basker 6ST1 crude oils. A detailed summary of Basker 2 and Basker 6ST1 oil data is available in COE (2020).

Basker 6ST1 crude has a density of 829.8 kg/m^3 (API of 45.2), a dynamic viscosity of 2.8 cP (at 25 °C) and a high pour point of 15 °C (when compared to ambient water temperature). This oil is categorised as a group II oil (light-persistent) based on categorisation and classification derived from AMSA (2015a) guidelines. The classification is based on the specific gravity of hydrocarbons in combination with relevant boiling point ranges.

Generally, about 19.4% of the crude mass should evaporate within the first 12 hours (BP < 180 °C); a further 19.5% should evaporate within the first 24 hours (180 °C < BP < 265 °C); and an additional 20.8% should evaporate over several days (265 °C < BP < 380 °C). Approximately 40.3% (by mass) of Basker 6ST1 crude is considered persistent compounds and characterised by a high pour point (above ambient water temperature) and a wax content of 27.7%. This portion of the crude will likely solidify over time to form small waxy flakes as it loses the light end hydrocarbons acting as solvent to the heavier compounds.

Figure 6-1 shows weathering graphs for a 2,321 m^3 subsea release of Basker 6ST1 crude over 24 hours (tracked for 60 days) under three static wind conditions. This volume represents the predicted maximum daily discharge rate which occurred on day 1. The graphs demonstrate that this oil has the capacity to entrain into the water column in the presence of moderate winds (> 10 knots) and can potentially remain entrained for as long as the winds persist. It is also worth noting that regardless of the wind conditions, the maximum portion of hydrocarbons that can be lost to the atmosphere varies between 30% and 50% under moderate and calm wind conditions, respectively.

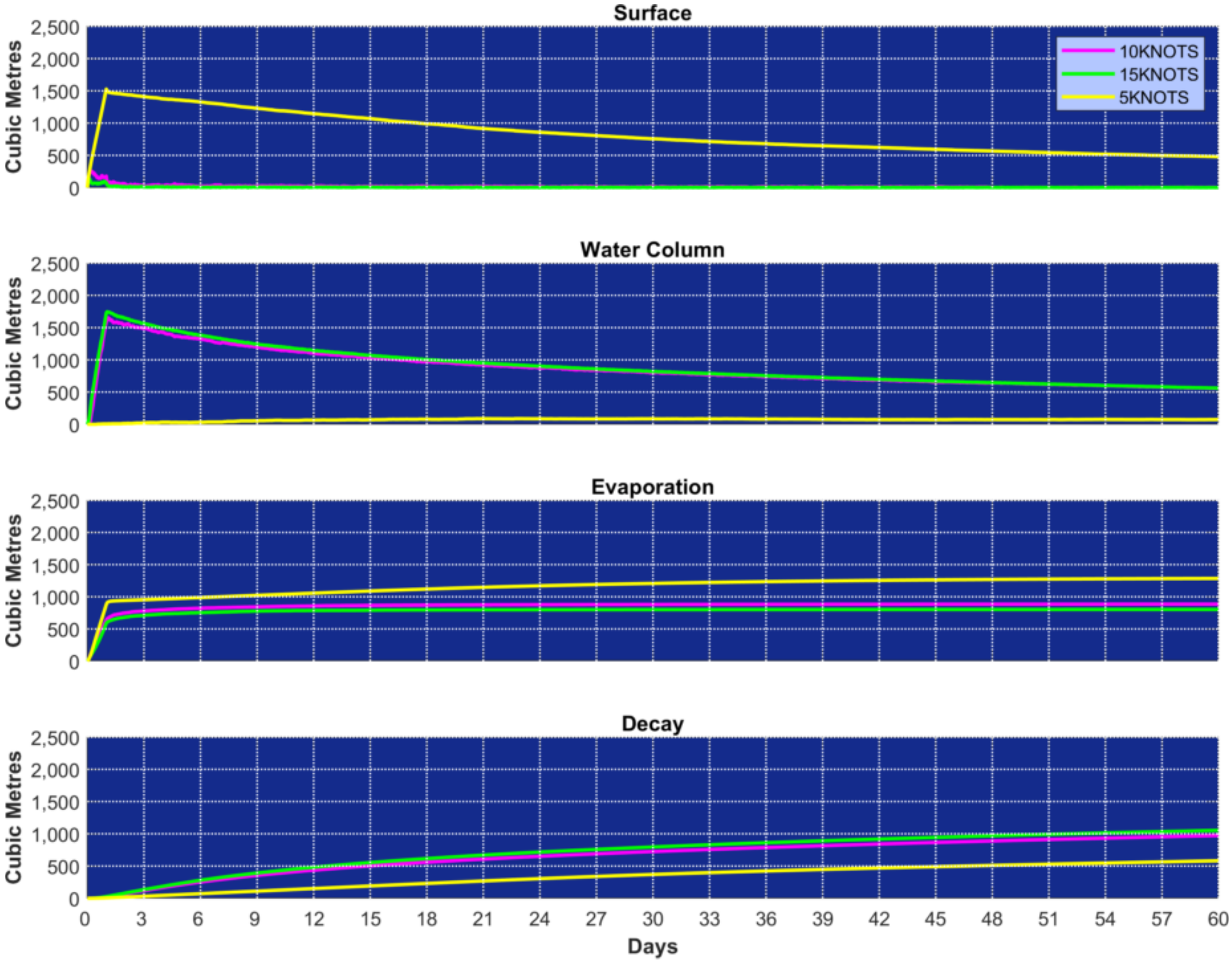


Figure 6-1 Weathering of Basker 6ST1 crude under three static wind conditions (5, 10 and 15 knots). The results are based on a 2,321 m³ subsea release of Basker 6ST1 crude over 24 hours and tracked for 60 days.

6.1.2 Marine Diesel Oil

MDO is a light-persistent fuel oil used in the maritime industry. It has a density of 829.1 kg/m³ (API of 37.6) and a low pour point (-14°C). The low viscosity (4 cP at 25 °C) indicates that this oil will spread quickly when released and will form a thin to low thickness film on the sea surface, increasing the rate of evaporation. The oil is categorised as a group II oil (light-persistent) based on categorisation and classification derived from AMSA (2015a) guidelines. The classification is based on the specific gravity of hydrocarbons in combination with relevant boiling point ranges.

Generally, about 6.0% of the MDO 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 an additional 54.4% should evaporate over several days (265 °C < BP < 380 °C). Approximately 5% (by mass) of MDO will not evaporate at atmospheric temperatures. These compounds will persist in the environment.

Figure 6-2 shows weathering graphs for a 500 m³ release of MDO over 5 hours (tracked for 30 days) during three static wind conditions. The prevailing weather conditions will influence the weathering and fate of the MDO. Under lower wind-speeds (5 knots), the MDO will remain on the surface longer, spread quicker, and in turn increase the evaporative process. Conversely, sustained stronger winds (>15 knots) will generate breaking waves at the surface, causing a higher amount of MDO to be entrained into the water column and reducing the amount available to evaporate.

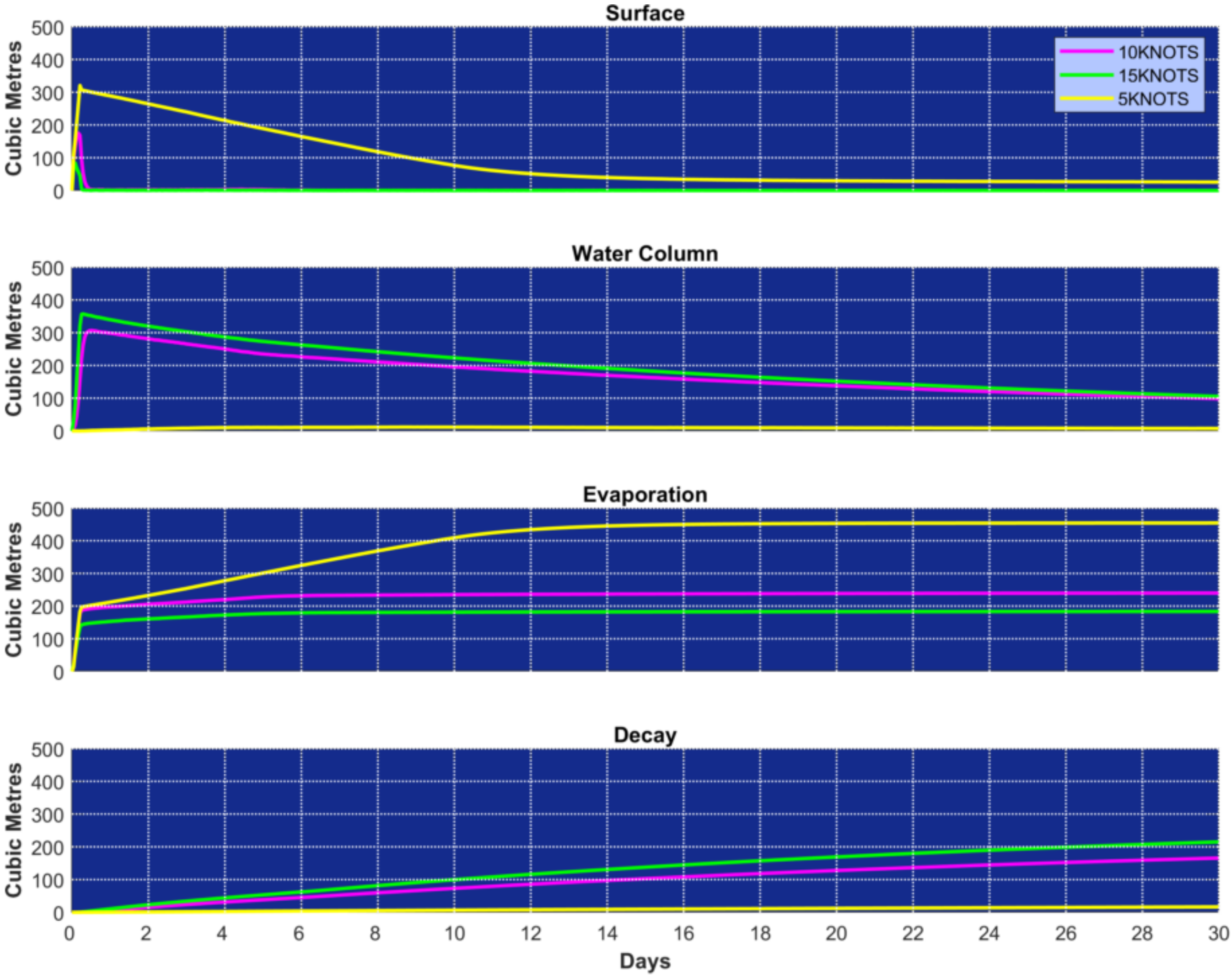


Figure 6-2 Weathering of MDO under three static wind conditions (5, 10 and 15 knots). The results are based on a 500 m³ surface release of MDO over 5 hours and tracked for 30 days.

6.2 Floating Oil, Shoreline and In-Water Thresholds

The thresholds described below for floating, shoreline, and in-water (entrained and dissolved) oil have been adopted according to low, moderate and high thresholds, based on increasing concentrations:

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.

It is important to note that selected thresholds for floating oil, shoreline accumulation, entrained and dissolved hydrocarbon exposure used herein are based on NOPSEMA spill modelling bulletin (NOPSEMA, 2019).

6.2.1 Floating Oil Exposure Thresholds

As a conservative approach, the same reporting thresholds for fresh and weathered oil exposure on the sea surface were applied in this study, which were 1 g/m^2 (low), 10 g/m^2 (moderate) and above 50 g/m^2 (high; Table 6.3). As the effects of fresh oil are better understood than for weathered oil, appropriate effects thresholds for fresh oil are more readily identifiable. Exposure pathways of species to weathered oil (i.e. smothering and potential ingestion for some species) are less likely to result in adverse effects.

Table 6.3 Floating oil exposure thresholds used in this report (in alignment with NOPSEMA 2019).

Exposure 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

* 50 g/m^2 also used to define the threshold for actionable sea surface oil.

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 6.4). 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 6.4 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 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). Concentrations above 50 g/m^2 are also considered the lower actionable threshold, where oil may be thick enough for containment and recovery.

Figure 6.3 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 6.4 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

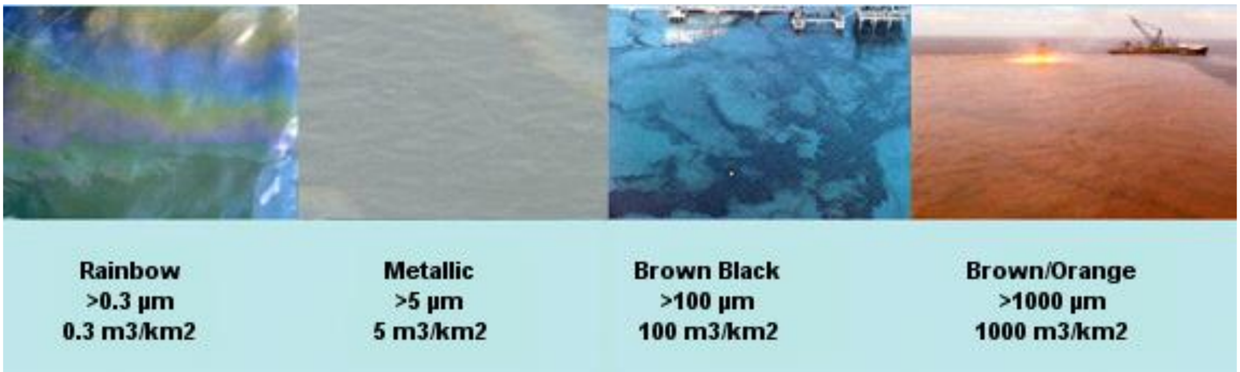


Figure 6.3 Photographs showing the difference between oil colour and thickness on the sea surface (source: adapted from Oil Spill Solutions.org, 2015).

6.2.2 Shoreline Accumulation Thresholds

The minimum thresholds for shoreline accumulation were 10 g/m^2 (low), 100 g/m^2 (moderate) and above 1,000 g/m^2 (high).Table 6.5 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 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.

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 accumulation. The appearance is described as an oil cover.

Table 6.5 Thresholds for oil accumulation on shorelines.

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.

6.2.3 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.

6.2.3.1 Dissolved Hydrocarbons

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

Hydrocarbon compounds vary in water-solubility and the toxicity exerted by individual compounds is inversely related to solubility, however bioavailability will be modified by the volatility of individual compounds (Nirmalakhandan & Speece, 1988; Blum & Speece, 1990; McCarty, 1986; McCarty et al., 1992a, 1992b; Mackay et al., 1992; McCarty & Mackay, 1993; Verhaar et al., 1992, 1999; Swartz et al., 1995; French-McCay, 2002; McGrath & 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.

Thresholds of 10, 50 or 400 ppb over a 1 hour timestep (see Table 6.6) to indicate increasing potential for sub-lethal to lethal toxic effects (low to high), based on NOPSEMA (2019).

6.2.3.2 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, 2003).

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 (see Table 6.6).

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 6.6 Dissolved and entrained hydrocarbon instantaneous exposure thresholds used in this report (in alignment with NOPSEMA, 2019).

	Exposure level	In-water threshold (ppb)	Description
Dissolved hydrocarbons	Low	10	Establishes planning area for scientific monitoring based on potential for exceedance of water quality triggers
	Moderate	50	Approximates potential toxic effects, particularly sublethal effects to sensitive species
	High	400	Approximates toxic effects including lethal effects to sensitive species
Entrained hydrocarbons	Low	10	Establishes planning area for scientific monitoring based on potential for exceedance of water quality triggers
	High	100	As appropriate given oil characteristics for informing risk evaluation

6.3 Sensitive Receptors Assessed

A range of environmentally sensitive receptors and biological receptors and shorelines were assessed for floating oil exposure, shoreline accumulation and water column exposure as part of the study (see Figure 6-4 to Figure 6-13). Additional receptors were also requested by Cooper Energy which include sensitive areas and estuaries (see Figure 6-14 to Figure 6-16). Receptor categories (see Table 6-7) 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 http://www.environment.gov.au/. Risks of exposure were separately calculated for each sensitive receptor area and have been tabulated.

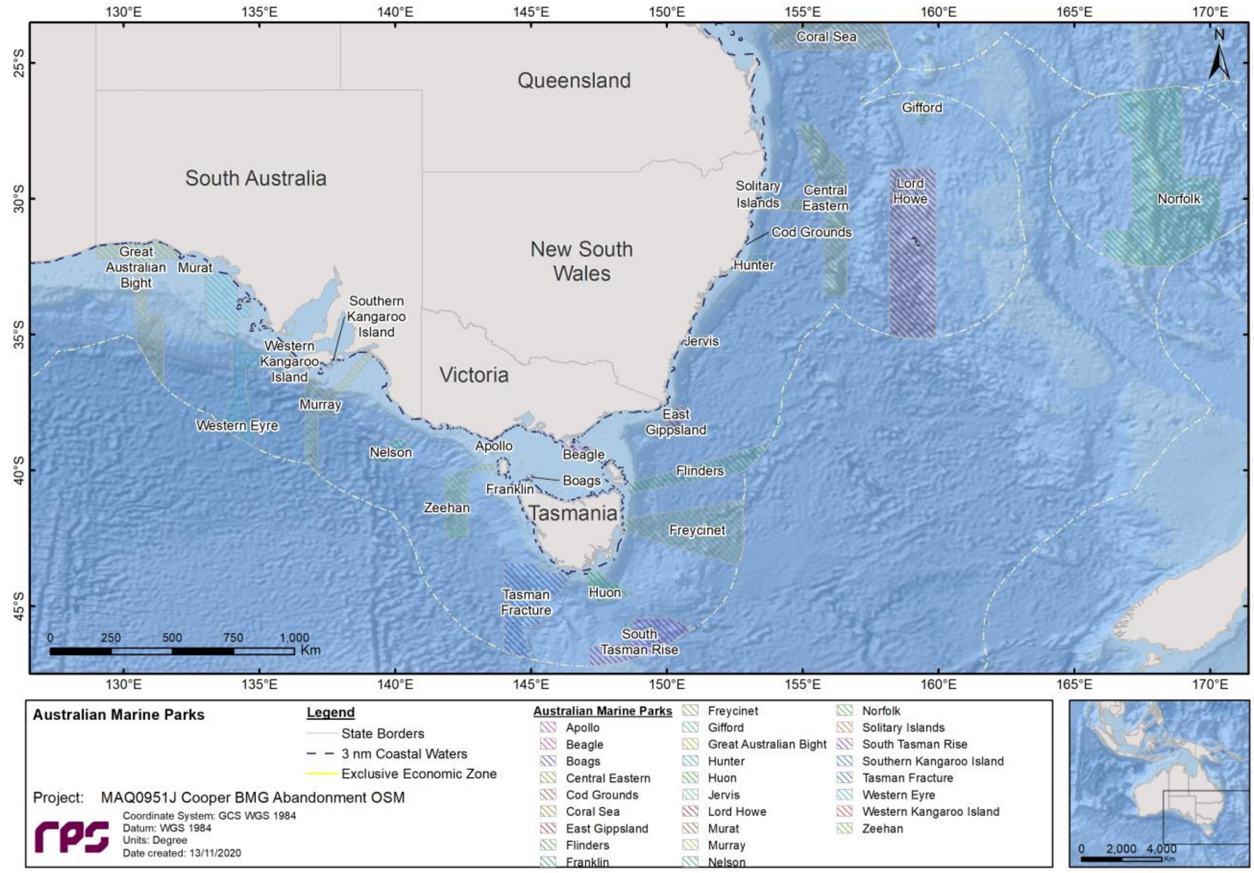
Receptor maps of Biologically Important Areas (BIA') have not been presented herein, therefore, it is recommended to use the following website to obtain detailed maps: http://www.environment.gov.au/webgis-framework/apps/ncva/ncva.jsf

Table 6-7 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	✓	✓	×
Aquatic Reserve	AQR	✓	✓	×
Biologically Important Areas	BIA	✓	✓	
Marine Park	MP	✓	✓	×
Marine National Park	MNP	✓	✓	×
National Park	NP	✓	✓	×
Marine Sanctuary	MS	✓	✓	×
Integrated Marine and Coastal Regionalisation of Australia	IMCRA	✓	✓	×
Interim Biogeographic Regionalisation of Australia	IBRA	✓	✓	×
Reefs, Shoals and Banks	RSB	✓	✓	×
Key Ecological Feature	KEF	✓	✓	×
Ramsar	Ramsar	✓	✓	×
State Waters	State Waters	✓	✓	×
Sub-Local Government Areas	Sub-LGAs	✓	✓	✓
Local Government Areas	LGAs	✓	✓	✓
Additional Sensitive Areas				
Estuaries	Estuaries	✓	✓	✓
Tactical Response Planning	TRP	✓	✓	✓
Protection Priorities	PP	✓	✓	✓
Other Sensitive Areas	OTHER	✓	✓	✓

Table 6-8 Summary of the receptors that each release location lies within. A tick (✓) denotes that the release location for that scenario resides within the boundaries of the receptor while a cross (✗) signifies that the release location does not reside within the receptor boundaries.

Receptor category	Acronym	Scenario 1	Scenario 2
Antipodean Albatross - Foraging	BIA	✓	✓
Black-browed Albatross - Foraging	BIA	✓	✓
Bullers Albatross - Foraging	BIA	✓	✓
Campbell Albatross - Foraging	BIA	✓	✓
Common Diving-petrel - Foraging	BIA	✓	✓
Indian Yellow-nosed Albatross - Foraging	BIA	✓	✓
Pygmy Blue Whale - Distribution	BIA	✓	✓
Pygmy Blue Whale - Foraging	BIA	✓	✓
Shy Albatross - Foraging	BIA	✓	✓
Southern Right Whale - Migration	BIA	✗	✓
Wandering Albatross - Foraging	BIA	✓	✓
White Shark - Distribution	BIA	✓	✓
Twofold Shelf	IMCRA	✗	✓
Upwelling East of Eden	KEF	✓	✓



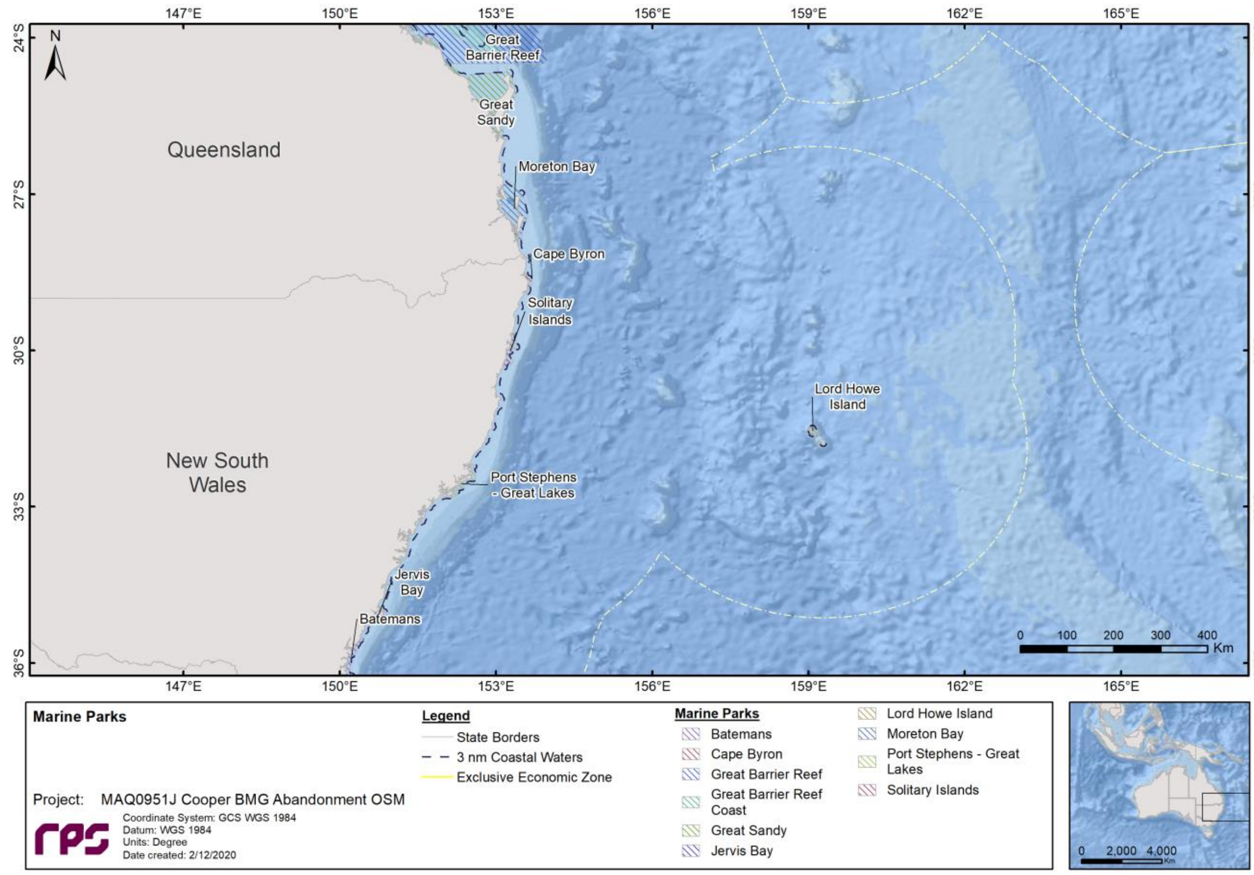
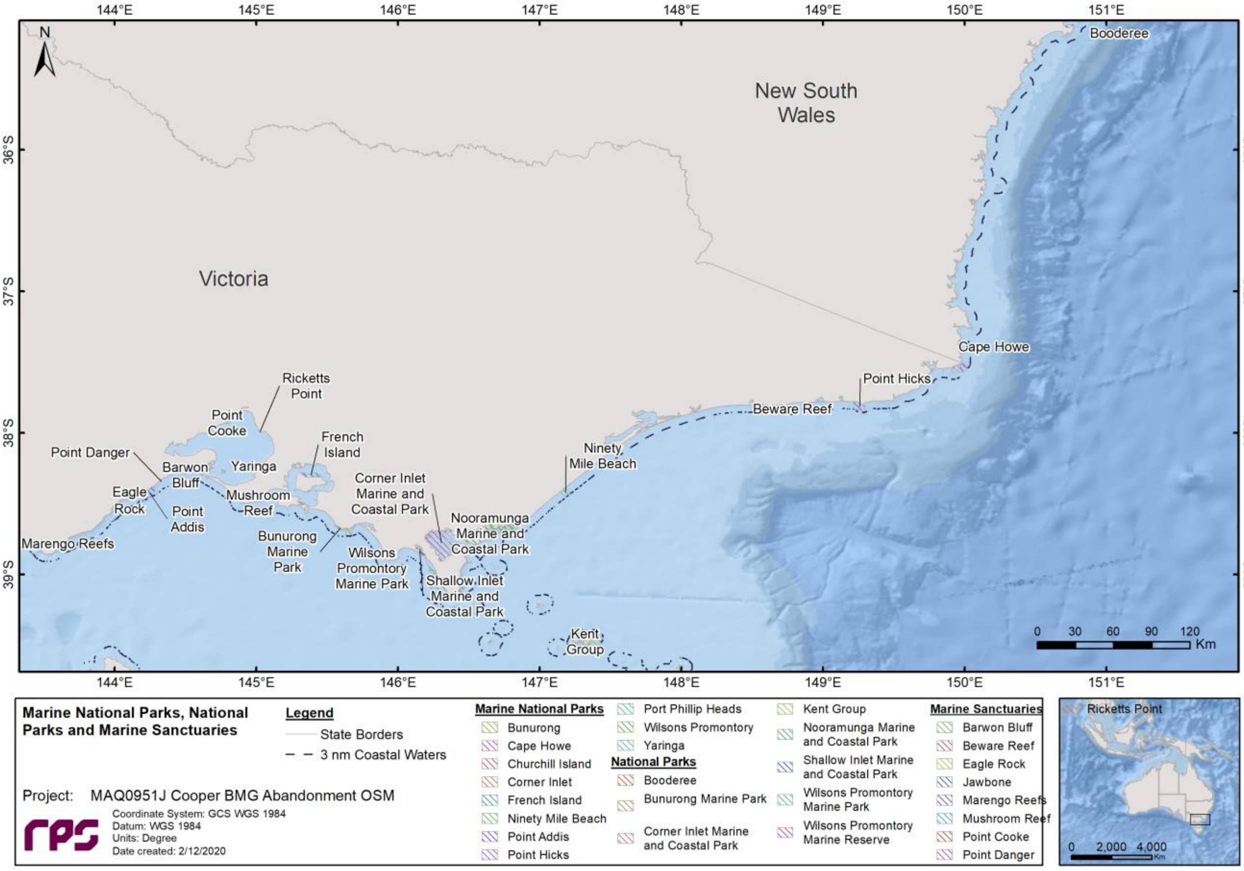


Figure 6-4 Receptor maps for Australian Marine Parks (AMP; Top) and Marine Parks (MP; Bottom).



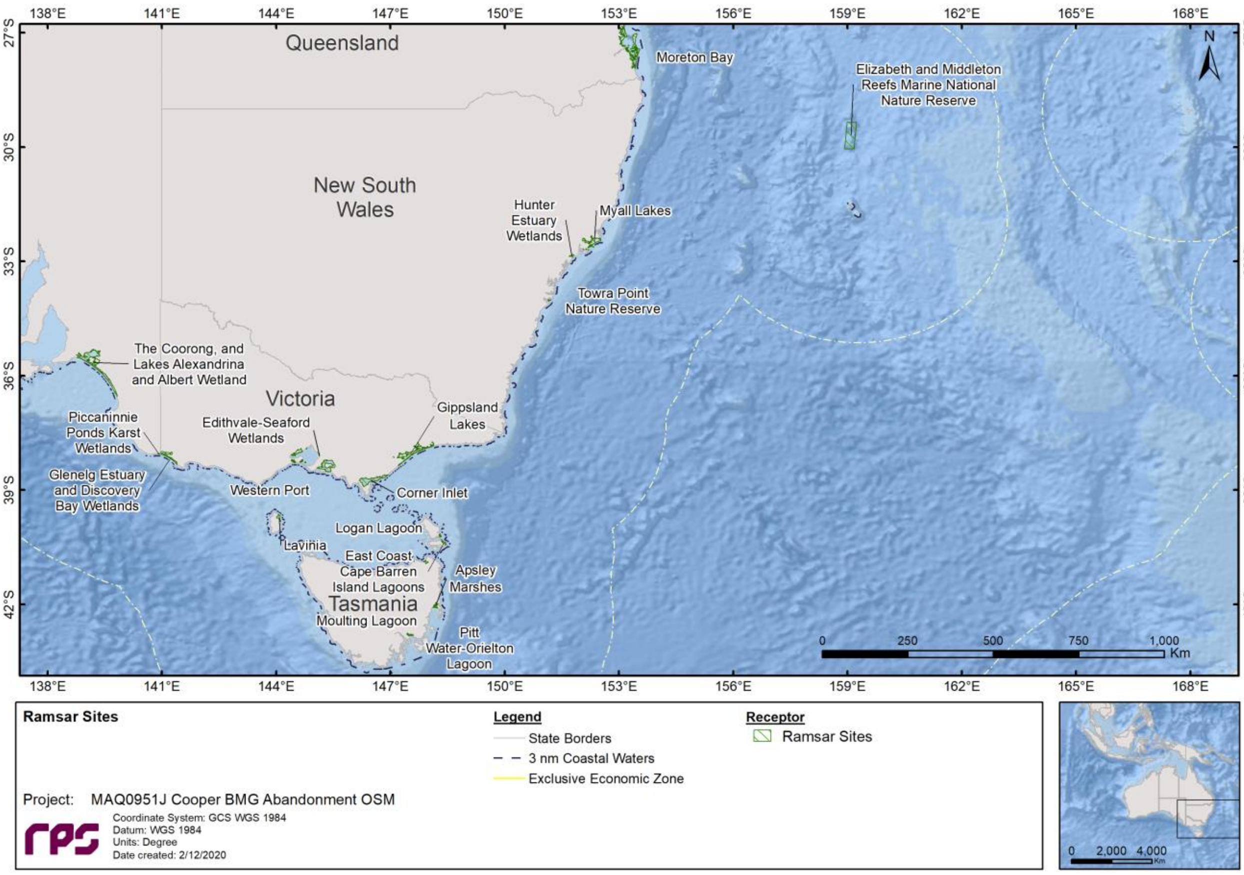
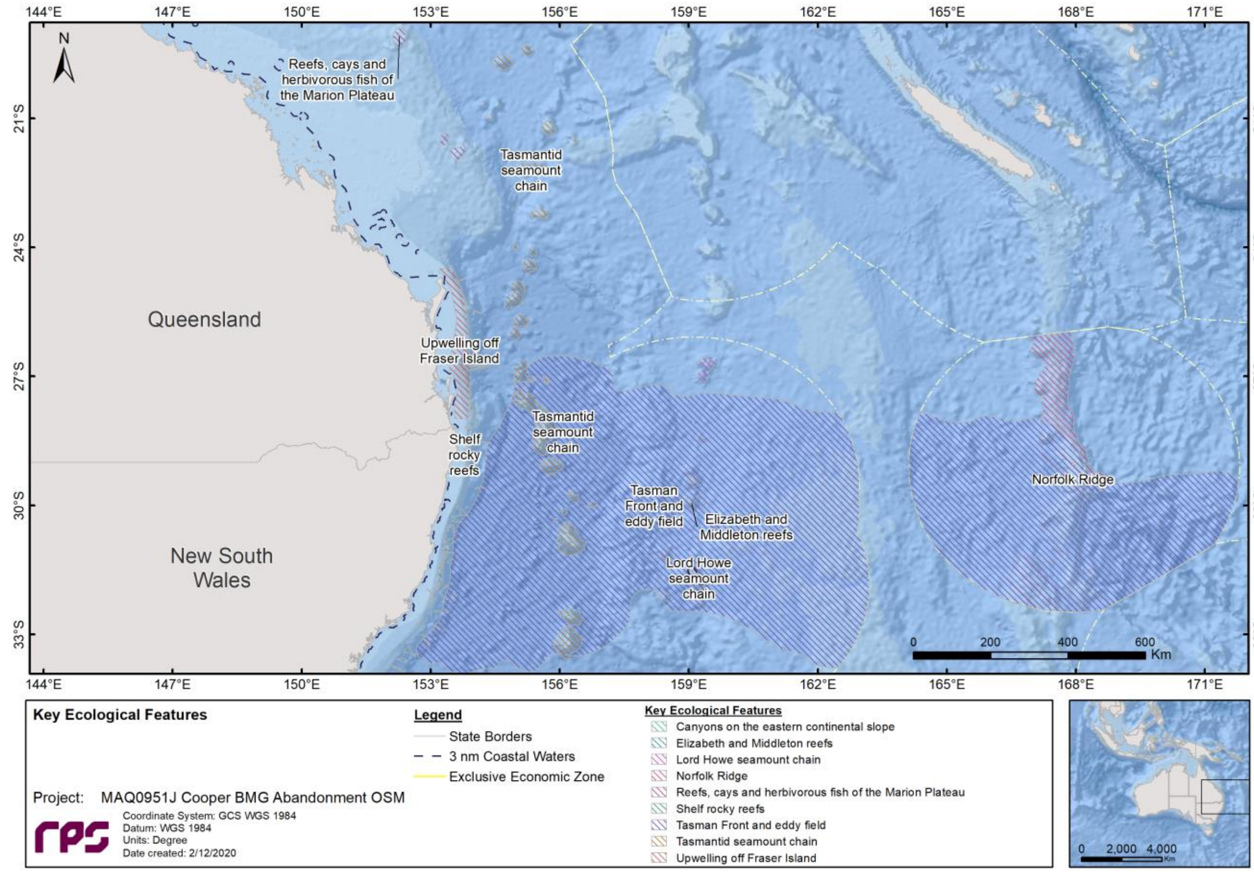


Figure 6-5 Receptor maps for Marine National Parks (MNP), National Parks (NP) and Marine Sanctuaries (MS; Top) and Ramsar Sites (Bottom).



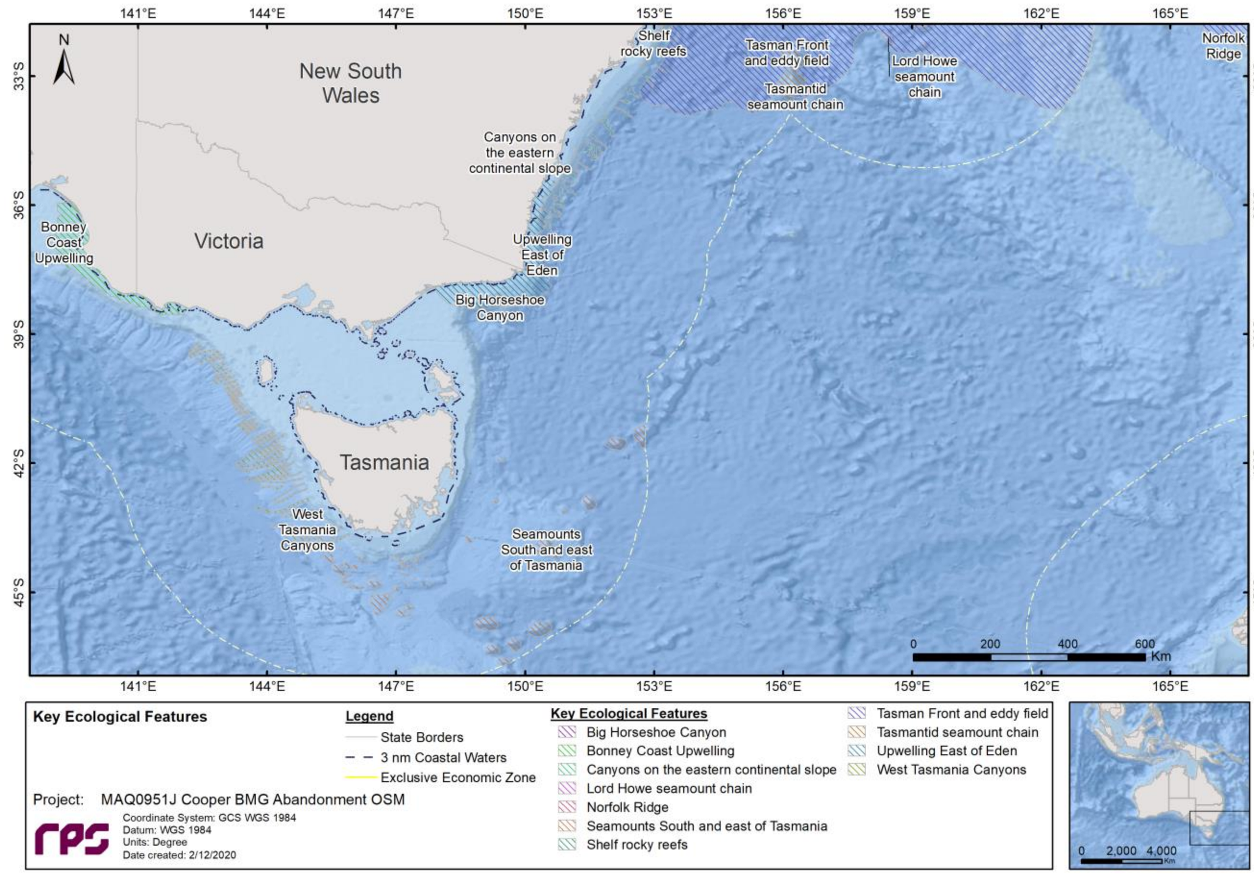
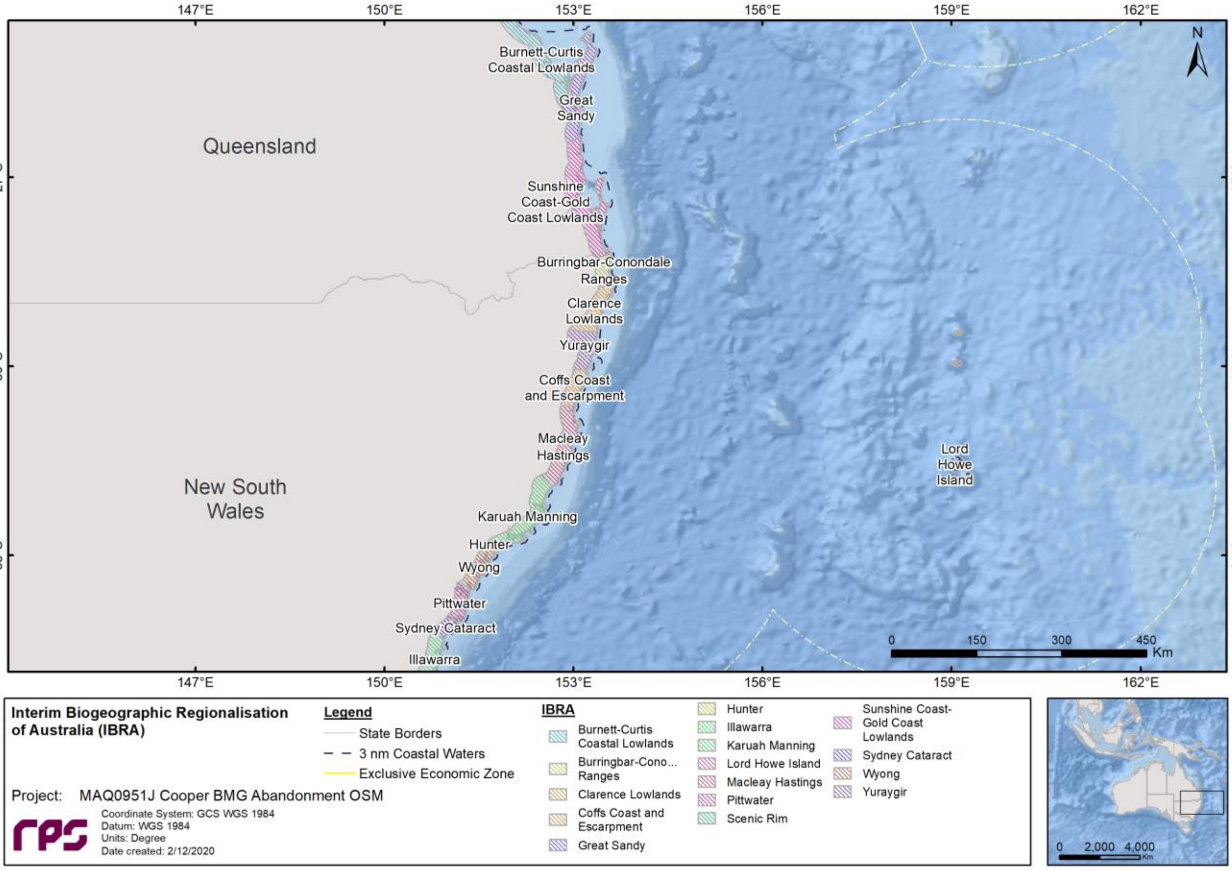


Figure 6-6 Receptor map for Key Ecological Features.



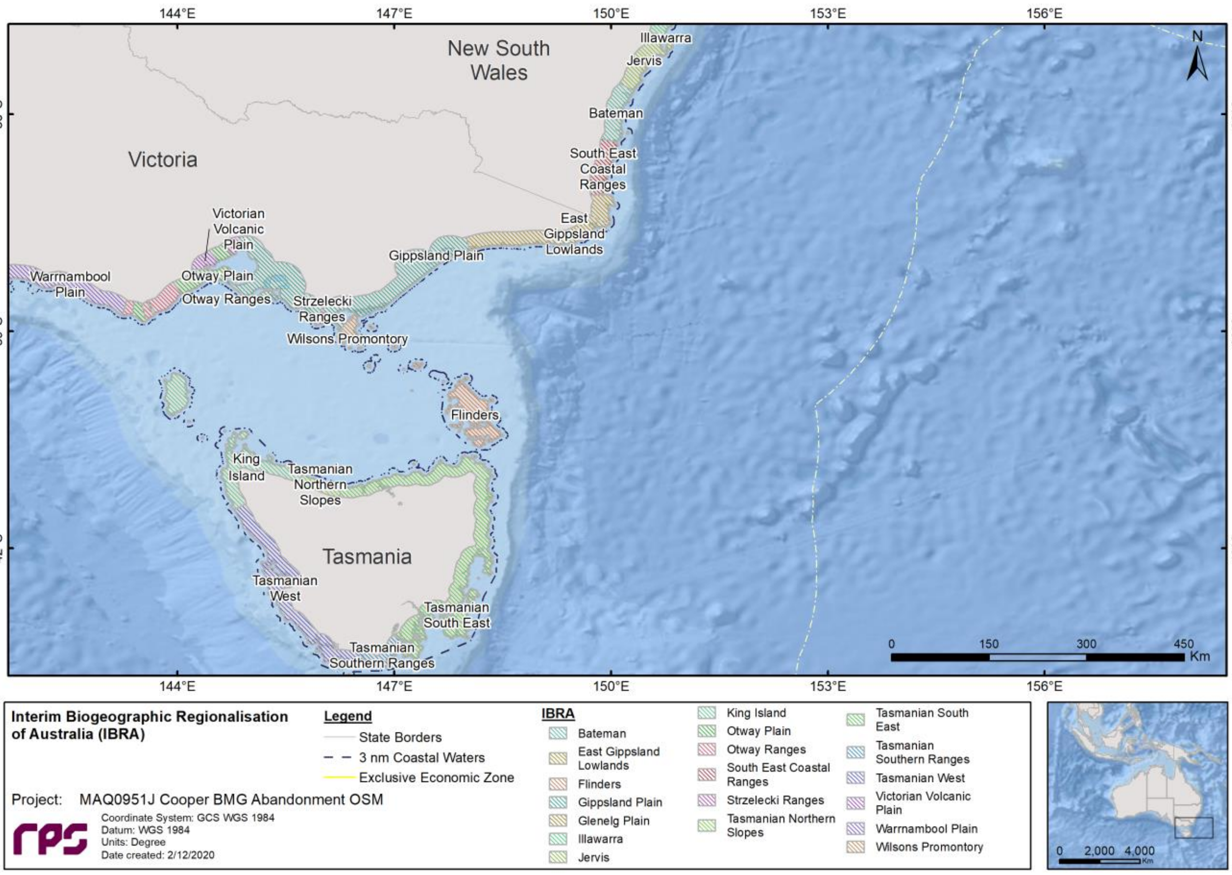


Figure 6-7 Receptor map for Interim Biogeographic Regionalisation for Australia (IBRA).

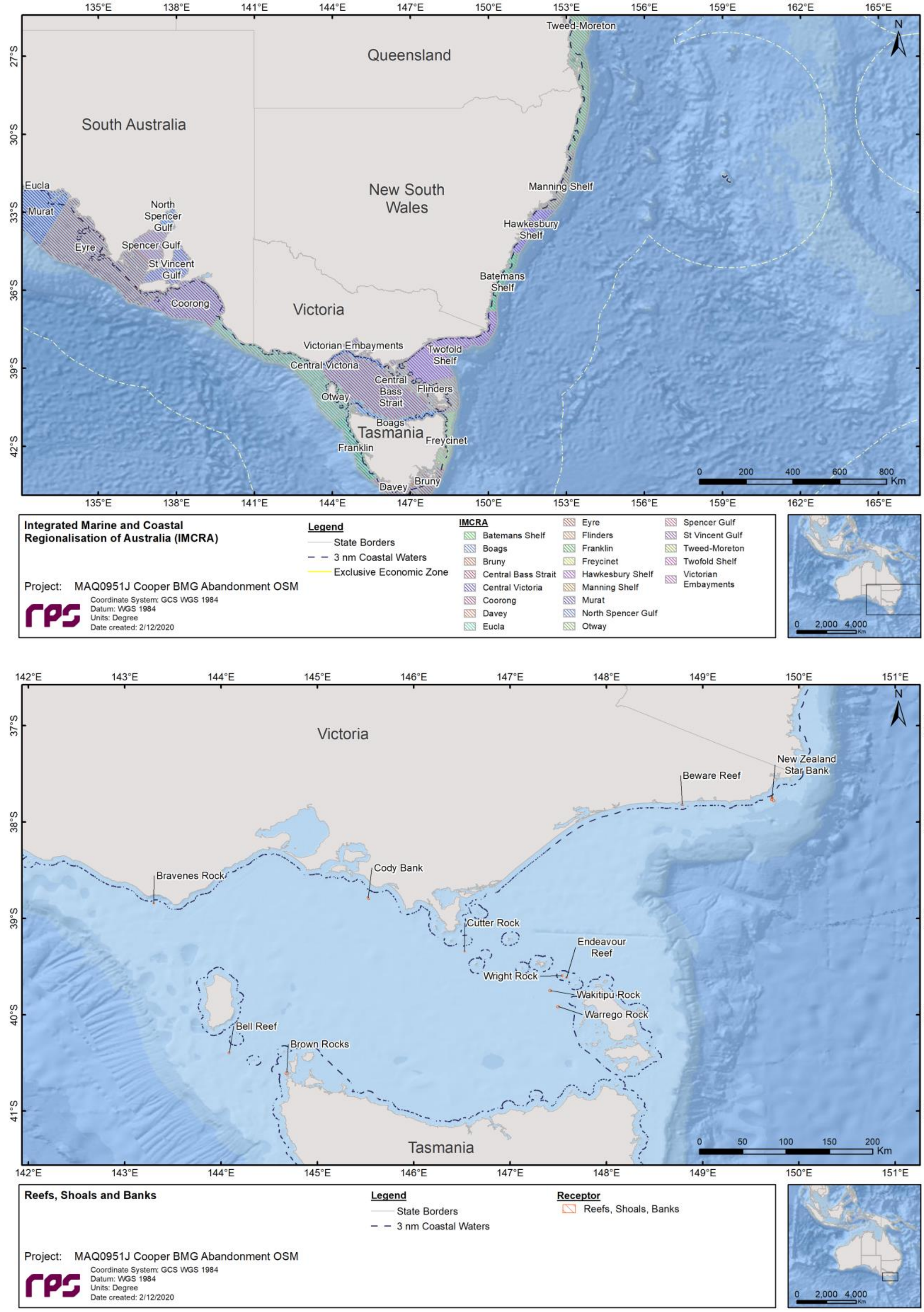


Figure 6-8 Receptor map for Integrated Marine and Coastal Regionalisation of Australia (IMCRA; Top) and Reefs, Shoals and Banks (RSB; Bottom).

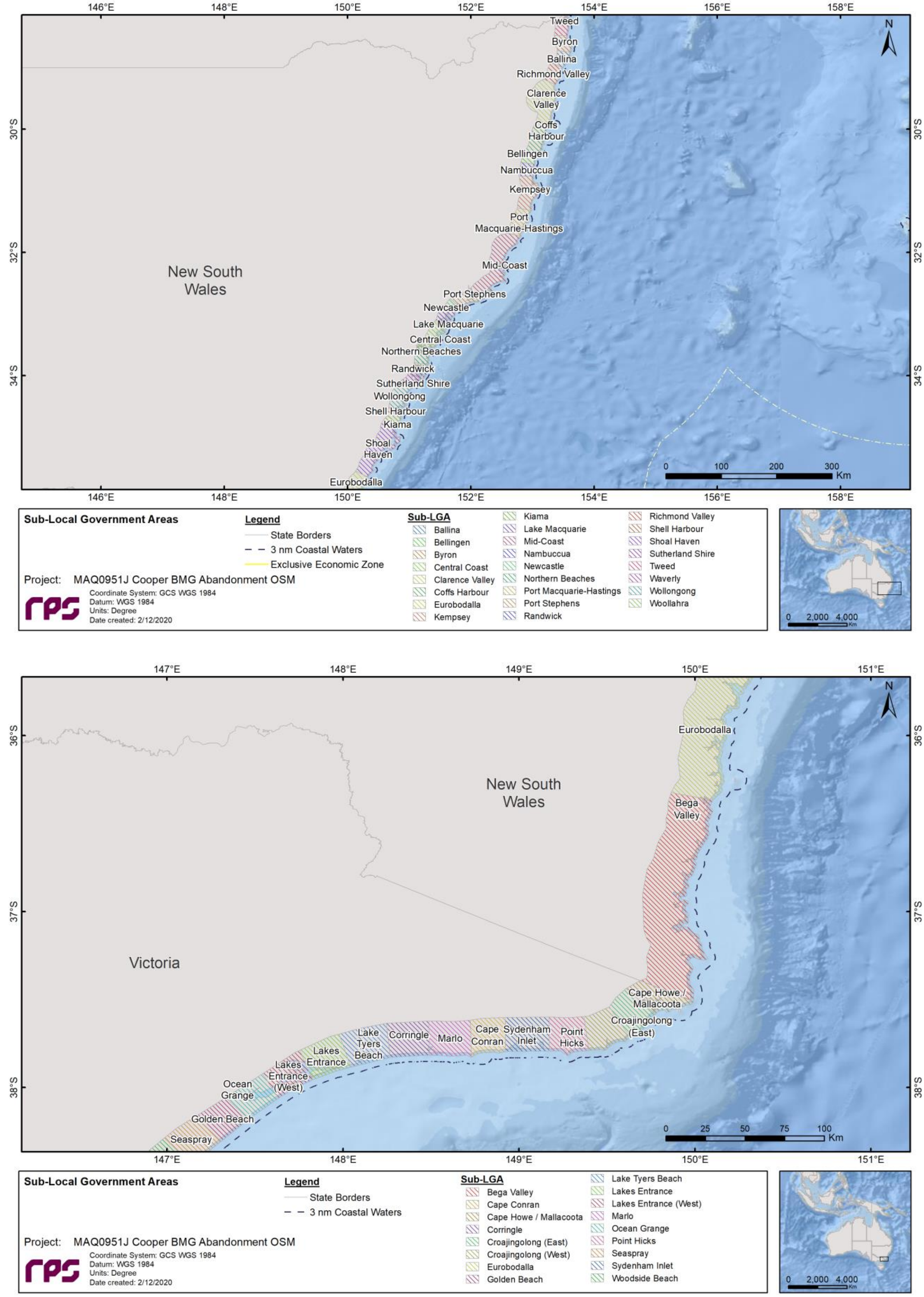


Figure 6-9 Receptor map for Sub-Local Government Areas (Sub-LGAs).

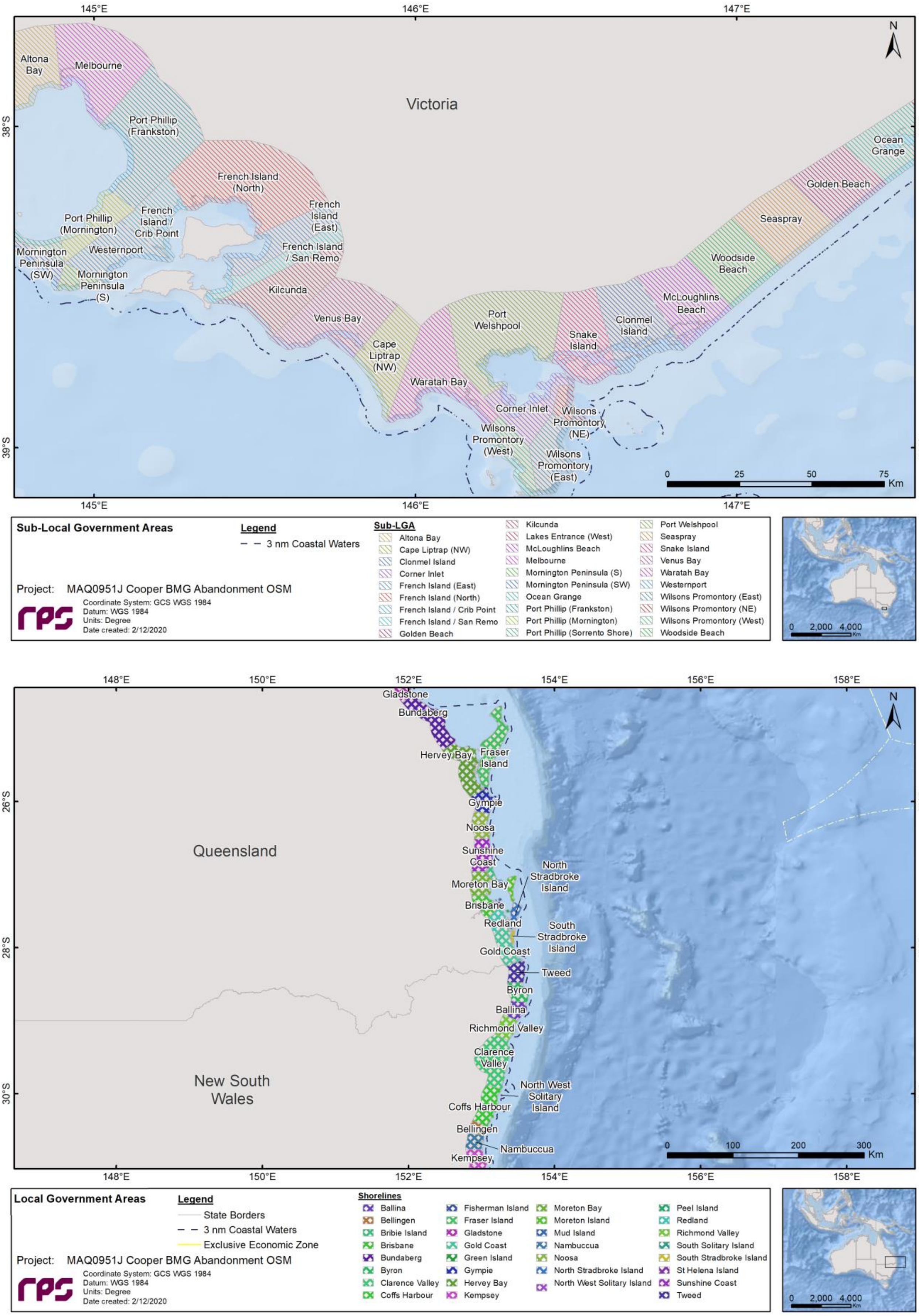


Figure 6-10 Receptor map for Sub-Local Government Areas (Sub-LGAs; Top) and Local Government Areas (Bottom).

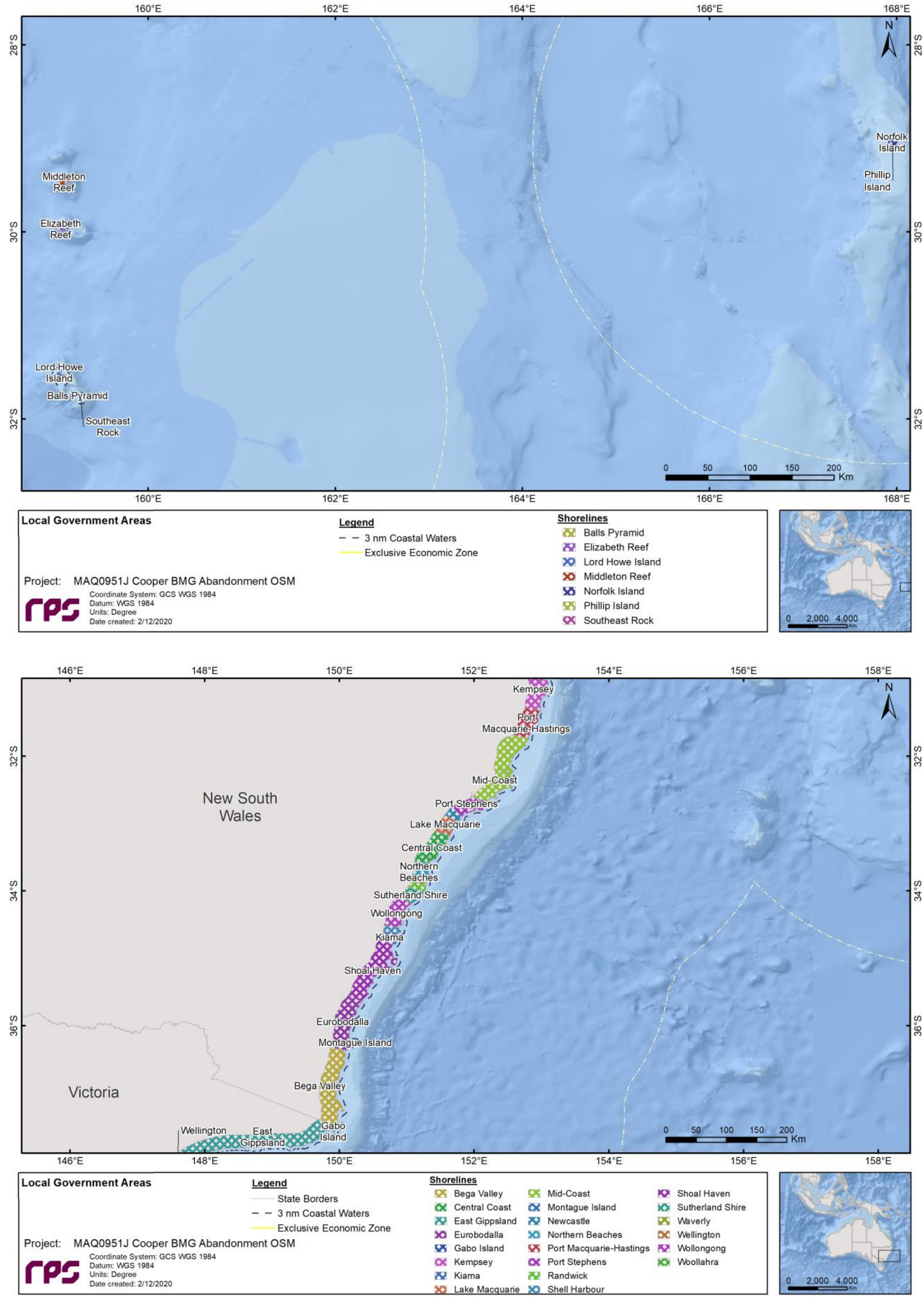
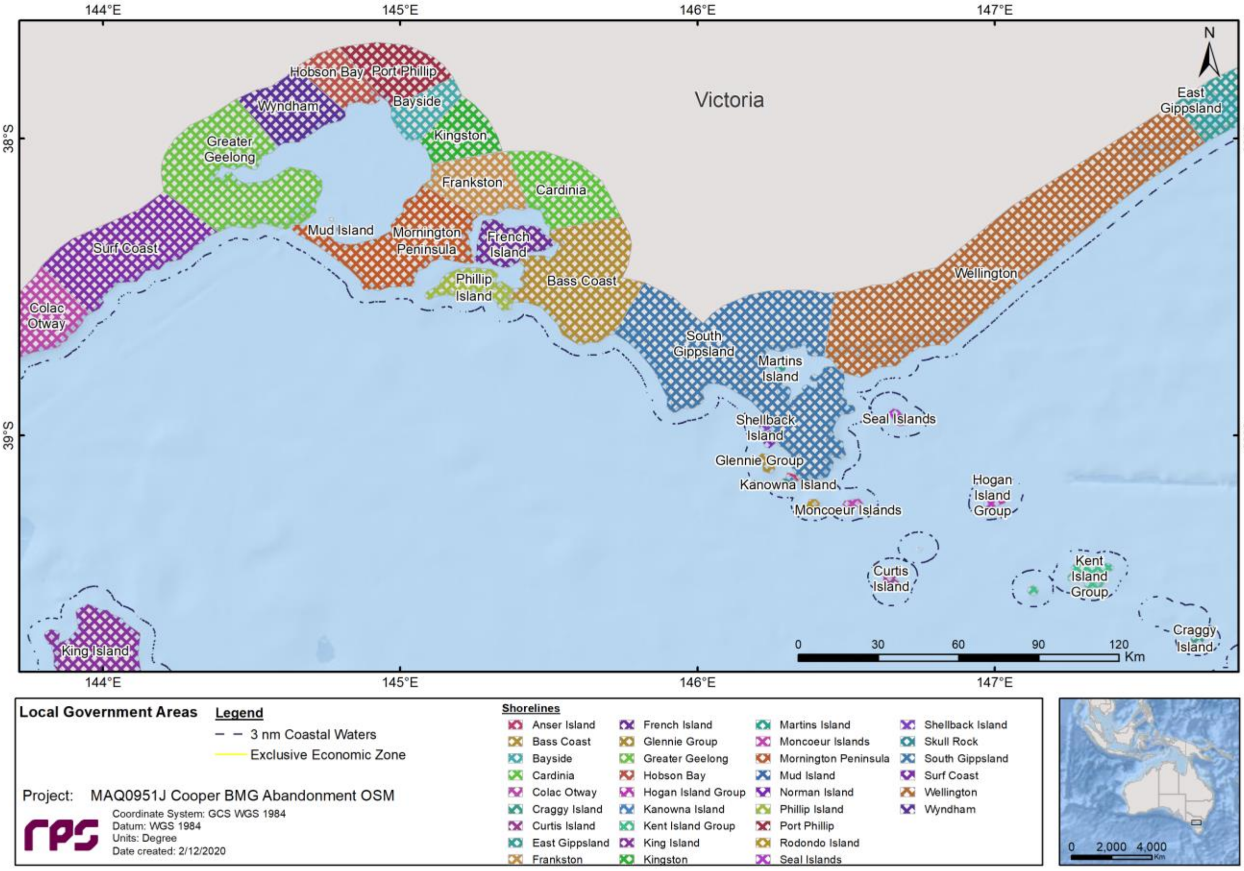


Figure 6-11 Receptor map for Local Government Areas.



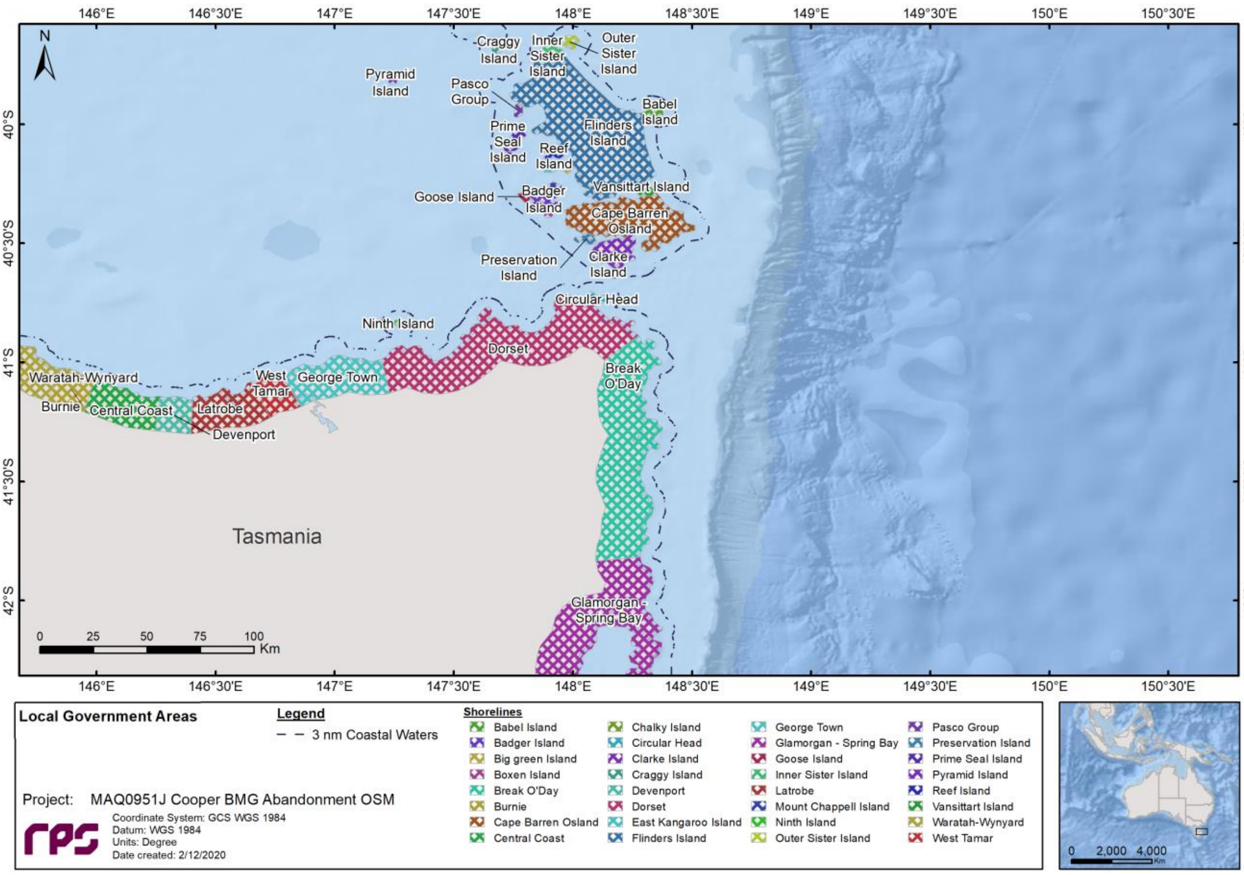
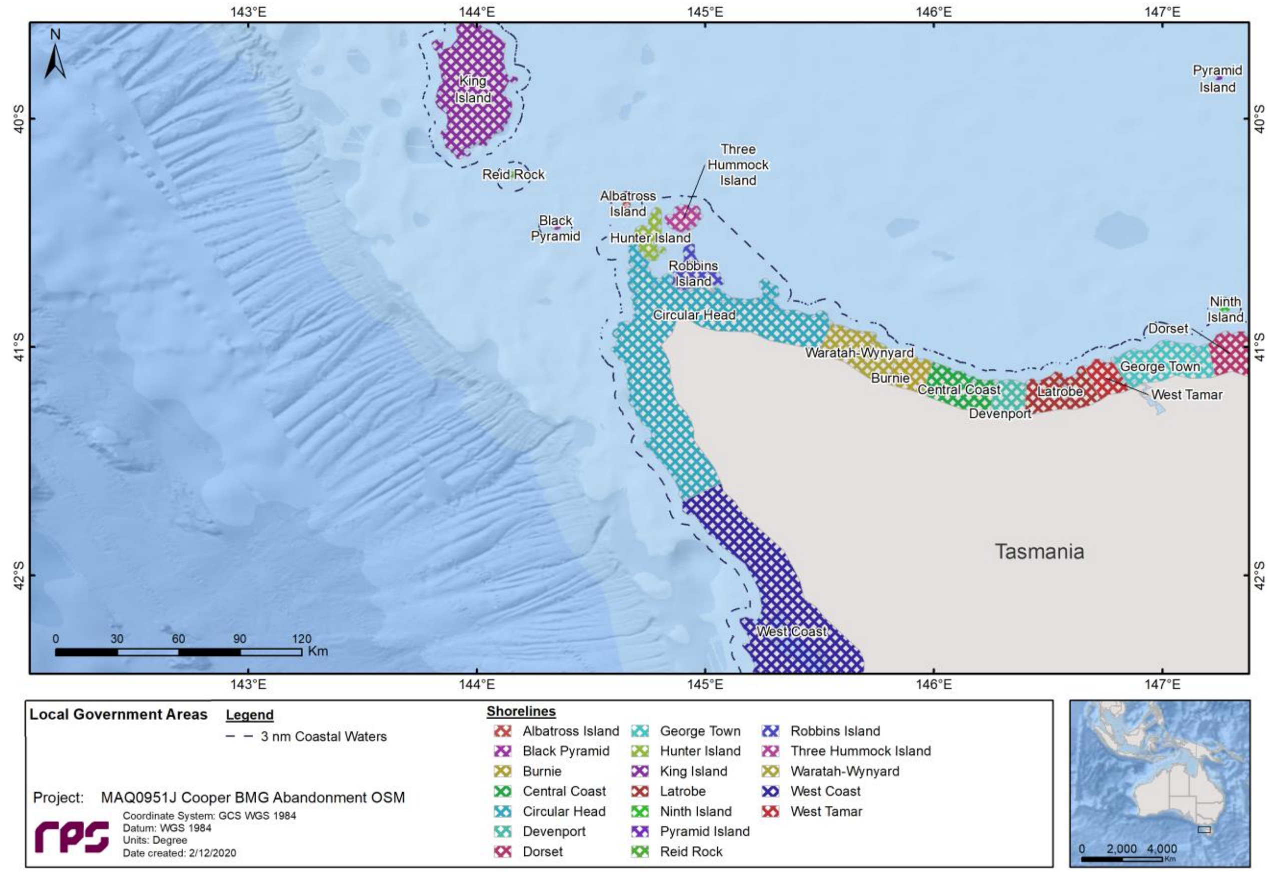


Figure 6-12 Receptor map for Local Government Areas.



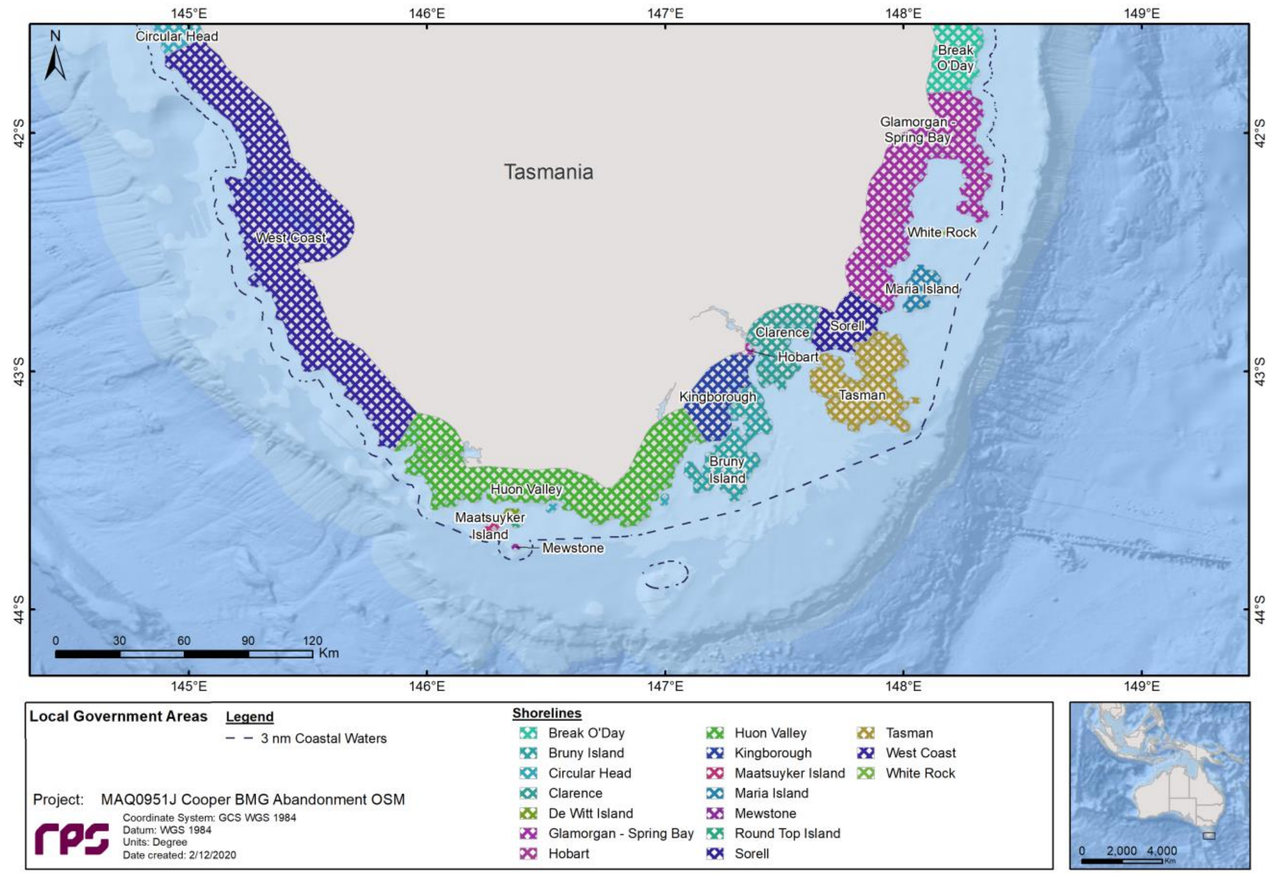
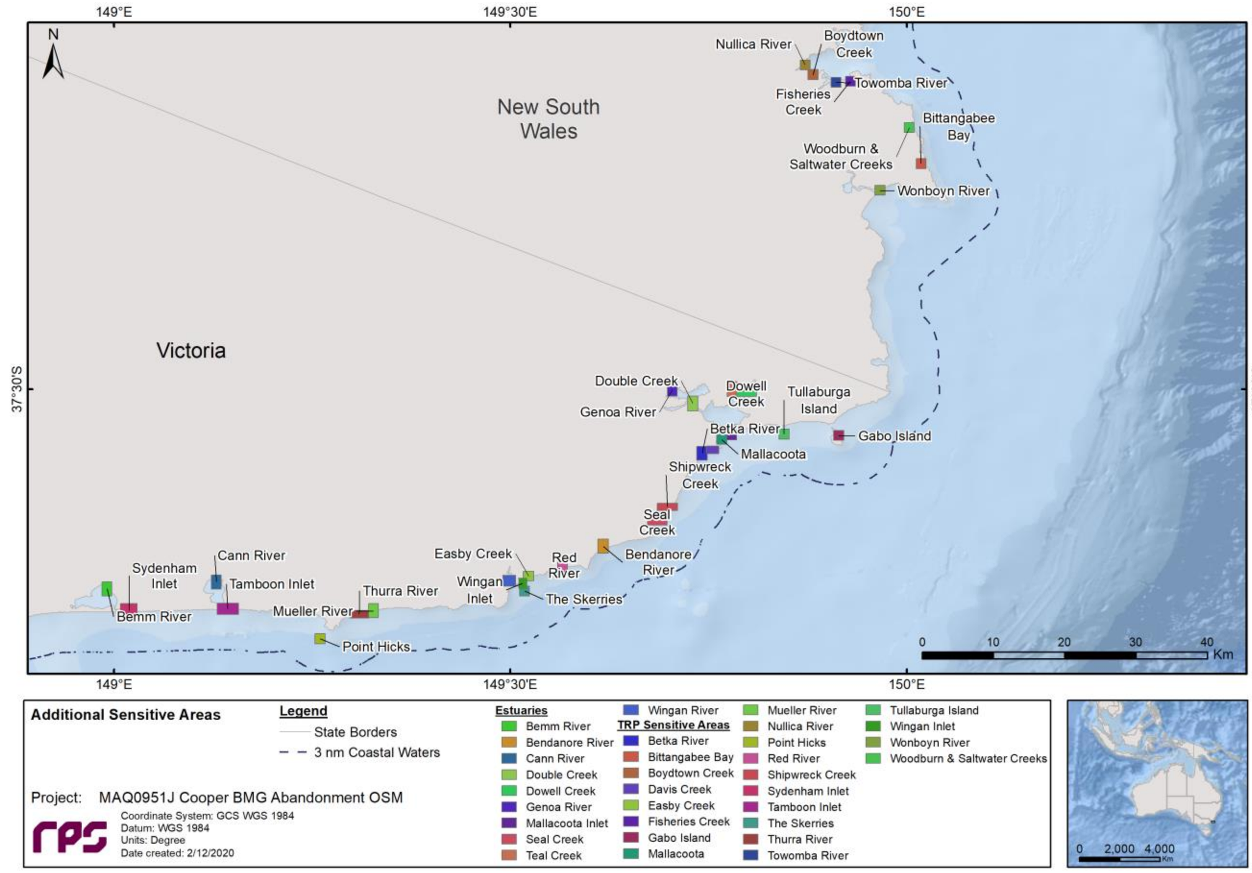


Figure 6-13 Receptor map for Local Government Areas.



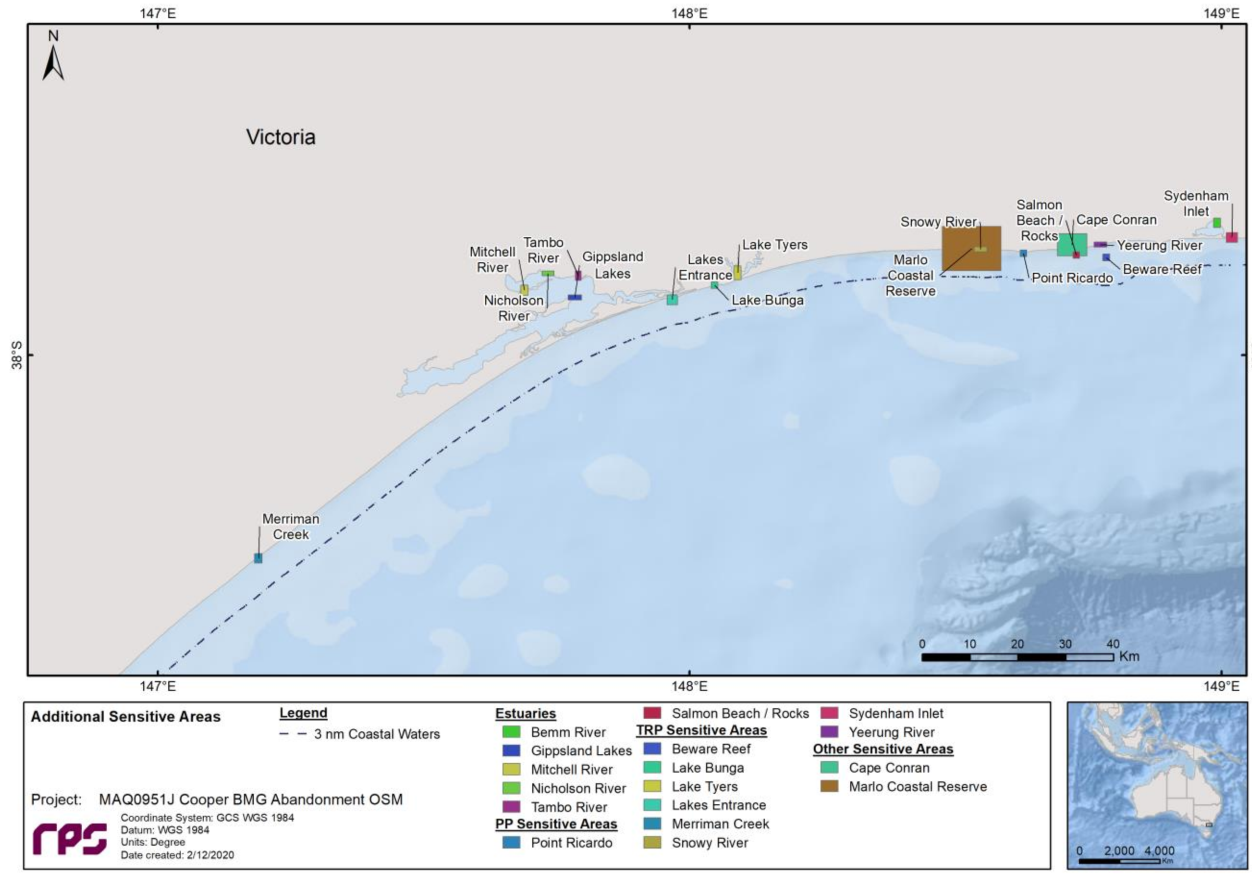


Figure 6-14 Receptor map for additional Sensitive Areas.

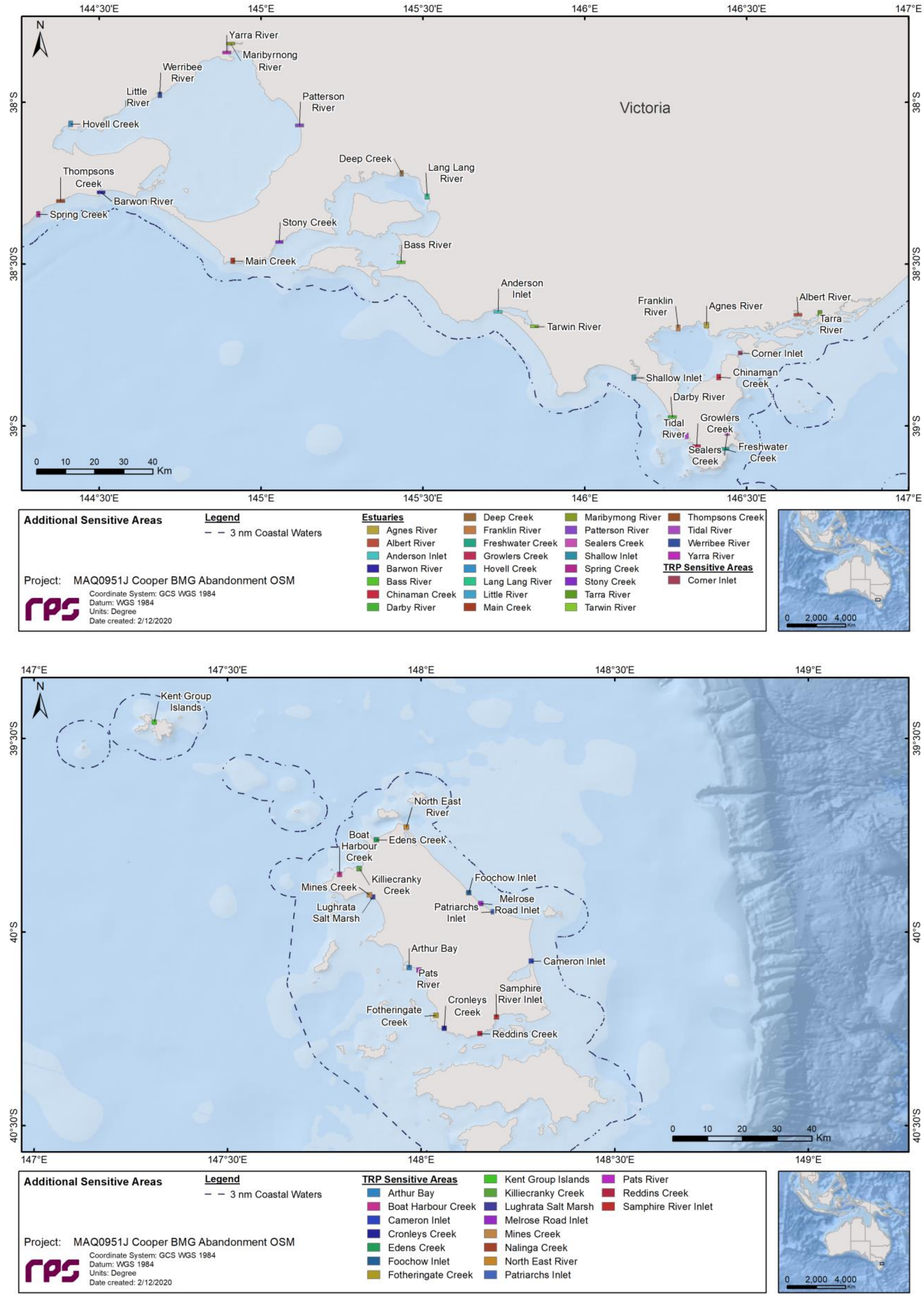


Figure 6-15 Receptor map for additional Sensitive Areas.

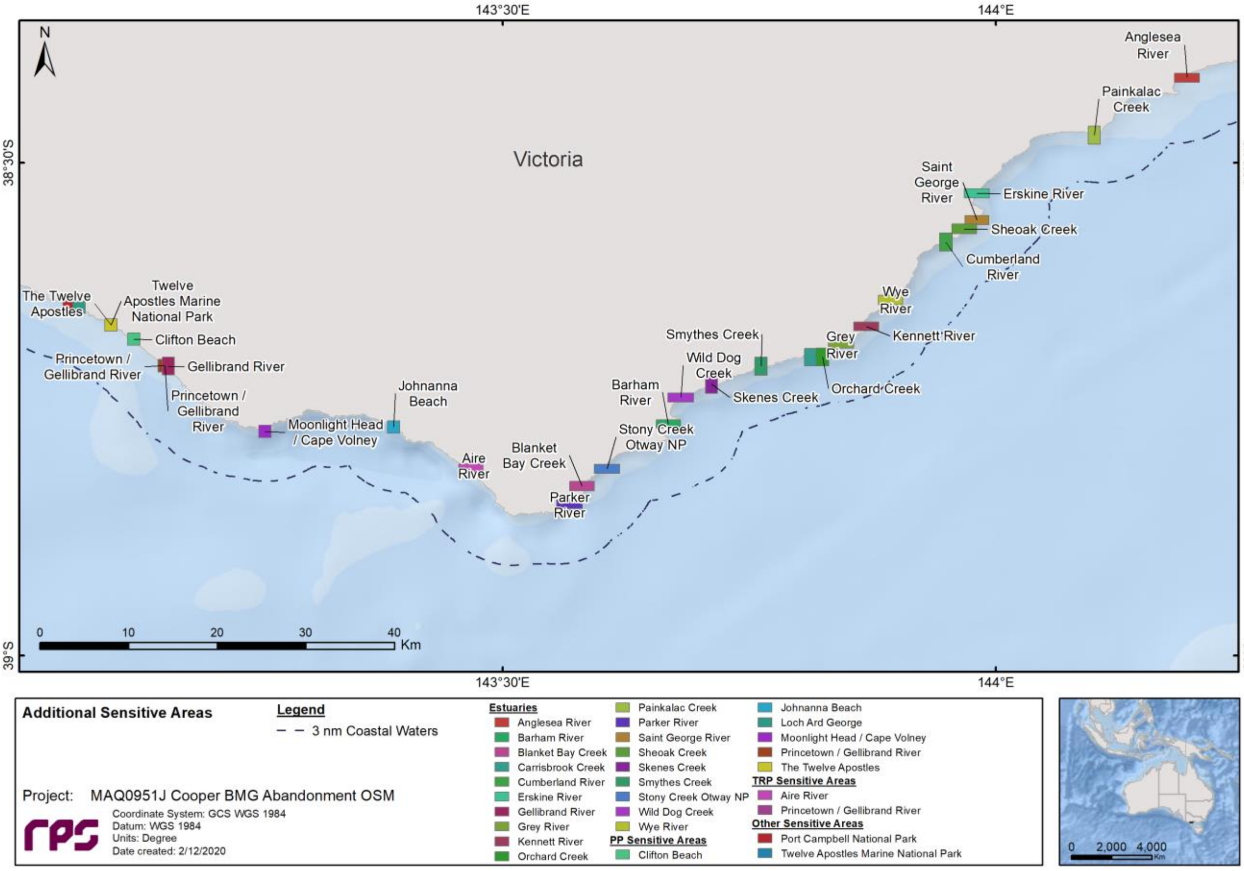


Figure 6-16 Receptor map for additional Sensitive Areas.

7 MODEL SETTINGS

Table 7-1 provides a summary of the oil spill model settings. The table also shows the thresholds that were used.

The potential risk of exposure to the surrounding waters and oil accumulation to shorelines was assessed for annual conditions for Scenario 1 and for two distinct seasons for Scenario 2; (i) summer (October to the following April), (ii) winter (May to September).

The simulation length was carefully selected based on extensive sensitivity testing. During the sensitivity testing process, sample spill simulations were run for longer than intended durations. Upon completion of the spill simulations, the results were carefully assessed to examine the persistence of the hydrocarbon (i.e. whether the maximum evaporative loss has been achieved for the period of time modelled; and whether a substantial volume of hydrocarbons remain in the water column (if any)) in conjunction with the extent of floating oil exposure based on reporting thresholds. Once there was agreement between the two factors (i.e. the final fate of hydrocarbon is accounted for and the full exposure area is identified) the simulation length was deemed appropriate.

Table 7-1 Summary of the oil spill model settings used in this assessment.

	Scenario 1	Scenario 2
Scenario description	Loss of well control	Vessel collision
Location	38° 17' 58.5" S 148° 42' 24.7" E	38° 16' 39.8" S 148° 42' 58.4" E
Total spill volume (m^3)	77,339 (486,408 bbl)	500
Oil type	Basker 6ST1 Crude	MDO
Release type	Subsea (153 m)	Surface
Release duration	120 days	5 hours
Simulation length (days)	180	30
Model period	Annual (January to December)	Summer (October to the following April) Winter (May to September)
Surface thresholds (g/m^2)	**NOPSEMA threshold** 1 g/m^2, 10 g/m^2, 50 g/m^2	
Shoreline thresholds (g/m^2)	**NOPSEMA threshold** 10 g/m^2, 100 g/m^2, 1,000 g/m^2	
Dissolved hydrocarbon exposure thresholds (ppb)	**NOPSEMA threshold** 10 ppb, potential low exposure 50 ppb, potential moderate exposure 400 ppb, potential high exposure	
Entrained hydrocarbon exposure thresholds (ppb)	**NOPSEMA threshold** 10 ppb potential low exposure 100 ppb, potential high exposure	

8 MODELLING RESULTS

8.1 Scenario 1 – Loss of well control – 77,338 m^3 subsea release of Basker 6ST1 Crude over 120 days

This scenario examined a 77,338 m^3 subsea release of Basker 6ST1 crude over 120 days, tracked for 180 days, representing a loss of well control at the Basker-2 (B2) well location. A total of 100 spill trajectories were simulated during annual conditions.

Section 8.1.1 presents the deterministic results and Section 8.1.1.6 presents the annual stochastic analysis.

8.1.1 Deterministic Analysis

8.1.1.1 Deterministic Case: Largest volume of oil ashore

The deterministic trajectory that resulted in the largest (total) volume of oil ashore (1,975 m^3) was identified as run number 53, which commenced at 7 pm 30th of August 2016. The oil accumulated ashore over 37 days.

Zones of exposure from floating oil (swept area) and shoreline loading over the entire simulation is presented in Figure 8-1. Surface slicks were predicted to travel northeast of the release location towards the Gippsland coast and the Victoria and NSW state border. Additionally, floating oil was predicted to travel south and east of the release location.

Figure 8-2 displays the time series of the area of visible (1 g/m^2) and actionable (50 g/m^2) floating oil along with actionable shoreline accumulation (100 g/m^2) over the 180-day simulation. The maximum area of coverage of visible floating oil was predicted to occur 7 days after the spill started and covered approximately 500 km^2. While the maximum length of actionable shoreline oil at any given time was predicted as 23 km, approximately 45 days into the simulation. Figure 8-3 is a time series of the volume on shore at the low (10 g/m^2), moderate (100 g/m^2) and high (1,000 g/m^2) thresholds.

Figure 8-4 presents the fates and weathering graph for the corresponding single spill trajectory and Table 8-1 summarises the mass balance at the end of the simulation. At the conclusion of the simulation, approximately 40% spilled oil was lost to the atmosphere through evaporation. Approximately 47% of the oil was predicted to have decayed, while 12% was predicted to remain within the water column and 1% to remain on the shoreline.

Table 8-1 Summary of the mass balance at day 180, for the trajectory that resulted in the largest volume of oil ashore. Results are based on a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, 7 pm 30th August 2016.

Exposure Metrics	End of the simulation (day 180)
Surface (%)	0
Ashore (%)	1
Entrained (%)	12
Evaporated (%)	40
Decay (%)	47

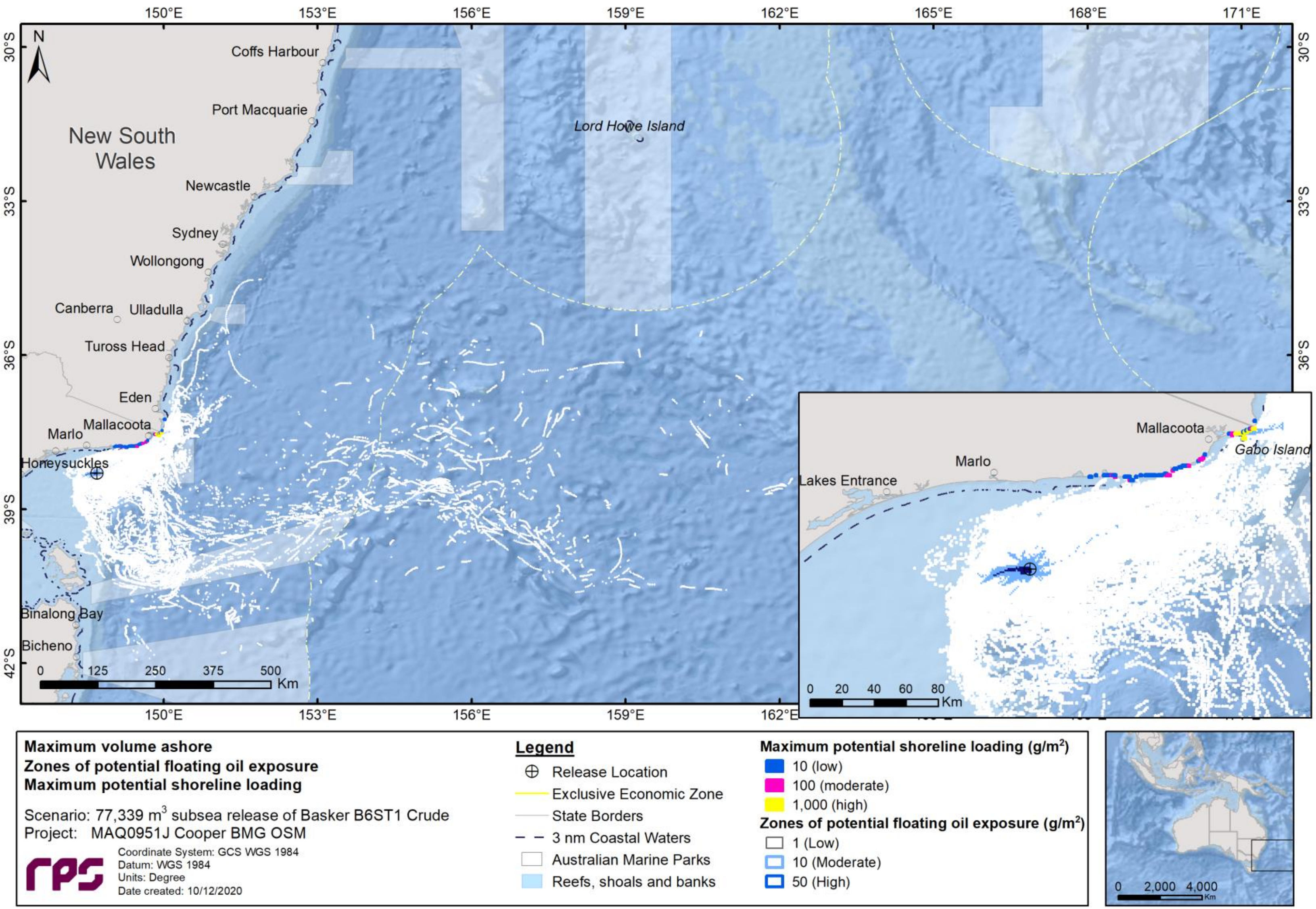


Figure 8-1 Exposure from floating oil and shoreline accumulation for the trajectory with the largest volume of oil ashore. Results are based on a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days, 7 pm 30th August 2016.

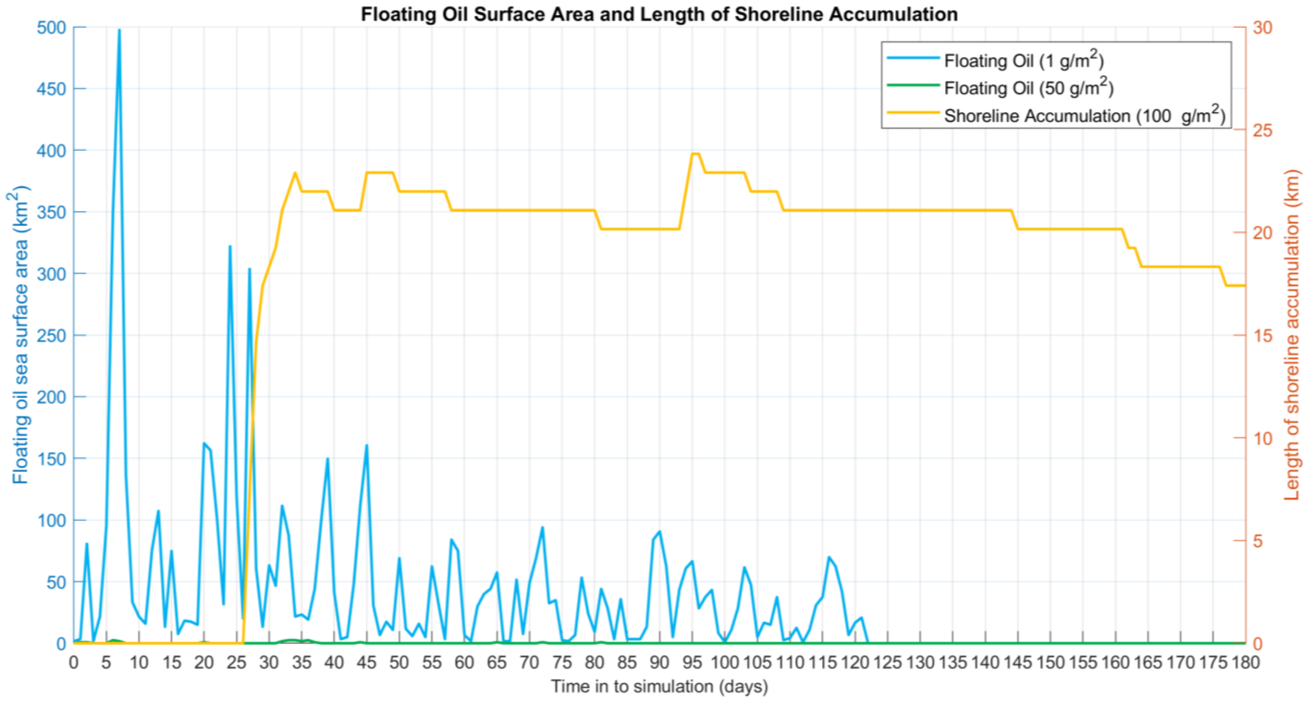


Figure 8-2 Time series of the area of visible or low exposure (1 g/m²) and actionable (50 g/m²) floating oil (left axis) and length of actionable shoreline oil (100 g/m²) (right axis) for the trajectory with the largest volume of oil ashore. Results are based on a 77,338 m³ subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days, 7 pm 30th August 2016.

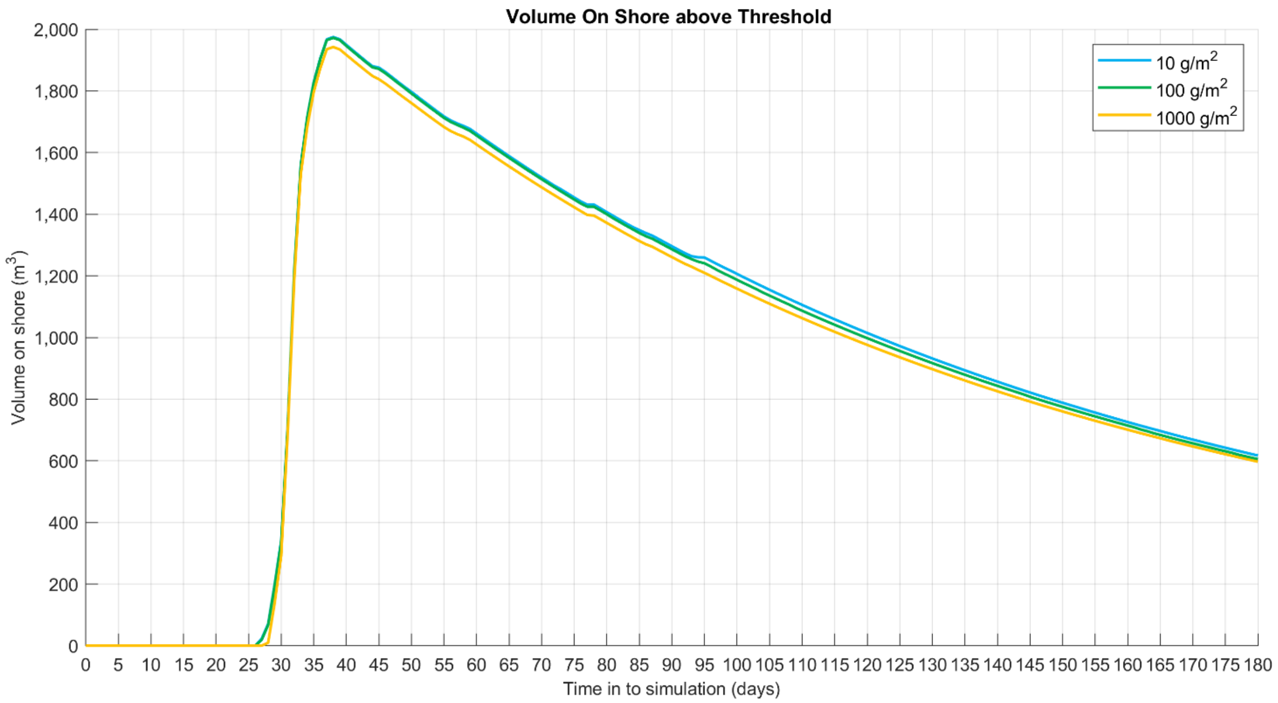


Figure 8-3 Time series of the mass on shore at the low (10 g/m²), moderate (100 g/m²) and high (1,000 g/m²) thresholds for the trajectory with the largest volume of oil ashore. Results are based on a 77,338 m³ subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days, 7 pm 30th August 2016.

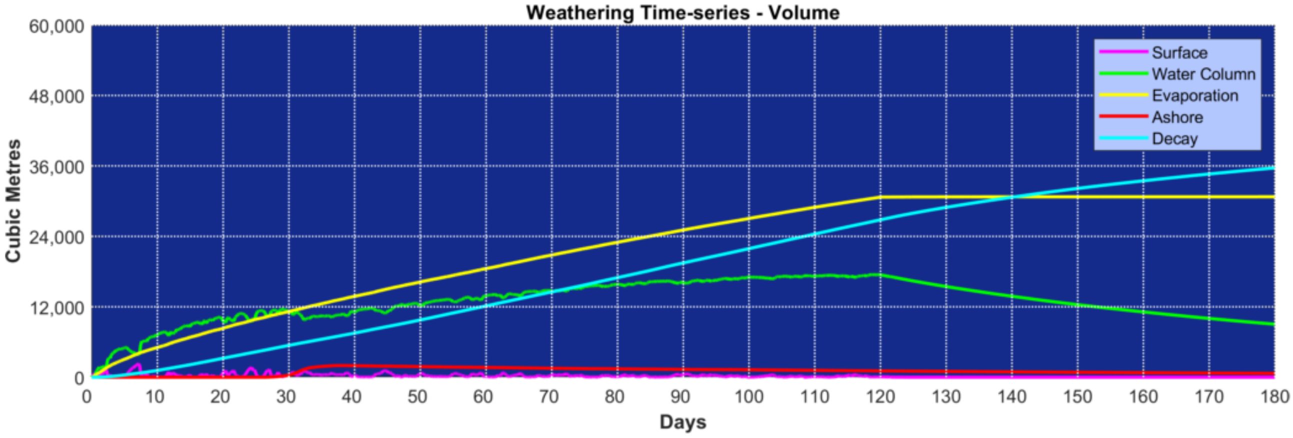


Figure 8-4 Predicted weathering and fates graph for the trajectory with the largest volume of oil ashore. Results are based on a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days, 7 pm 30th August 2016.

8.1.1.2 Deterministic Case: Longest length of shoreline accumulation above 100 g/m^2

The deterministic trajectory that resulted in the longest length of shoreline accumulation above 100 g/m^2 (194 km) was identified as run number 1 which commenced at 2 pm 23rd July 2014.

Zones of exposure from floating oil (swept area) and shoreline loading over the entire simulation is presented in Figure 8-5. When released in the environment, surface slicks were predicted to travel in all directions from the release location with shoreline accumulation predicted to occur along the Gippsland coast, NSW coastline and the eastern coastline of Flinders Island (Tasmania). Note, no oil accumulation was predicted to occur along the QLD coast.

Figure 8-6 displays the time series of the area of visible (1 g/m^2) and actionable (50 g/m^2) floating oil along with actionable shoreline accumulation (100 g/m^2) over the 180-day simulation. The maximum area of coverage of visible floating oil was predicted to occur 11 days after the spill started and covered approximately 545 km^2. While the maximum length of actionable shoreline oil at any given time was predicted as 194 km, approximately 89 days into the simulation. Figure 8-7 is a time series of the volume on shore at the low (10 g/m^2), moderate (100 g/m^2) and high (1,000 g/m^2) thresholds.

Figure 8-8 presents the fates and weathering graph for the corresponding single spill trajectory and Table 8-2 summarises the mass balance at the end of the simulation. At the conclusion of the simulation, approximately 41% spilled oil was lost to the atmosphere through evaporation. Approximately 47% of the oil was predicted to have decayed, while 11% was predicted to remain within the water column and 1% was predicted to remain ashore.

Table 8-2 Summary of the mass balance at day 180, for the trajectory that resulted in longest length of shoreline accumulation above 100 g/m^2. Results are based on a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, 2 pm 23rd July 2014.

Exposure Metrics	End of the simulation (day 180)
Surface (%)	0
Ashore (%)	0.9
Entrained (%)	11.4
Evaporated (%)	40.8
Decay (%)	47.0

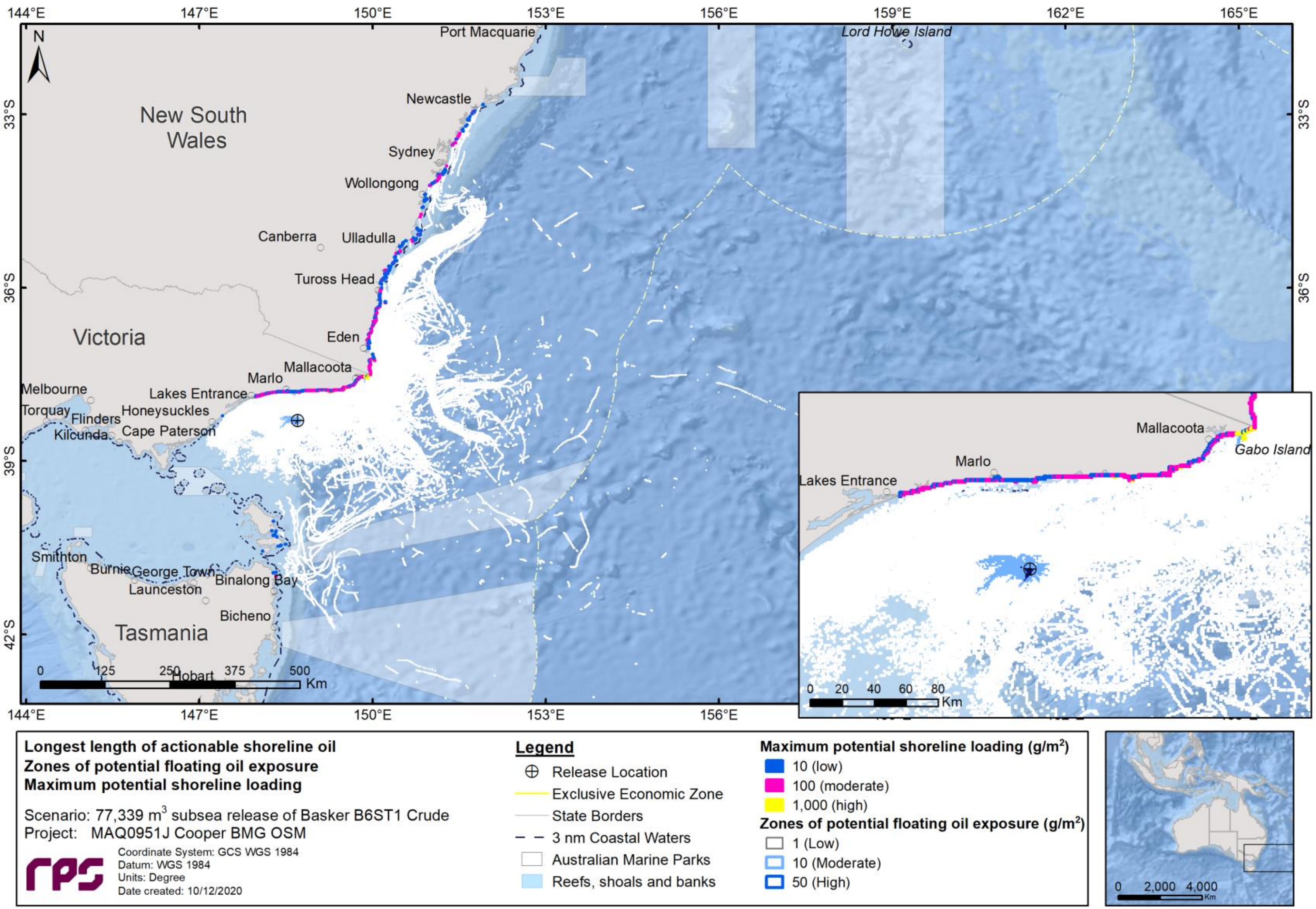


Figure 8-5 Exposure from floating oil and shoreline accumulation for the trajectory with the longest length of shoreline accumulation above 100 g/m^2. Results are based on a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days, 2 pm 23rd July 2014.

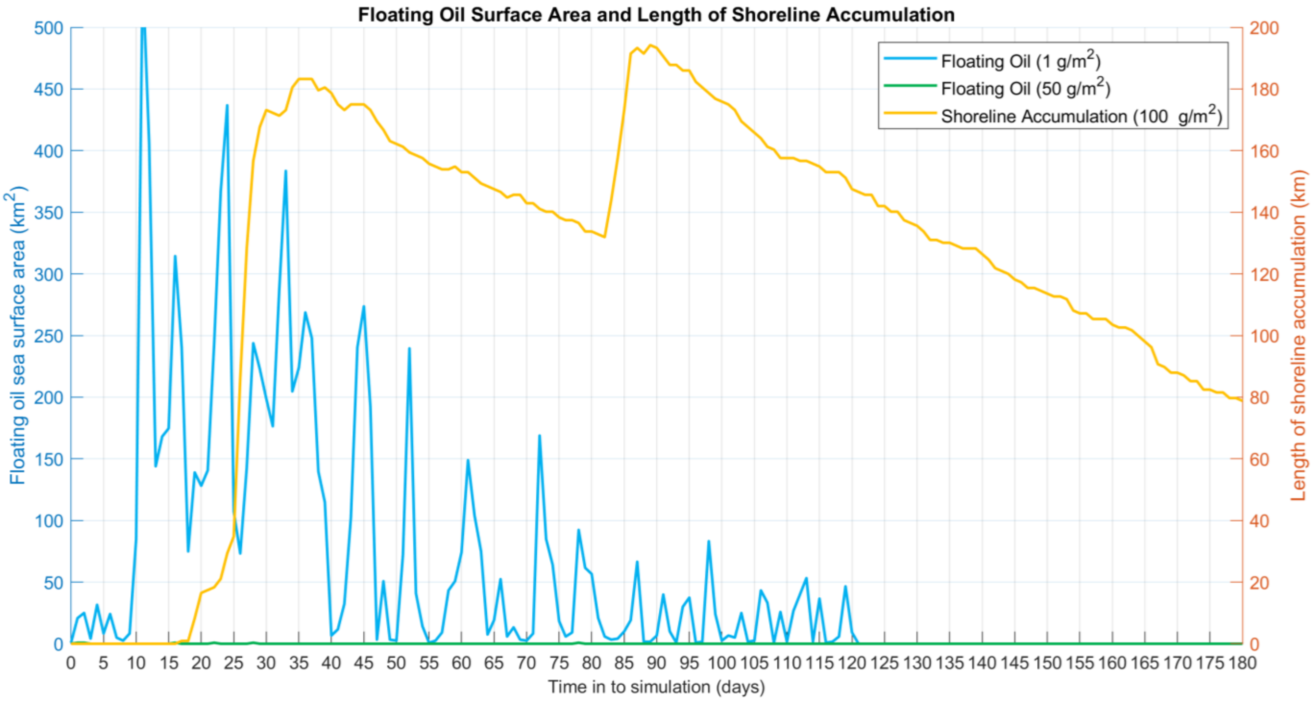


Figure 8-6 Time series of the area of visible or low exposure (1 g/m²) and actionable (50 g/m²) floating oil (left axis) and length of actionable shoreline oil (100 g/m²) (right axis) for the trajectory with the longest length of shoreline accumulation above 100 g/. Results are based on a 77,338 m³ subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days, 2 pm 23rd July 2014.

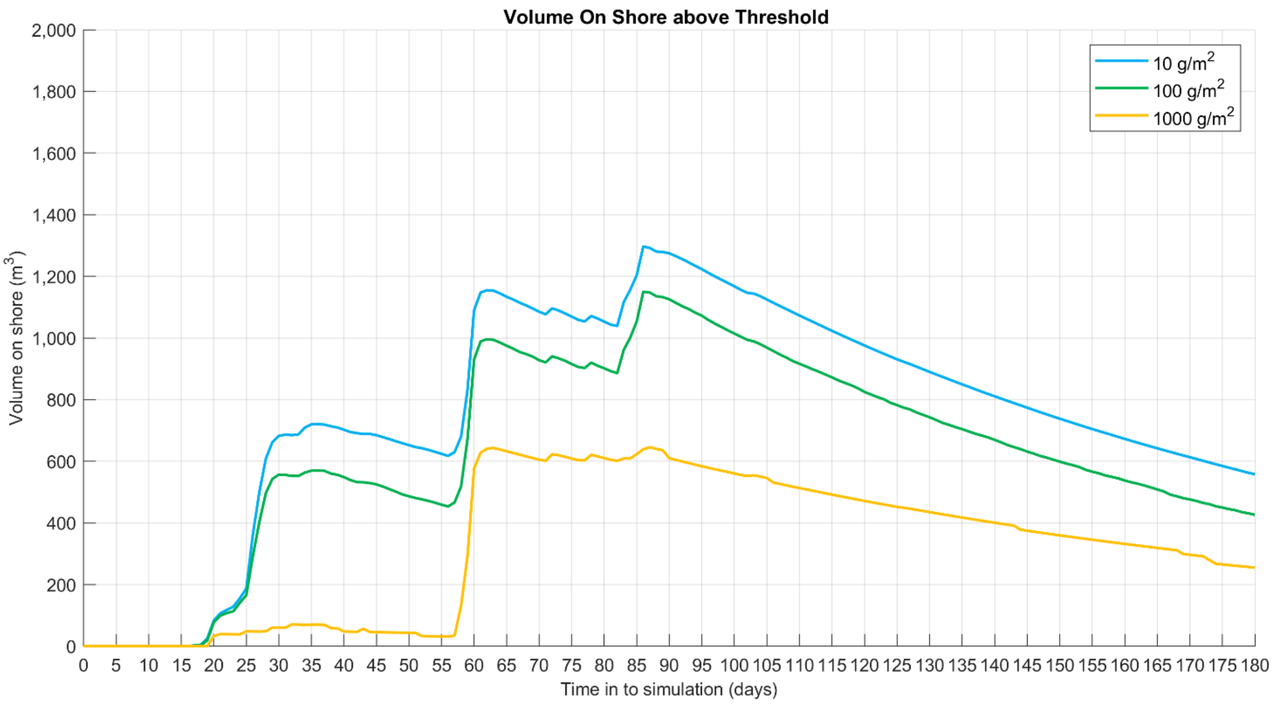


Figure 8-7 Time series of the mass on shore at the low (10 g/m²), moderate (100 g/m²) and high (1,000 g/m²) thresholds for the trajectory with the longest length of shoreline accumulation above 100 g/m². Results are based on a 77,338 m³ subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days, 2 pm 23rd July 2014.

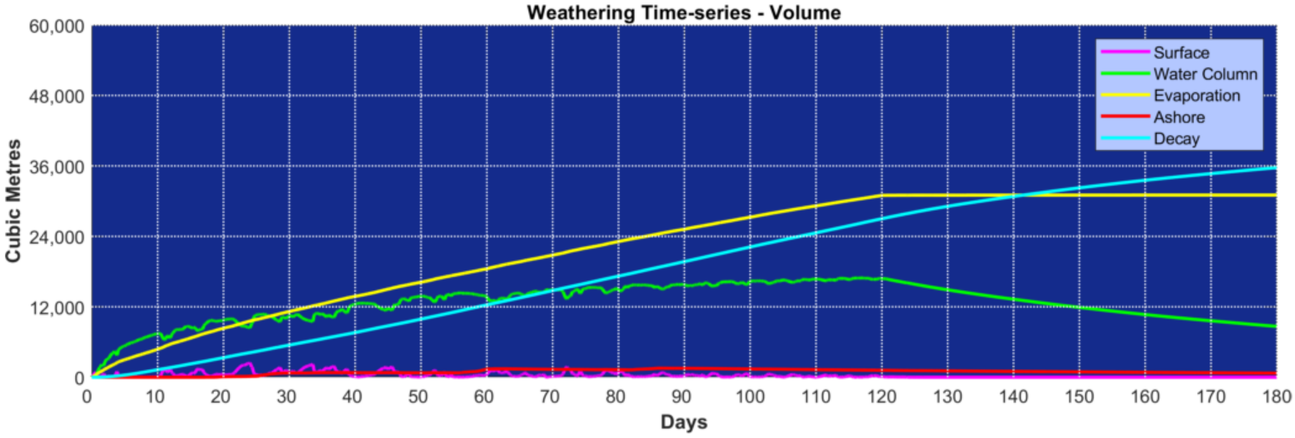


Figure 8-8 Predicted weathering and fates graph for the trajectory with the longest length of shoreline accumulation above 100 g/m^2. Results are based on a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days2 pm 23rd July 2014.

8.1.1.3 Deterministic Case: Minimum time before shoreline accumulation

The deterministic trajectory that resulted in the minimum time before shoreline accumulation at the low threshold (10 g/m^2) was identified as run number 89, which commenced at 6 pm 6th June 2011.

Zones of exposure from floating oil (swept area) and shoreline loading over the entire simulation is presented in Figure 8-9. Floating oil was predicted to travel west-southwest and east-northeast of the release location and reaching the shoreline 3.4 days after the initial release.

Figure 8-10 displays the time series of the area of visible (1 g/m^2) and actionable (50 g/m^2) floating oil along with actionable shoreline accumulation (100 g/m^2) over the 180-day simulation. The maximum area of coverage of visible floating oil was predicted to occur 68 days after the spill started and covered approximately 212 km^2. While the maximum length of actionable shoreline oil at any given time was predicted as 29 km and occurred on day 48 and day 112 into the simulation. Figure 8-11 is a time series of the volume on shore at the low (10 g/m^2), moderate (100 g/m^2) and high (1,000 g/m^2) thresholds.

Figure 8-12 presents the fates and weathering graph for the corresponding single spill trajectory and Table 8-3 summarises the mass balance at the end of the simulation. At the conclusion of the simulation, approximately 41% spilled oil was lost to the atmosphere through evaporation. Approximately 47% of the oil was predicted to have decayed, while 12% was predicted to remain within the water column and <1% was predicted to remain ashore.

Table 8-3 Summary of the mass balance at day 180, for the trajectory that resulted in the minimum time before shoreline accumulation above the low threshold (10 g/m^2). Results are based on a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, 6 pm 6th June 2011.

Exposure Metrics	End of the simulation (day 180)
Surface (%)	0
Ashore (%)	0.3
Entrained (%)	11.6
Evaporated (%)	40.6
Decay (%)	47.4

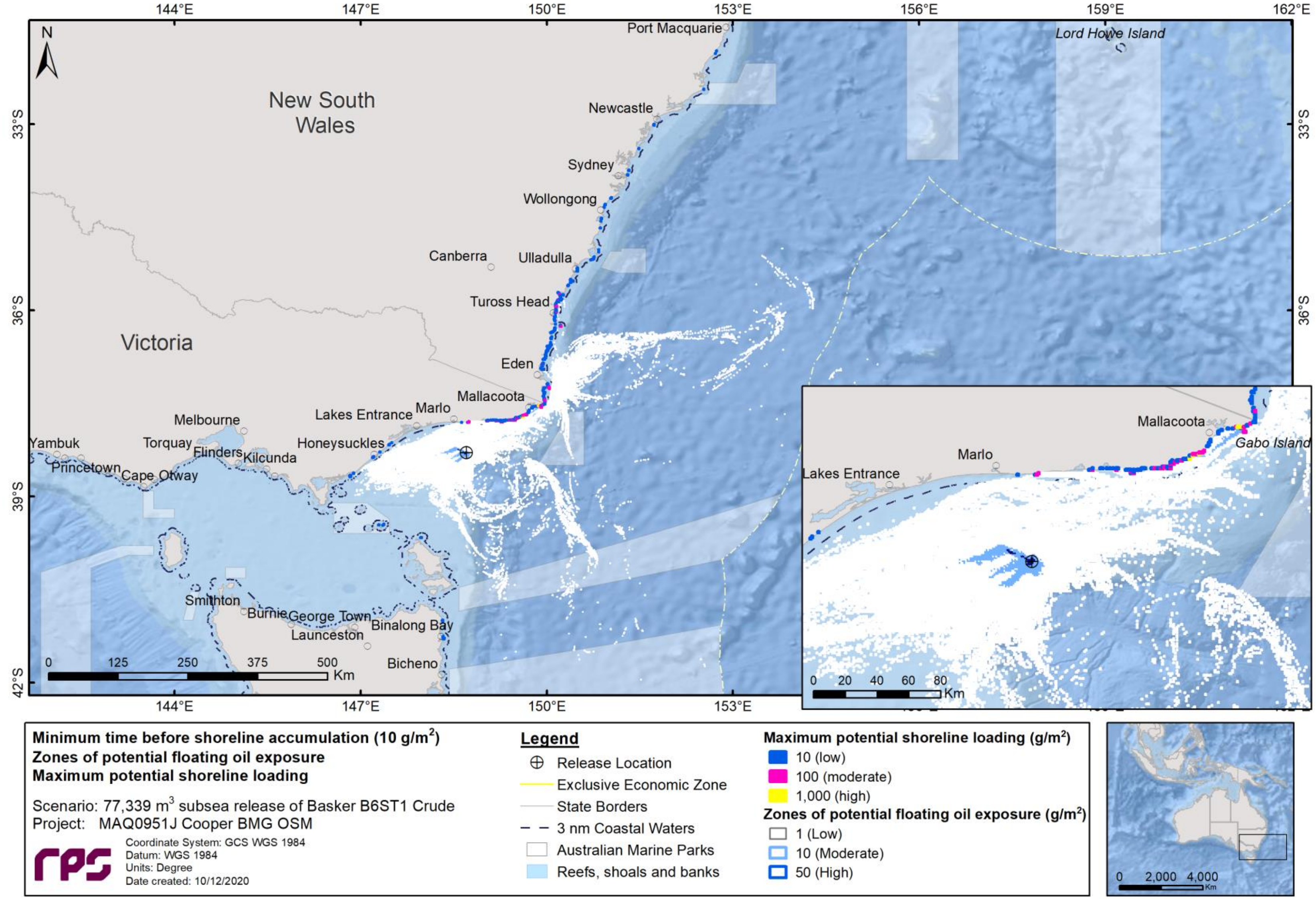


Figure 8-9 Exposure from floating oil and shoreline accumulation for the trajectory with the minimum time before shoreline accumulation at, or above the low threshold. Results are based on a 77,338 m³ subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days, 6 pm 6th June 2011.

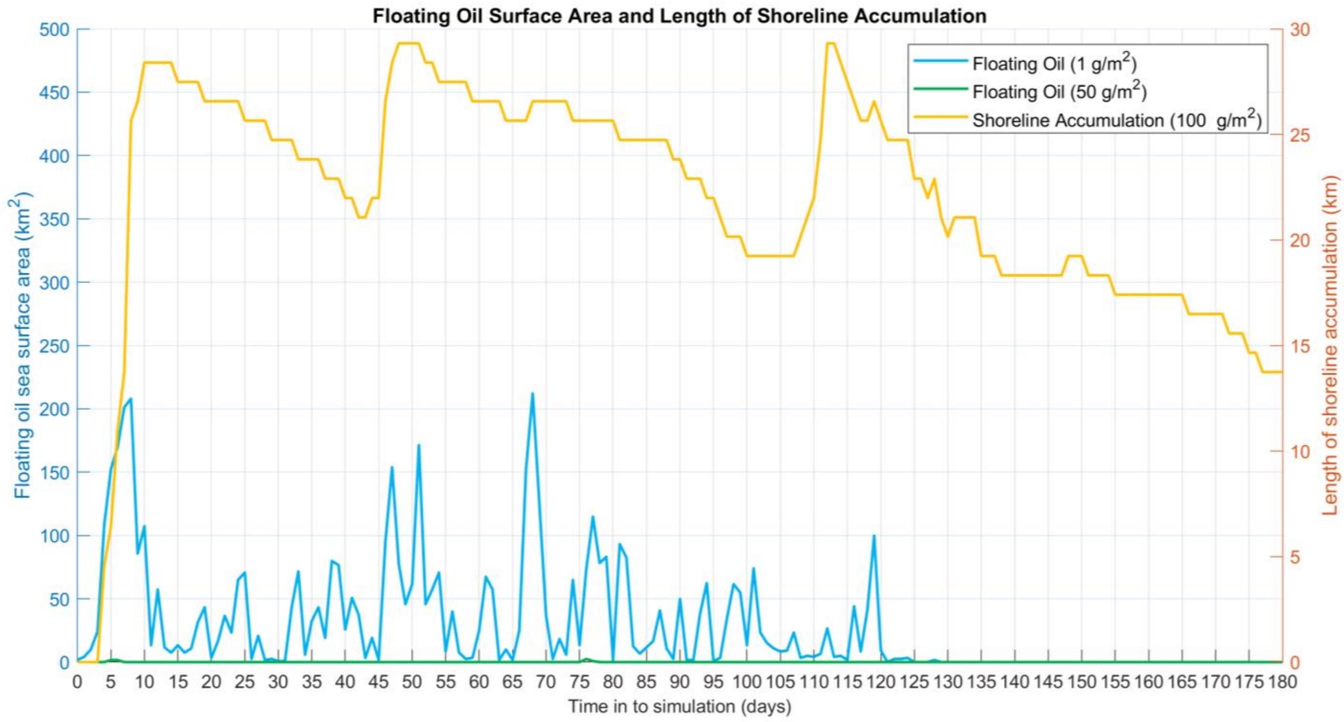


Figure 8-10 Time series of the area of low exposure (1 g/m²) and actionable (50 g/m²) floating oil (left axis) and length of actionable shoreline oil (100 g/m²) (right axis) for the trajectory with the minimum time before shoreline accumulation at, or above the low threshold. Results are based on a 77,338 m³ subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days, 6 pm 6th June 2011.

Figure 8-11 Time series of the mass on shore at the low (10 g/m²), moderate (100 g/m²) and high (1,000 g/m²) thresholds for the trajectory with the minimum time before shoreline accumulation at, or above the low threshold. Results are based on a 77,338 m³ subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days, 6 pm 6th June 2011.

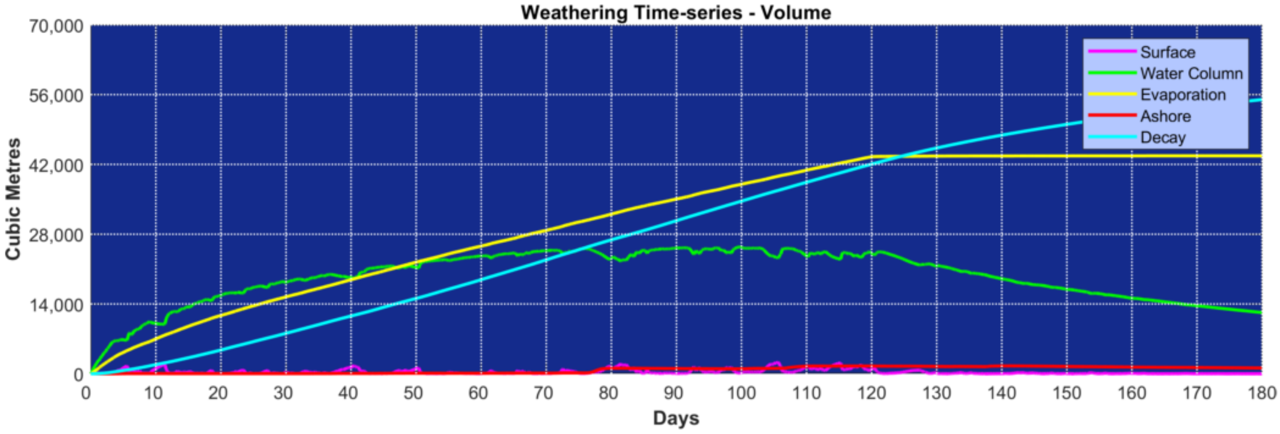


Figure 8-12 Predicted weathering and fates graph for the trajectory with the minimum time before shoreline accumulation at, or above the low threshold. Results are based on a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days, 6 pm 6th June 2011.

8.1.1.4 Deterministic Case: Largest area of floating oil above 10 g/m^2

The deterministic trajectory that resulted in the largest area of floating oil above 10 g/m^2 was identified as run number 8, which commenced at 9 am 23rd August 2012.

Zones of exposure from floating oil (swept area) and shoreline loading over the entire simulation is presented in Figure 8-13. Floating oil was predicted to travel east and northeast of the release location with potential shoreline accumulation along the Gippsland coast and southern NSW coastline.

Figure 8-14 the time series of the area of visible (1 g/m^2) and actionable (50 g/m^2) floating oil along with actionable shoreline accumulation (100 g/m^2) over the 180-day simulation. The maximum area of coverage of visible floating oil was predicted to occur 41 days after the spill started and covered approximately 438 km^2. While the maximum length of actionable shoreline oil at any given time was predicted as 72 km, approximately 67 days into the simulation. Figure 8-15 is a time series of the volume on shore at the low (10 g/m^2), moderate (100 g/m^2) and high (1,000 g/m^2) thresholds.

Figure 8-16 presents the fates and weathering graph for the corresponding single spill trajectory and Table 8-4 summarises the mass balance at the end of the simulation. At the conclusion of the simulation, approximately 41% spilled oil was lost to the atmosphere through evaporation. Approximately 47% of the oil was predicted to have decayed, while 12% was predicted to remain within the water column and <1% was predicted to remain ashore.

Table 8-4 Summary of the mass balance at day 180, for the trajectory that resulted in the largest area of floating oil above 10 g/m^2. Results are based on a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, 9 am 23rd August 2012.

Exposure Metrics	End of the simulation (day 180)
Surface (%)	0.0
Ashore (%)	0.6
Entrained (%)	11.9
Evaporated (%)	40.9
Decay (%)	46.6

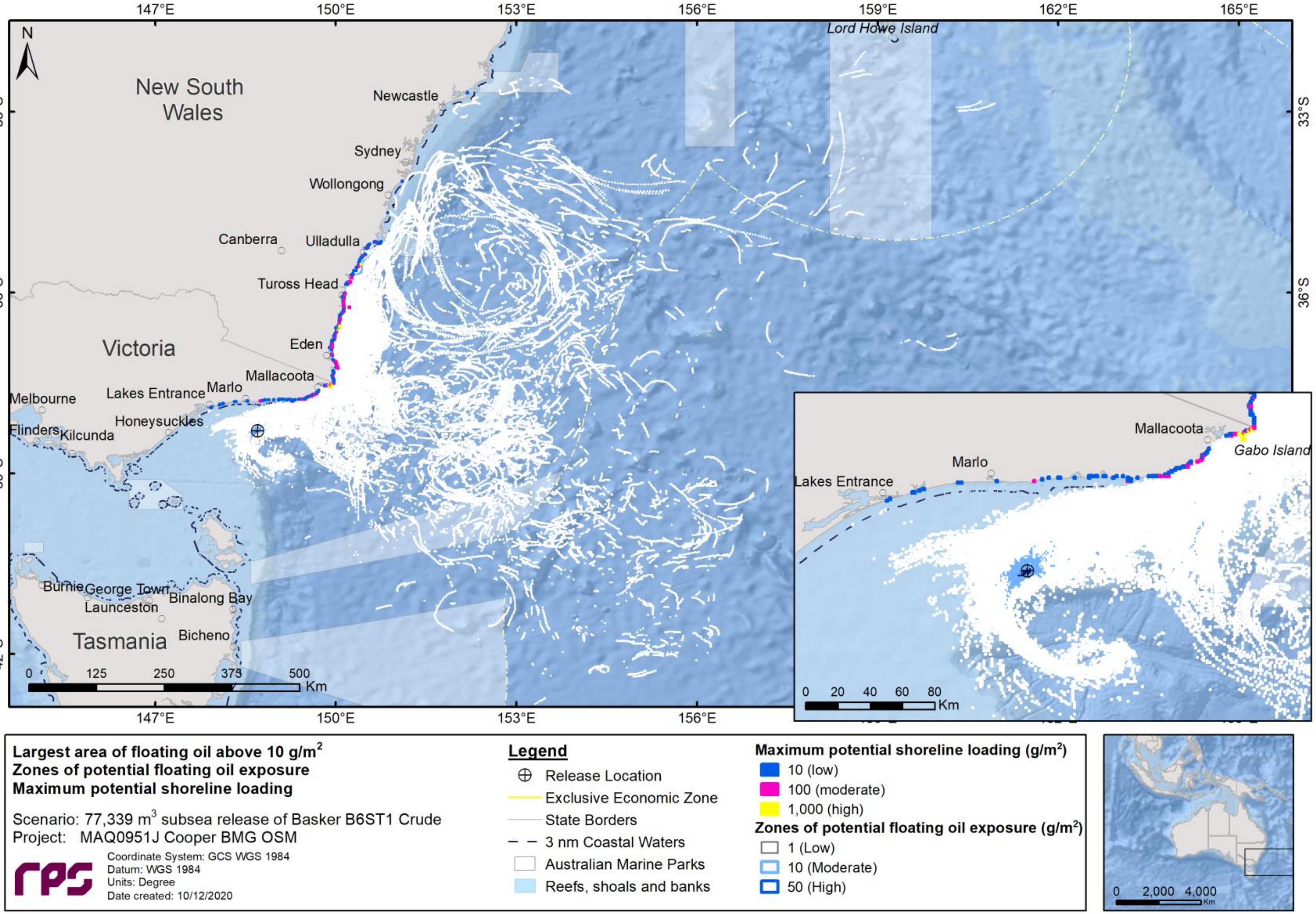


Figure 8-13 Exposure from floating oil and shoreline accumulation for the trajectory with the largest area of floating oil above 10 g/m². Results are based on a 77,338 m³ subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days, 9 am 23rd August 2012.

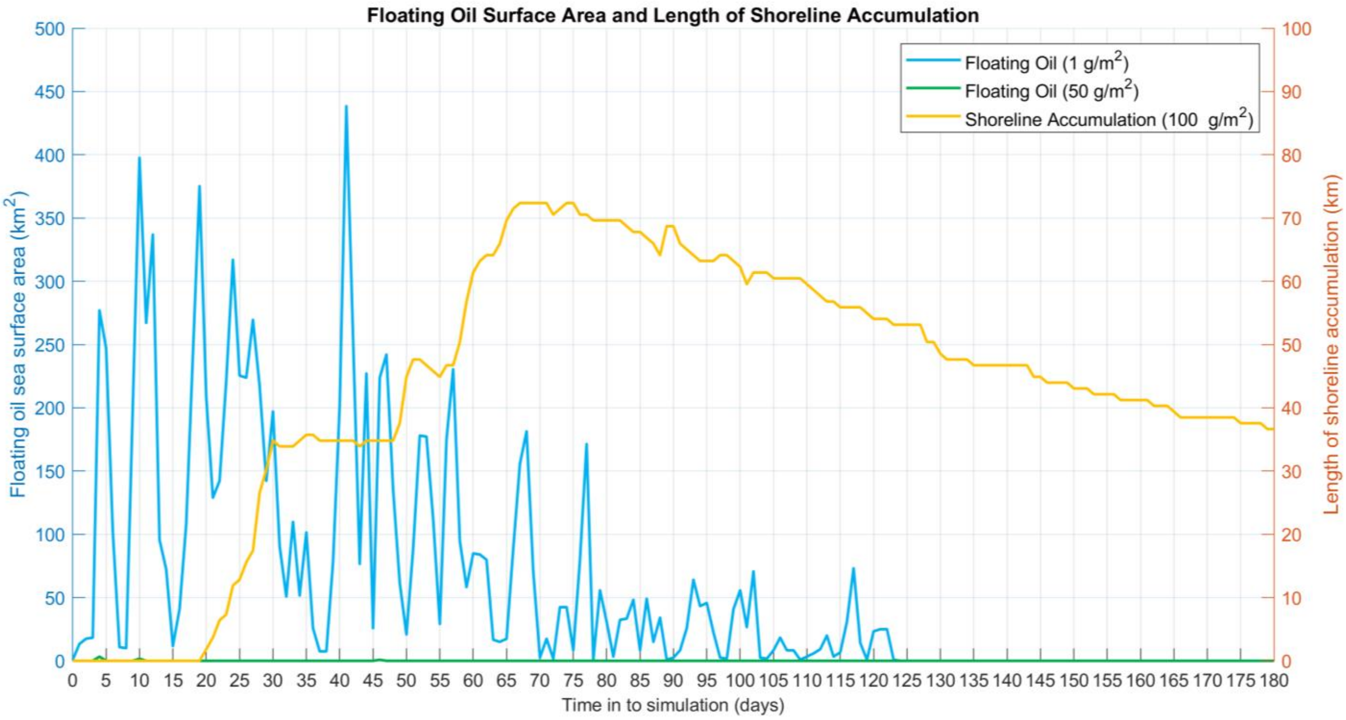


Figure 8-14 Time series of the area of low exposure (1 g/m²) and actionable (50 g/m²) floating oil (left axis) and length of actionable shoreline oil (100 g/m²) (right axis) for the trajectory with the largest area of floating oil above 10 g/m². Results are based on a 77,338 m³ subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days, 9 am 23rd August 2012.

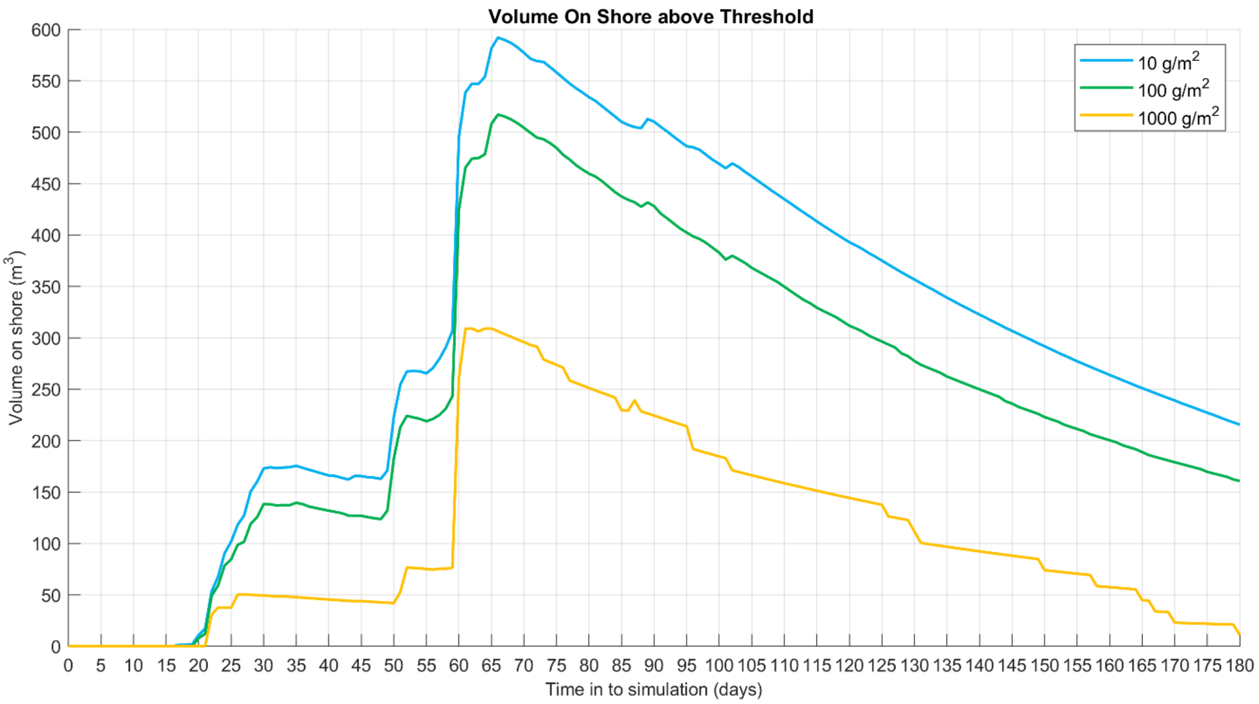


Figure 8-15 Time series of the mass on shore at the low (10 g/m²), moderate (100 g/m²) and high (1,000 g/m²) thresholds for the trajectory with the largest area of floating oil above 10 g/m². Results are based on a 77,338 m³ subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days, 9 am 23rd August 2012.

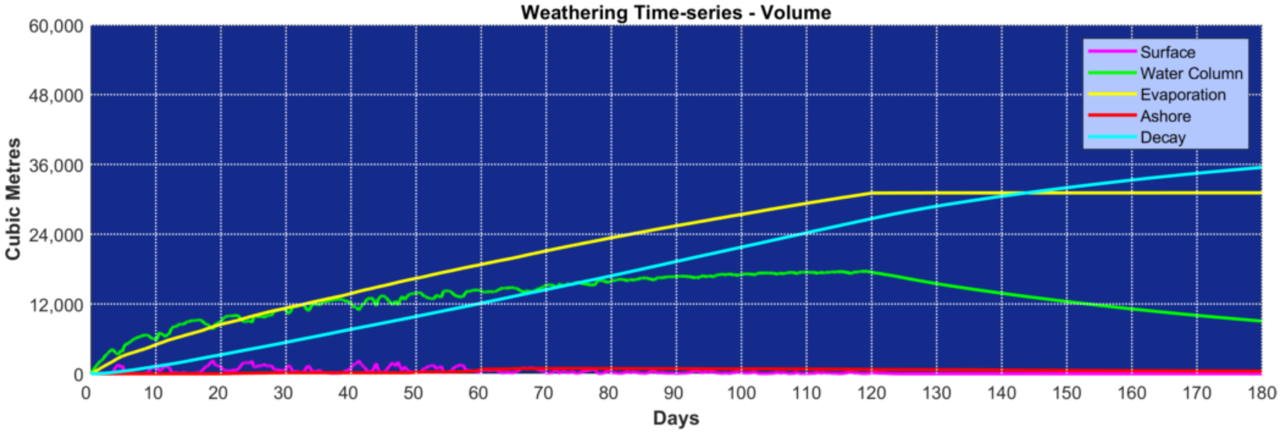


Figure 8-16 Predicted weathering and fates graph for the trajectory with the largest area of floating oil above 10 g/m^2. Results are based on a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days, 9 am 23rd August 2012.

8.1.1.5 Deterministic Case: Largest swept area of entrained oil exposure above 10 ppb

The deterministic trajectory that resulted in the largest swept area of entrained oil exposure above 10 ppb (or low threshold) was identified as run number 20, which commenced at 8 pm 4th January 2015.

Zones of exposure from entrained oil (swept area) over the entire simulation is presented in Figure 8-17. Entrained oil was predicted to drift vast distances in all directions from the release location.

Figure 8-18 displays the time series of the area of entrained oil at the low (10 ppb) and moderate (100 ppb) thresholds over the 180-day simulation. The maximum area of coverage of low entrained oil exposure was predicted to occur 55 days after the spill started and covered approximately 45,000 km^2.

Figure 8-19 presents the fates and weathering graph for the corresponding single spill trajectory and Table 8-5 summarises the mass balance at the end of the simulation. At the conclusion of the simulation, approximately 40% spilled oil was lost to the atmosphere through evaporation. Approximately 47% of the oil was predicted to have decayed, while approximately 12% was predicted to remain within the water column and <1% m^3 (1%) was predicted to remain ashore.

Table 8-5 Summary of the mass balance at day 180, for the trajectory that resulted in the largest swept area of entrained oil exposure above 10 ppb. Results are based on a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, 8 pm 4th January 2015.

Exposure Metrics	End of the simulation (day 180)
Surface (%)	0.0
Ashore (%)	0.1
Entrained (%)	12.3
Evaporated (%)	40.2
Decay (%)	47.4

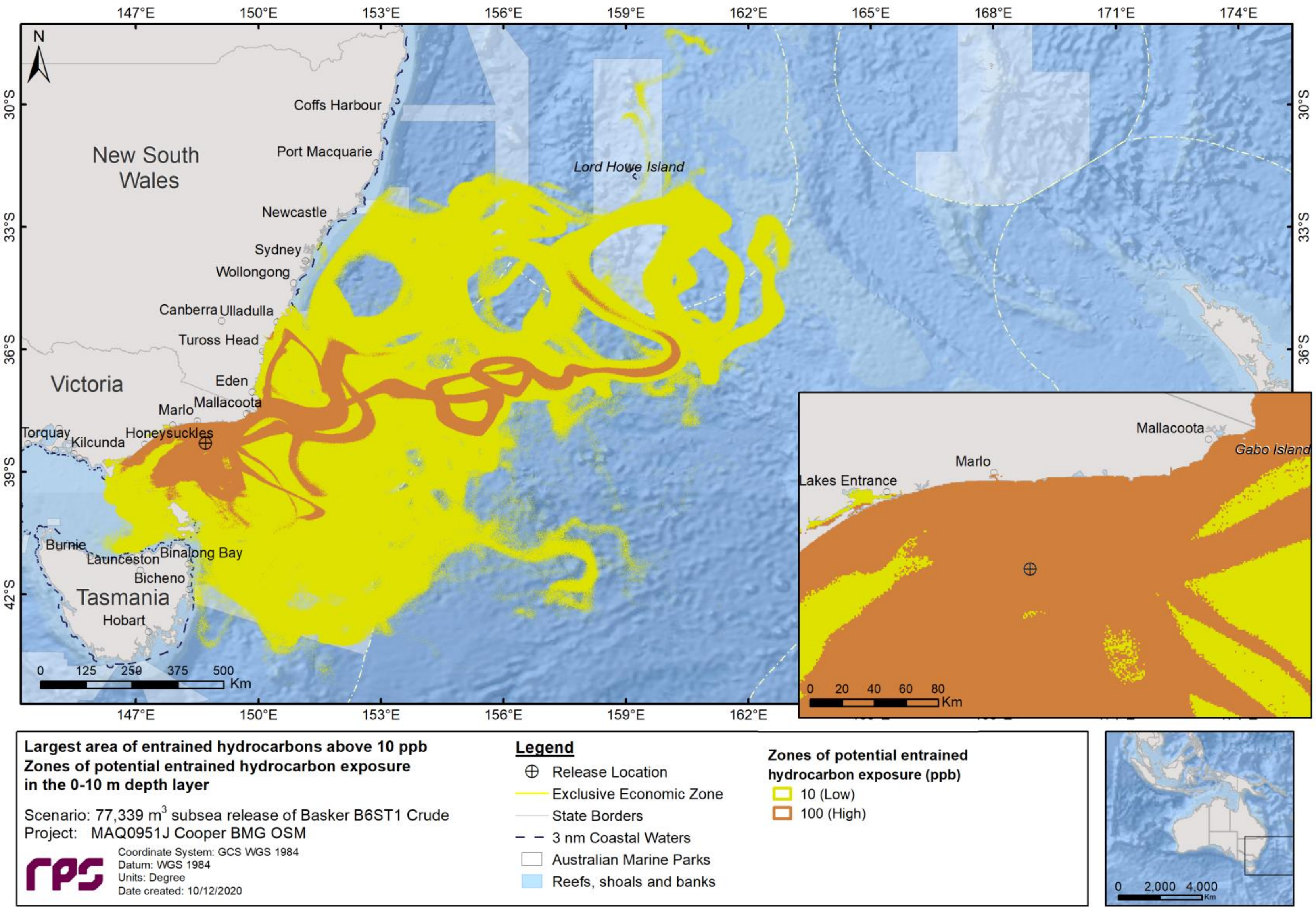


Figure 8-17 Exposure from entrained oil for the trajectory with largest swept area of entrained oil exposure above 10 ppb. Results are based on a 77,338 m³ subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days, 8 pm 4th January 2015.

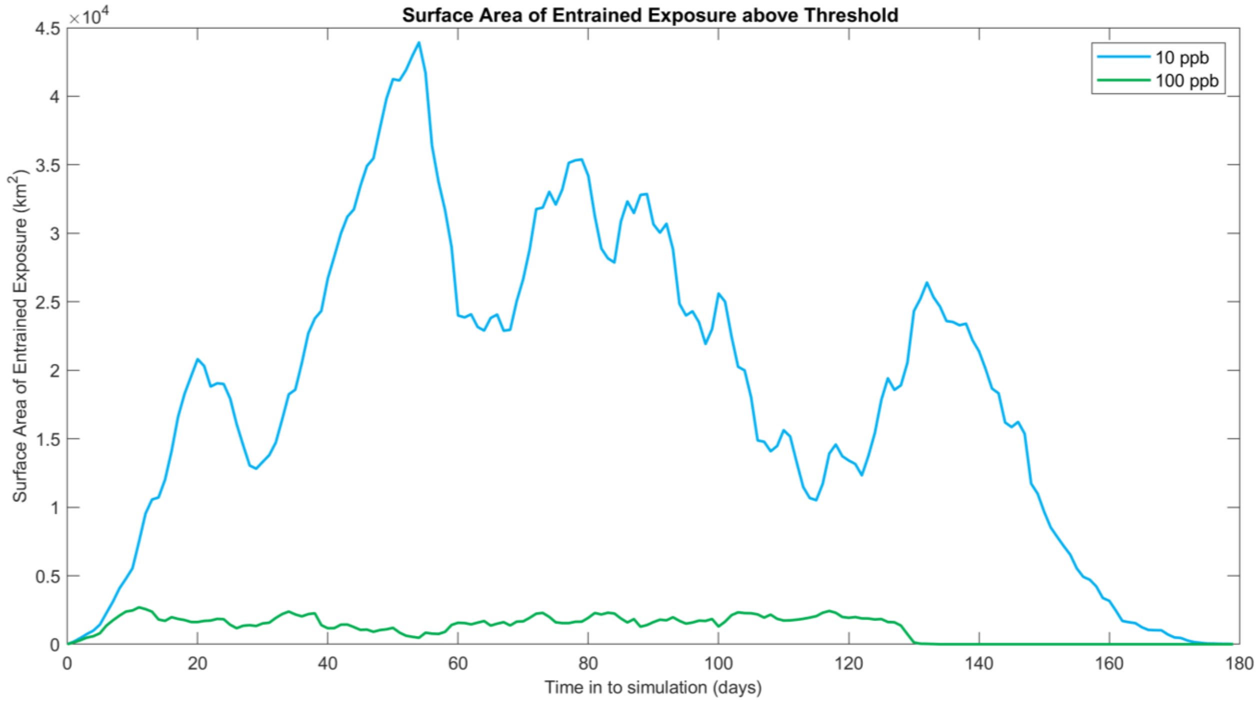


Figure 8-18 Time series of the area of low (10 ppb) and moderate (100 ppb) entrained oil exposure for the trajectory with the largest swept area of entrained oil above 10 ppb. Results are based on a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days, 8 pm 4th January 2015.

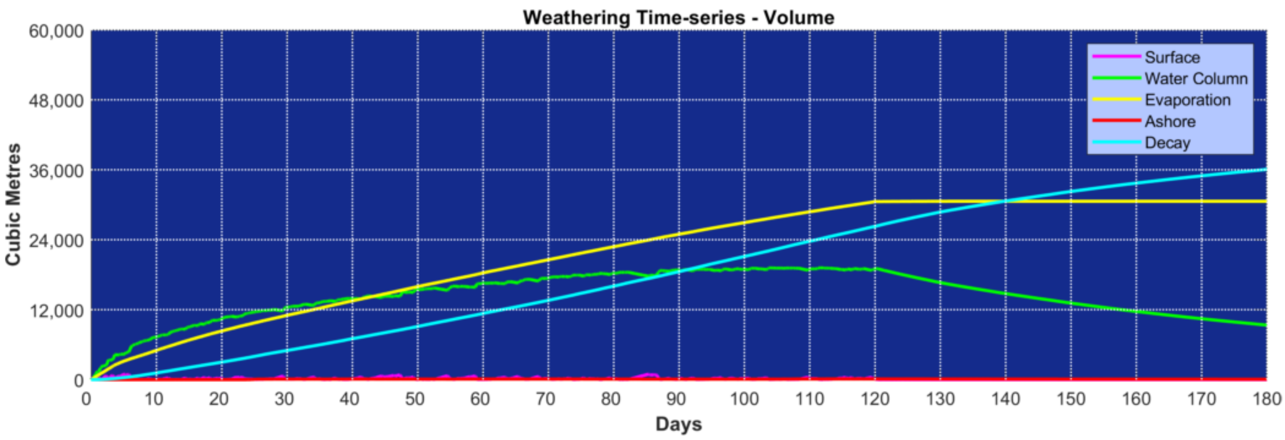


Figure 8-19 Predicted weathering and fates graph for the trajectory with the largest swept area of entrained oil above 10 ppb. Results are based on a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days, 8 pm 4th January 2015.

8.1.1.6 Deterministic Case: Largest swept area of dissolved hydrocarbon above 10 ppb

The deterministic trajectory that resulted in the largest swept area of dissolved hydrocarbon exposure above 10 ppb (or low threshold) was identified as run number 99, which commenced at 5 pm 16th February 2015.

Zones of exposure from dissolved hydrocarbons over the entire simulation is presented in Figure 8-17. Dissolved hydrocarbons were predicted to occur predominantly towards the Gippsland coast and southern NSW coastline to the south and east into offshore waters.

Figure 8-18 displays the time series of the area of dissolved hydrocarbons at the low (10 ppb), moderate (50 ppb) and high (400 ppb) thresholds over the 180-day simulation. The maximum area of coverage of low dissolved hydrocarbon exposure was predicted to occur 18 days after the spill started and covered approximately 900 km^2.

Figure 8-19 presents the fates and weathering graph for the corresponding single spill trajectory and Table 8-5 summarises the mass balance at the end of the simulation. At the conclusion of the simulation, approximately 40% spilled oil was lost to the atmosphere through evaporation. Approximately 48% of the oil was predicted to have decayed, while approximately 12% was predicted to remain within the water column and <1% was predicted to remain ashore.

Table 8-6 Summary of the mass balance at day 180, for the trajectory that resulted in the largest swept area of dissolved hydrocarbon exposure above 10 ppb. Results are based on a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, 5 pm 16th February 2015.

Exposure Metrics	End of the simulation (day 180)
Surface (m^3)	0.0
Ashore (m^3)	0.1
Entrained (m^3)	12.0
Evaporated (m^3)	40.3
Decay (m^3)	47.6

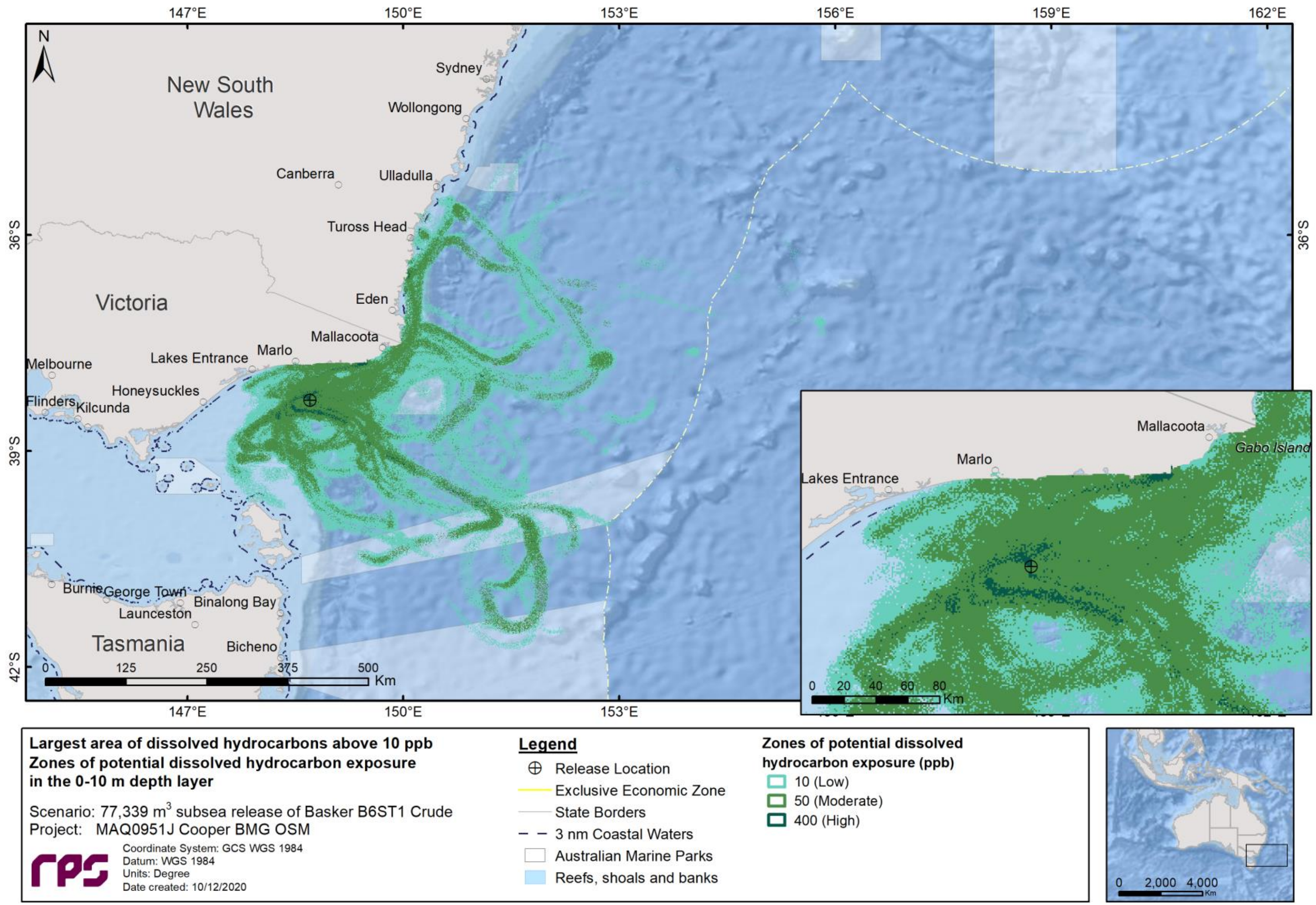


Figure 8-20 Exposure from floating oil for the trajectory with largest swept area of dissolved hydrocarbon exposure above 10 ppb. Results are based on a 77,338 m³ subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days, 5 pm 16th February 2015.

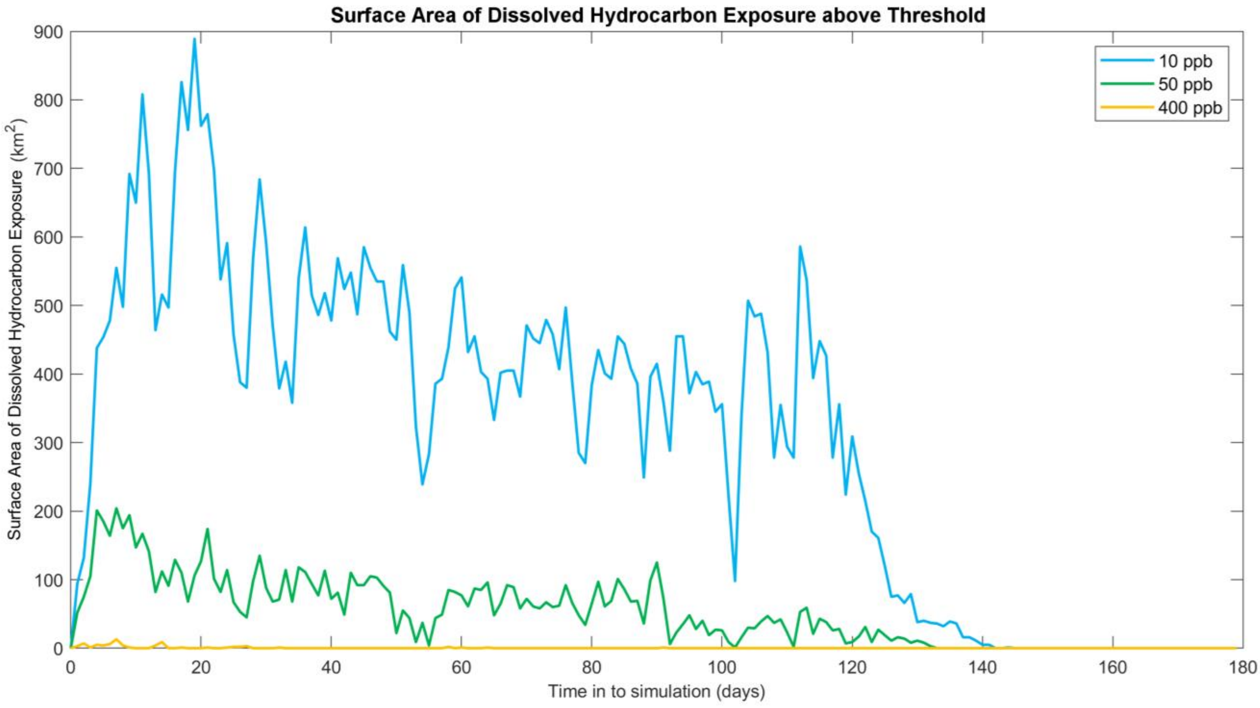


Figure 8-21 Time series of the area of low, moderate and high dissolved hydrocarbon exposure for the trajectory with the largest swept area of dissolved hydrocarbon exposure above 10 ppb. Results are based on a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days, 5 pm 16th February 2015.

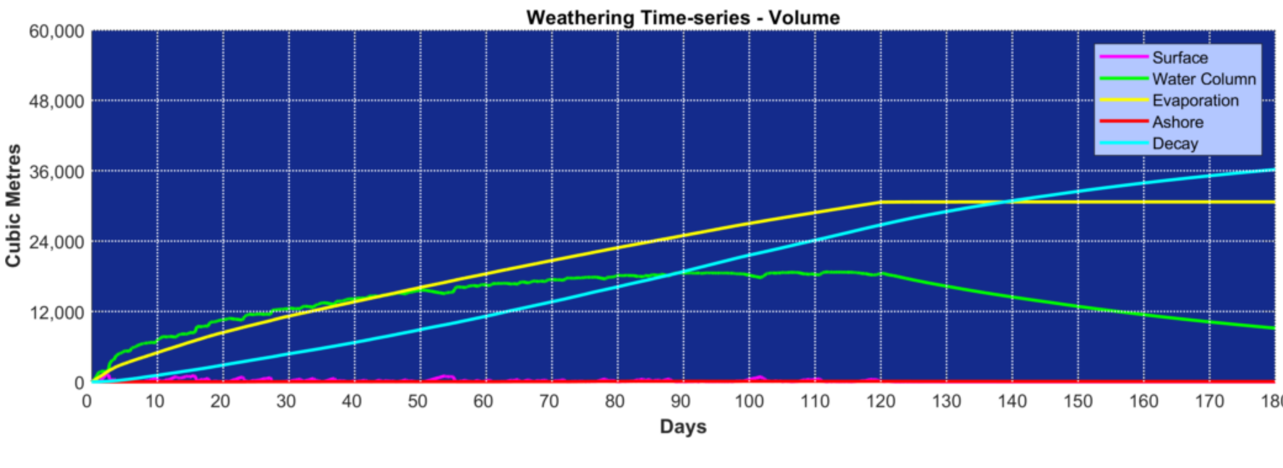


Figure 8-22 Predicted weathering and fates graph for the trajectory with the largest swept area of dissolved hydrocarbon exposure above 10 ppb. Results are based on a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days, 5 pm 16th February 2015.

8.1.1.7 Additional Deterministic Cases: Largest volume of oil ashore for NSW, Vic, NSW and Tas

Figure 8-23 to Figure 8-26 illustrate the single spill trajectory resulting in the largest volume of oil ashore predicted for the New South Wales, Victoria, Queensland and Tasmania. Animated GIFs were created for those runs displaying daily time interval over the 180-day simulations.

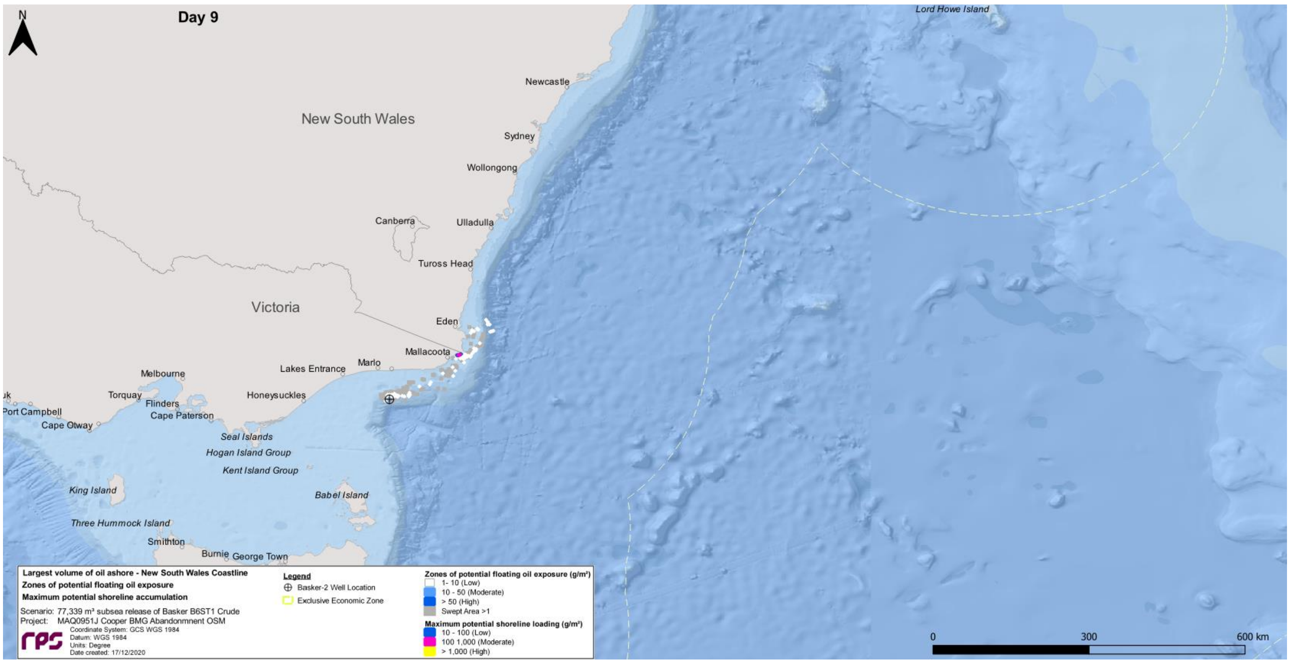


Figure 8-23 Exposure from floating oil at day 9, resulting from the trajectory with the largest volume ashore predicted for New South Wales.

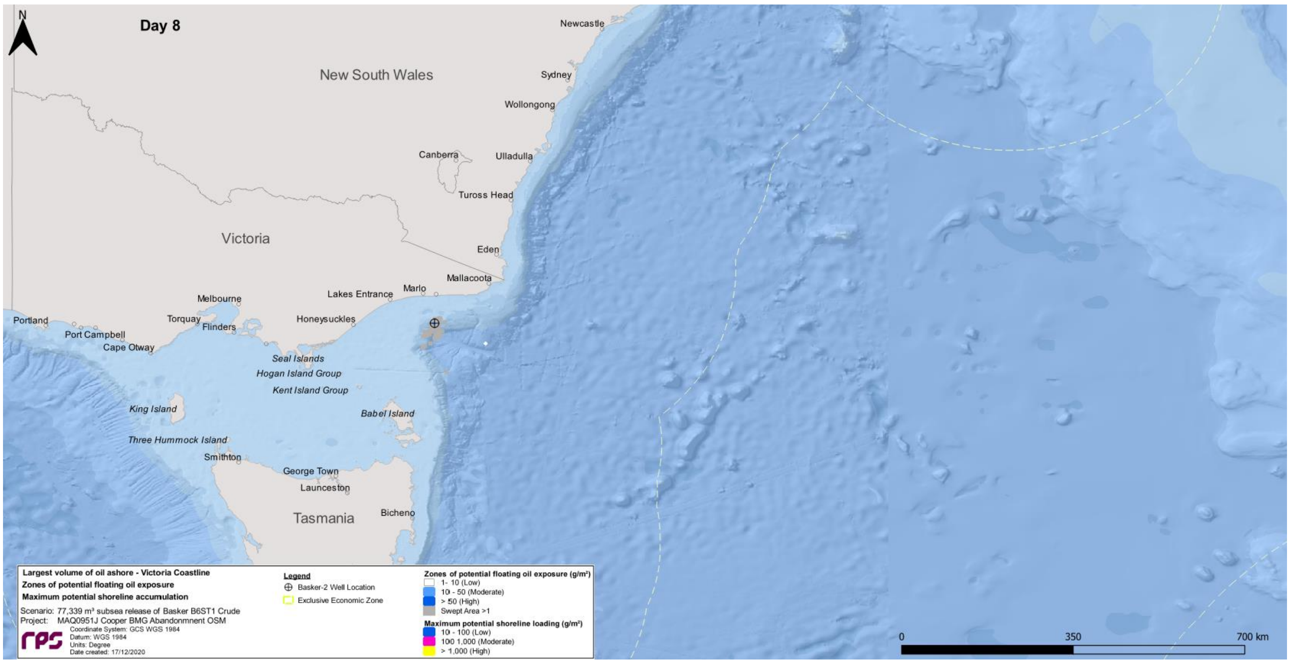


Figure 8-24 Exposure from floating oil at day 9, resulting from the trajectory with the largest volume ashore predicted for Victoria.

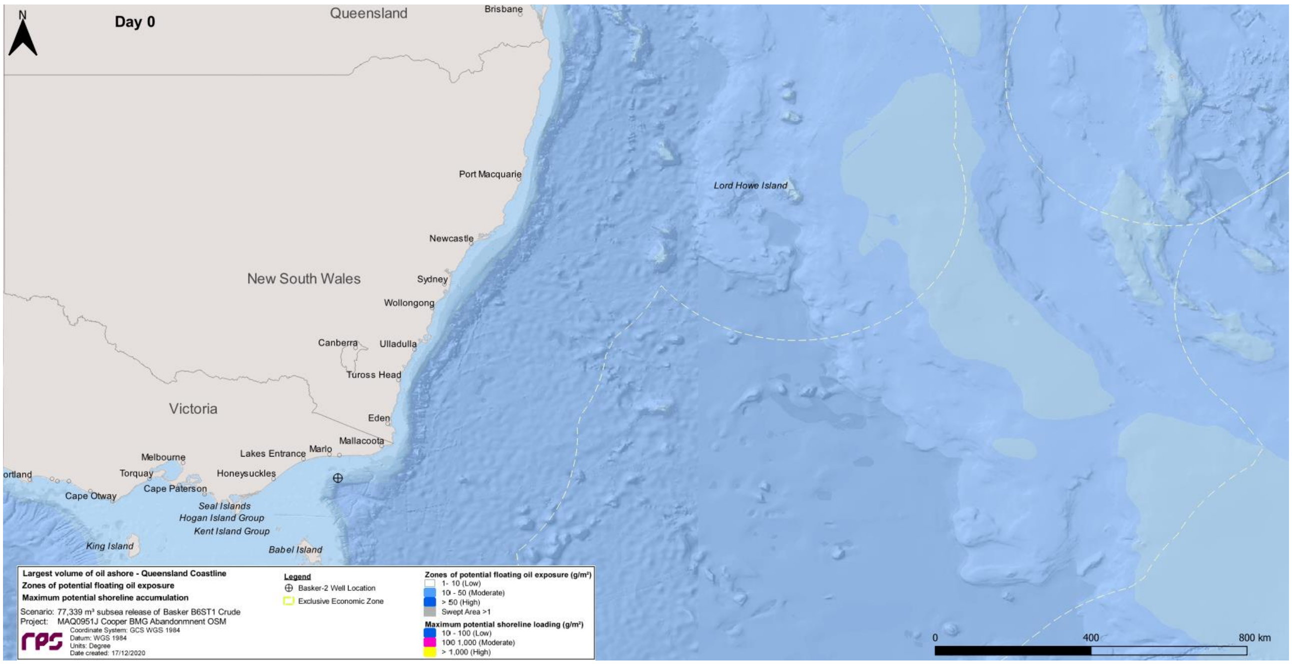


Figure 8-25 Exposure from floating oil at day 9, resulting from the trajectory with the largest volume ashore predicted for Queensland.

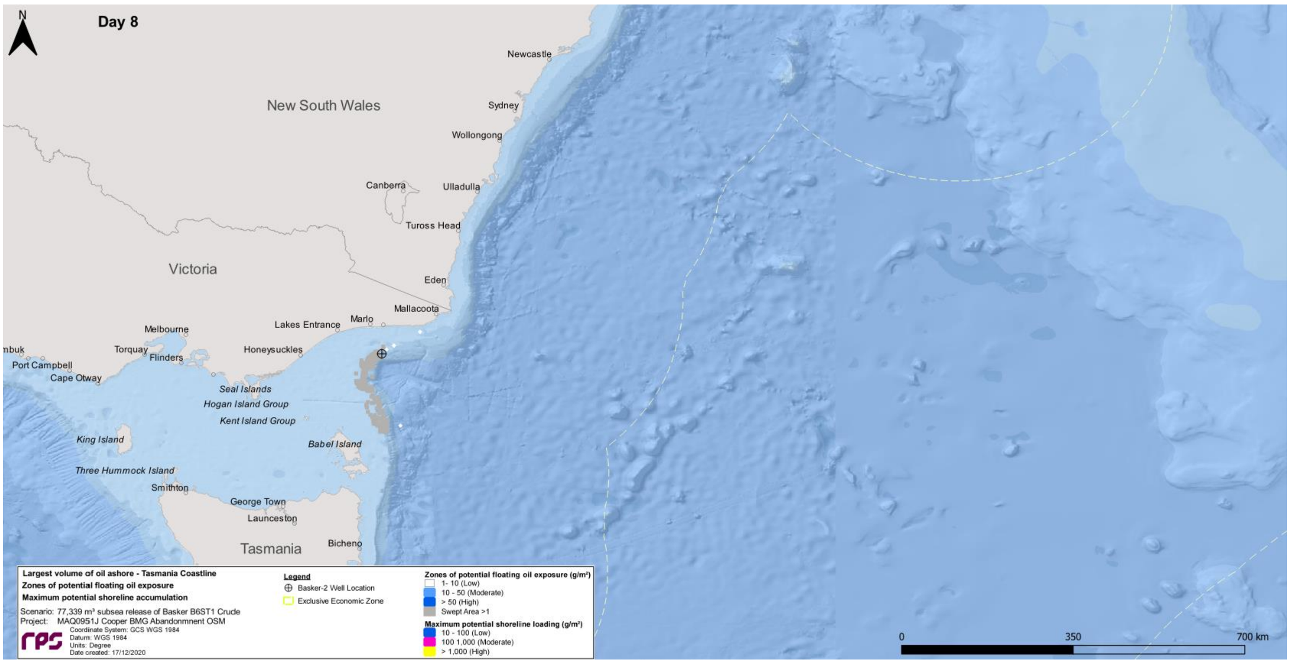


Figure 8-26 Exposure from floating oil at day 9, resulting from the trajectory with the largest volume ashore predicted for Tasmania.

8.1.2 Stochastic Analysis

8.1.2.1 Floating Oil Exposure

Table 8-7 summarises the maximum distances from the release location to floating oil exposure zones. The maximum distance from the release location to the low (≥ 1 g/m^2), moderate (≥ 10 g/m^2) and high (≥ 50 g/m^2) exposure thresholds was 1,540 km northeast, 386 km northeast and 140 km east northeast, respectively.

Table 8-8 presents the potential floating oil exposure to individual receptors during annual conditions.

A total of 65 Biologically Important Areas (BIAs) were predicted to be exposed to floating oil at or above the low threshold during annualised conditions. Aside from the 11 BIAs that the release location resides within (see Section 6.3), the highest probability of low, moderate and high floating oil exposure was predicted at the Southern Right Whale - Migration BIA with 100%, 100% and 72%, respectively. This same receptor also recorded the minimum time before floating oil exposure at the low, moderate and high thresholds with 0.04 days (1 hour), 0.04 days (1 hour) and 0.13 days (3 hours), respectively. It is important to note that the Southern Right Whale - Migration BIA boundary lies approximately 1.9 km northeast of the release location.

Eight Australian Marine Parks (AMPs) were predicted to be exposed to floating oil at the low threshold. East Gippsland recorded the highest probability of low exposure with 83% which was followed by Flinders AMP, recording a 62% probability of exposure. The minimum time before low floating oil exposure at an AMP was predicted at East Gippsland with 2.5 days.

A total of two Reefs, Shoals and Banks (RSB) were predicted to be exposed to floating oil at the low threshold. Beware Reef and the New Zealand Star Bank recorded 34% and 74% probabilities of exposure, respectively, while the minimum time before low floating oil exposure was 1.75 days, predicted at the New Zealand Star Bank.

Floating oil at, or above the low threshold was predicted to cross into New South Wales, Tasmania and Victoria state waters with probabilities of 82%, 4% and 99%, respectively. The minimum time before floating oil at the low threshold crossed state waters was 3.25 days, 24.88 days and 2.08 days for New South Wales, Tasmania and Victoria, respectively.

Figure 8-27 presents the zones of floating oil exposure for the NOPSEMA thresholds under annualised conditions.

Table 8-7 Maximum distance and direction from the release location to floating oil exposure thresholds. Results are based on a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days during annual conditions. The results were calculated from 100 spill trajectories.

Season	Distance and direction	Zones of potential floating oil exposure		
		Low	Moderate	High
Annual	Max. distance from release site (km)	1,540	386	140
	Max distance from release site (km) (99th percentile)	987	357	36
	Direction	NE	NE	ENE

Table 8-8 Summary of the potential floating oil exposure to individual receptors. Results are based on a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days during annual conditions. The results were calculated from 100 spill trajectories.

Receptor		Probability of floating oil exposure (%)			Minimum time before floating oil exposure (days)		
		Low	Moderate	High	Low	Moderate	High
AMP	Beagle / CWTH	4	-	-	13.42	-	-
	Central Eastern / CWTH	17	-	-	30.46	-	-
	East Gippsland / CWTH	83	-	-	2.50	-	-
	Flinders / CWTH	62	-	-	8.04	-	-
	Freycinet / CWTH	24	-	-	25.88	-	-
	Hunter / CWTH	4	-	-	28.29	-	-
	Jervis / CWTH	27	-	-	16.75	-	-
	Lord Howe / CWTH	19	-	-	33.96	-	-
AQR	Boat Harbour / NSW	1	-	-	26.58	-	-
BIA	Antipodean Albatross - Foraging / CWTH **	100	100	100	0.04	0.04	0.08
	Black Noddy - Foraging / QLD / CWTH	3	-	-	51.29	-	-
	Black Petrel - Foraging / CWTH	76	3	-	7.38	15.58	-
	Black-browed Albatross - Foraging / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.08
	Black-faced Cormorant - Foraging / TAS / CWTH	3	-	-	22.46	-	-
	Black-winged Petrel - Foraging / CWTH	8	-	-	38.00	-	-
	Bullers Albatross - Foraging / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.08
	Campbell Albatross - Foraging / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.08
	Common Diving-petrel - Foraging / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.08
	Common Noddy - Foraging / QLD / CWTH	9	-	-	38.00	-	-
	Crested Tern - Breeding / NSW / QLD / CWTH	38	2	-	10.00	14.29	-
	Crested Tern - Foraging / NSW / QLD / CWTH	69	2	-	8.25	14.71	-
	Flesh-footed Shearwater - Foraging / NSW / CWTH	76	3	-	7.38	15.58	-
	Goulds Petrel - Foraging / NSW	2	-	-	27.67	-	-
	Great-winged Petrel - Foraging / CWTH	74	2	-	7.38	22.79	-

Receptor	Probability of floating oil exposure (%)			Minimum time before floating oil exposure (days)		
	Low	Moderate	High	Low	Moderate	High
Grey Nurse Shark - Foraging / NSW / QLD / CWTH	80	5	-	4.04	11.54	-
Grey Nurse Shark - Migration / NSW / QLD / CWTH	81	3	-	3.92	17.67	-
Grey Ternlet - Foraging / CWTH	8	-	-	38.00	-	-
Humpback Whale - Foraging / NSW / CWTH	90	10	-	2.92	11.54	-
Humpback Whale - Migration / QLD / CWTH	25	-	-	31.58	-	-
Indian Yellow-nosed Albatross - Foraging / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.08
Indo-Pacific/Spotted Bottlenose Dolphin - Breeding / NSW / QLD / CWTH	82	10	-	2.75	11.54	-
Indo-Pacific/Spotted Bottlenose Dolphin - Foraging / NSW	1	-	-	27.88	-	-
Kermadec Petrel - Foraging / NSW / CWTH	8	-	-	39.21	-	-
Little Penguin - Breeding / NSW / VIC / TAS / CWTH	54	3	-	9.92	14.29	-
Little Penguin - Foraging / VIC / TAS / CWTH	86	26	5	1.96	3.42	4.29
Little Shearwater - Foraging / CWTH	8	-	-	38.00	-	-
Masked Booby - Foraging / CWTH	8	-	-	38.00	-	-
Northern Giant Petrel - Foraging / CWTH	74	2	-	7.38	22.79	-
Providence Petrel - Foraging / CWTH	8	-	-	38.00	-	-
Pygmy Blue Whale - Distribution / NSW / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.08
Pygmy Blue Whale - Foraging / NSW / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.08
Red-tailed Tropicbird - Foraging / CWTH	8	-	-	38.00	-	-
Short-tailed Shearwater - Foraging / NSW / VIC / TAS / CWTH	100	34	-	1.58	2.46	-
Shy Albatross - Foraging / NSW / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.08
Soft-plumaged Petrel - Foraging / TAS / CWTH	1	-	-	46.75	-	-
Sooty Shearwater - Foraging / NSW / TAS / CWTH	78	4	-	4.58	14.29	-
Sooty Tern - Foraging / NSW / CWTH	8	-	-	38.00	-	-
Southern Giant Petrel - Foraging / CWTH	74	2	-	7.38	22.79	-
Southern Right Whale - Connecting Habitat / TAS / CWTH	3	-	-	24.88	-	-

Receptor		Probability of floating oil exposure (%)			Minimum time before floating oil exposure (days)		
		Low	Moderate	High	Low	Moderate	High
	Southern Right Whale - Migration / NSW / VIC / TAS / CWTH	100	100	72	0.04	0.08	0.13
	Wandering Albatross - Foraging / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.08
	Wedge-tailed Shearwater - Foraging / NSW / VIC / QLD / TAS / CWTH	93	33	5	1.96	3.42	4.29
	White Shark - Aggregation / NSW / QLD / CWTH	4	-	-	27.00	-	-
	White Shark - Breeding / VIC / CWTH	58	2	-	4.08	4.92	-
	White Shark - Distribution / NSW / VIC / QLD / TAS / CWTH **	100	100	100	0.04	0.04	0.08
	White Shark - Foraging / VIC / TAS / CWTH	99	10	-	1.29	3.50	-
	White Tern - Foraging / CWTH	8	-	-	39.21	-	-
	White-bellied Storm Petrel - Foraging / CWTH	8	-	-	38.00	-	-
	White-capped Albatross - Foraging / CWTH	74	2	-	7.38	22.79	-
	White-faced Storm-petrel - Breeding / NSW / CWTH	75	4	-	6.25	14.29	-
	White-faced Storm-petrel - Foraging / NSW / VIC / TAS / CWTH	100	97	14	0.21	0.38	2.42
	White-fronted Tern - Foraging / TAS / CWTH	4	-	-	22.46	-	-
	Wilsons Storm Petrel - Migration / CWTH	74	2	-	7.38	22.79	-
EEZ	Australian Exclusive Economic Zone **	100	100	100	0.04	0.04	0.08
IBRA	Bateman / NSW	41	2	-	10.71	15.21	-
	East Gippsland Lowlands / NSW / VIC	96	34	7	3.21	3.54	4.29
	Flinders / TAS / CWTH	4	-	-	26.04	-	-
	Gippsland Plain / VIC	20	-	-	10.88	-	-
	Hunter / NSW	1	-	-	28.08	-	-
	Illawarra / NSW	7	-	-	26.00	-	-
	Jervis / NSW	20	2	-	18.38	18.71	-
	Karuah Manning / NSW	2	-	-	27.63	-	-
	Pittwater / NSW	4	-	-	26.54	-	-
	South East Coastal Ranges / NSW	34	4	-	13.63	41.00	-

Receptor		Probability of floating oil exposure (%)			Minimum time before floating oil exposure (days)		
		Low	Moderate	High	Low	Moderate	High
	Sydney Cataract / NSW	6	-	-	25.92	-	-
	Wyong / NSW	2	-	-	27.54	-	-
IMCRA	Batemans Shelf / NSW / CWTH	70	4	-	8.25	14.29	-
	Flinders / VIC / TAS / CWTH	45	-	-	4.38	-	-
	Freycinet / TAS / CWTH	9	-	-	19.83	-	-
	Hawkesbury Shelf / NSW / CWTH	20	-	-	18.96	-	-
	Manning Shelf / NSW / CWTH	5	-	-	27.00	-	-
	Twofold Shelf / NSW / VIC / TAS / CWTH	100	100	78	0.04	0.08	0.13
KEF	Big Horseshoe Canyon / CWTH	100	11	-	1.13	1.42	-
	Canyons on the eastern continental slope / CWTH	73	2	-	8.83	22.96	-
	Lord Howe seamount chain / CWTH	4	-	-	39.21	-	-
	Seamounts South and east of Tasmania / CWTH	13	-	-	29.42	-	-
	Shelf rocky reefs / CWTH	50	-	-	9.88	-	-
	Tasman Front and eddy field / CWTH	27	-	-	28.46	-	-
	Tasmantid seamount chain / CWTH	10	-	-	33.33	-	-
	Upwelling East of Eden / NSW / VIC / CWTH **	100	100	100	0.04	0.04	0.08
MNP	Cape Howe / VIC	84	22	1	2.50	4.75	32.21
	Ninety Mile Beach / VIC	4	-	-	13.21	-	-
	Point Hicks / VIC	80	3	-	2.46	26.21	-
MP	Batemans / NSW	49	3	-	10.00	14.29	-
	Jervis Bay / NSW	13	-	-	19.17	-	-
	Port Stephens - Great Lakes / NSW	3	-	-	27.13	-	-
MS	Beware Reef / VIC	31	-	-	5.67	-	-
RAMSAR	Gippsland Lakes / VIC	10	-	-	25.38	-	-
RSB	Beware Reef / VIC	34	-	-	5.67	-	-
	New Zealand Star Bank / CWTH	74	-	-	1.75	-	-
LGA	Babel Island / TAS	3	-	-	26.04	-	-

Receptor		Probability of floating oil exposure (%)			Minimum time before floating oil exposure (days)		
		Low	Moderate	High	Low	Moderate	High
	Bega Valley / NSW / VIC	78	7	-	3.79	11.54	-
	Cape Barren Osland / TAS	2	-	-	26.75	-	-
	Central Coast / NSW	1	-	-	27.54	-	-
	East Gippsland / NSW / VIC	96	34	7	3.21	3.54	4.29
	Eurobodalla / NSW	33	2	-	13.17	16.88	-
	Flinders Island / TAS	3	-	-	26.42	-	-
	Gabo Island / VIC	76	16	3	3.83	5.00	23.67
	Kiama / NSW	6	-	-	26.00	-	-
	Lake Macquarie / NSW	2	-	-	27.67	-	-
	Mid-Coast / NSW	2	-	-	30.17	-	-
	Montague Island / NSW	26	2	-	10.71	15.21	-
	Newcastle / NSW	1	-	-	28.00	-	-
	Port Stephens / NSW	1	-	-	27.63	-	-
	Randwick / NSW	2	-	-	26.58	-	-
	Shell Harbour / NSW	6	-	-	26.17	-	-
	Shoal Haven / NSW	21	2	-	18.38	18.71	-
	Sutherland Shire / NSW	5	-	-	26.46	-	-
	Vansittart Island / TAS	2	-	-	38.58	-	-
	Waverly / NSW	1	-	-	26.71	-	-
	Wellington / VIC	9	-	-	12.29	-	-
	Wollongong / NSW	4	-	-	25.92	-	-
Sub-LGA	Bega Valley / NSW / VIC	78	7	-	3.79	11.54	-
	Cape Conran / VIC	45	2	-	5.79	8.96	-
	Cape Howe / Mallacoota / NSW / VIC	80	30	6	3.38	3.54	4.29
	Central Coast / NSW	1	-	-	27.54	-	-
	Corringle / VIC	23	-	-	8.29	-	-
	Croajingolong (East) / VIC	47	4	-	3.42	7.54	-

Receptor		Probability of floating oil exposure (%)			Minimum time before floating oil exposure (days)		
		Low	Moderate	High	Low	Moderate	High
	Croajingolong (West) / VIC	63	3	-	3.21	5.88	-
	Eurobodalla / NSW	33	2	-	13.17	16.88	-
	Golden Beach / VIC	1	-	-	19.21	-	-
	Kiama / NSW	6	-	-	26.00	-	-
	Lake Macquarie / NSW	2	-	-	27.67	-	-
	Lake Tyers Beach / VIC	17	-	-	10.58	-	-
	Lakes Entrance / VIC	12	-	-	13.00	-	-
	Lakes Entrance (West) / VIC	4	-	-	28.83	-	-
	Marlo / VIC	39	5	1	6.21	9.25	14.33
	McLoughlins Beach / VIC	3	-	-	12.29	-	-
	Mid-Coast / NSW	2	-	-	30.17	-	-
	Newcastle / NSW	1	-	-	28.00	-	-
	Ocean Grange / VIC	3	-	-	18.21	-	-
	Point Hicks / VIC	79	5	-	3.71	6.38	-
	Port Stephens / NSW	1	-	-	27.63	-	-
	Randwick / NSW	2	-	-	26.58	-	-
	Seaspray / VIC	3	-	-	27.08	-	-
	Shell Harbour / NSW	6	-	-	26.17	-	-
	Shoal Haven / NSW	21	2	-	18.38	18.71	-
	Sutherland Shire / NSW	5	-	-	26.46	-	-
	Sydenham Inlet / VIC	54	2	-	4.92	6.79	-
	Waverly / NSW	1	-	-	26.71	-	-
	Wollongong / NSW	4	-	-	25.92	-	-
	Woodside Beach / VIC	4	-	-	27.13	-	-
State Waters	New South Wales	82	10	-	3.25	11.54	-
	Tasmania State Waters	4	-	-	24.88	-	-
	Victoria State Waters	99	35	7	2.08	3.42	4.29

Receptor		Probability of floating oil exposure (%)			Minimum time before floating oil exposure (days)		
		Low	Moderate	High	Low	Moderate	High
Estuaries	Mallacoota Inlet / VIC	14	-	-	7.08	-	-
	Seal Creek / VIC	18	-	-	3.54	-	-
	Wingan River / VIC	6	-	-	6.92	-	-
Other	Cape Conran / VIC	36	2	-	7.83	13.75	-
	Marlo Coastal Reserve / VIC	26	1	-	7.71	9.67	-
PP	Point Ricardo / VIC	1	-	-	9.29	-	-
	Salmon Beach / Rocks / VIC	21	-	-	8.13	-	-
TRP	Beware Reef / VIC	25	-	-	7.67	-	-
	Davis Creek / VIC	20	-	-	21.08	-	-
	Gabo Island / VIC	41	2	-	4.54	18.75	-
	Lake Bunga / VIC	9	-	-	25.63	-	-
	Lakes Entrance / VIC	3	-	-	27.08	-	-
	Mallacoota / VIC	16	-	-	23.21	-	-
	Merriman Creek / VIC	3	-	-	27.17	-	-
	Mueller River / VIC	27	1	-	4.46	6.67	-
	Point Hicks / VIC	31	-	-	3.33	-	-
	Red River / VIC	27	-	-	5.96	-	-
	Shipwreck Creek / VIC	23	-	-	3.83	-	-
	Tamboon Inlet / VIC	30	-	-	5.54	-	-
	The Skerries / VIC	26	-	-	6.08	-	-
	Thurra River / VIC	21	-	-	4.42	-	-
	Towomba River / NSW	1	-	-	29.54	-	-
	Tullaburga Island / VIC	35	3	-	3.46	23.46	-
	Wingan Inlet / VIC	31	-	-	5.75	-	-
	Woodburn & Saltwater Creeks / NSW	1	-	-	37.75	-	-

**The release location resides within the receptor boundaries.

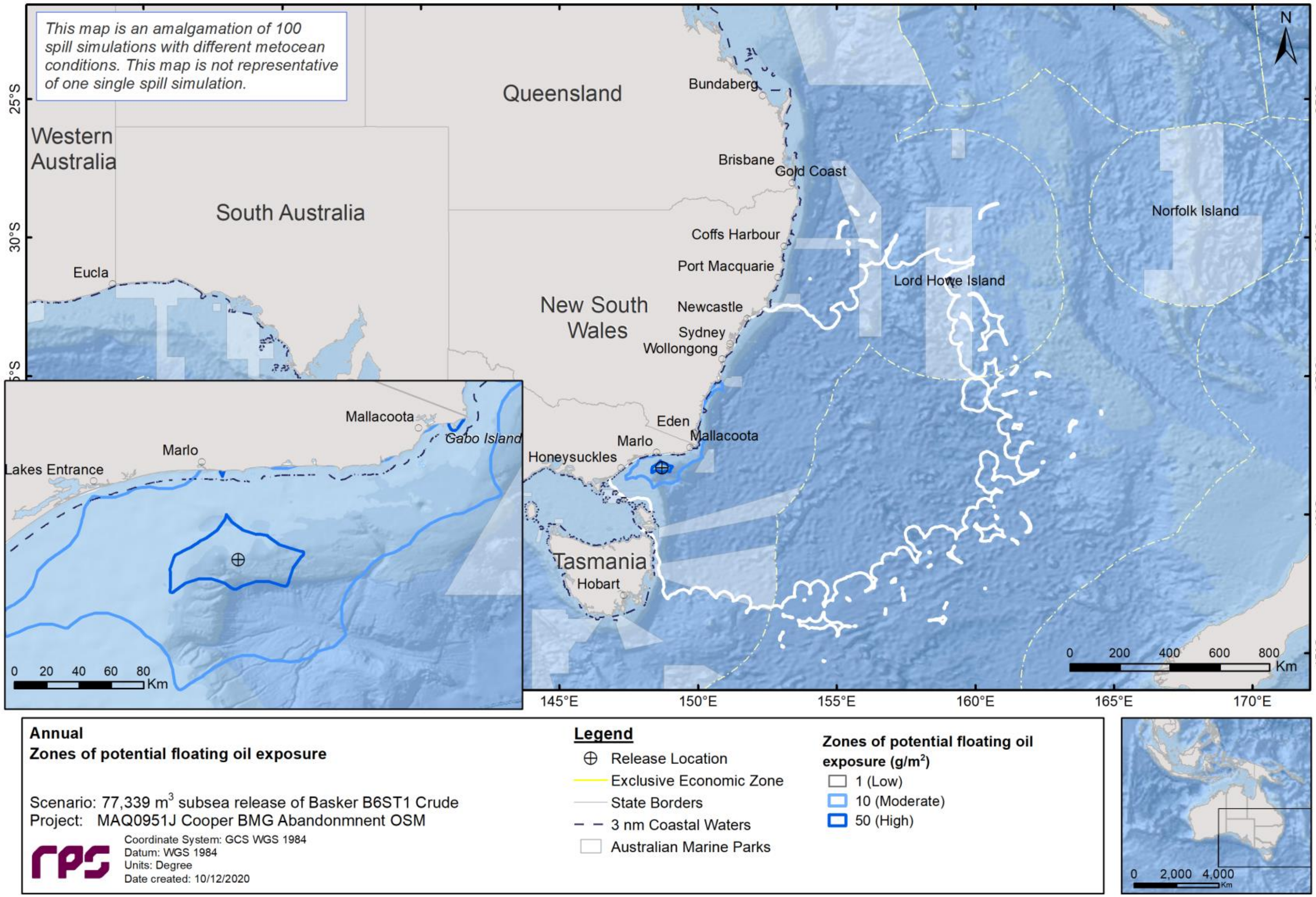


Figure 8-27 Zones of potential floating oil exposure, in the event of a 77,338 m³ subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days. The results were calculated from 100 spill trajectories simulated during annual conditions.

8.1.2.2 Shoreline Accumulation

Table 8-9 presents a summary of the predicted shoreline accumulation during annualised conditions. The probability of accumulation on any shoreline at, or above, the low threshold (10-100 g/m^2) was 100%, while the minimum time before shoreline accumulation was approximately 3.42 days and the maximum volume of oil ashore was 1,975 m^3.

Table 8-10 summarises the shoreline accumulation at individual receptors during annualised conditions. Eight LGAs and Sub-LGA receptors recorded probabilities of low shoreline accumulation above 80%. East Gippsland and Points Hicks recorded the highest probabilities of shoreline accumulation at the low threshold with 100% and 95%, respectively. The minimum time before low shoreline accumulation was 3.42 days, predicted at East Gippsland and Croajingolong (West).

17 shoreline and Sub-LGA receptors were predicted to accumulate shoreline oil at or above the high threshold. East Gippsland and Cape Howe / Mallacoota recorded the highest probabilities of shoreline accumulation at the high threshold with 53% and 50%, respectively. The minimum time before high shoreline accumulation was 4.13 days, predicted at East Gippsland and Cape Howe / Mallacoota. Additionally, the Gold Coast and North Stradbroke Island LGAs (located in Queensland) were the only receptors predicted to potentially receive shoreline oil above the low threshold.

The maximum volume of oil to accumulate on a shoreline receptor was 1,658.1 m^3, predicted at East Gippsland.

Figure 8-28 presents the maximum potential shoreline loading above the low, moderate and high shoreline thresholds for annualised conditions.

Table 8-9 Summary of oil accumulation across all shorelines. Results are based on a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days during annual conditions. The results were calculated from 100 spill trajectories.

Shoreline Statistics	Annual
Probability of contact (%) to any shoreline at, or above, the low threshold (10-100 g/m^2)	100
Absolute minimum time for visible oil to shore (days)	3.42
Maximum volume of hydrocarbons ashore (m^3)	1,975.0
Average volume of hydrocarbons ashore (m^3)	424.9
Maximum length of the shoreline at **10 g/m^2** (km)	640.0
Average shoreline length (km) at **10 g/m^2** (km)	217.1
Maximum length of the shoreline at **100 g/m^2** (km)	287.0
Average shoreline length (km) at **100 g/m^2** (km)	65.7
Maximum length of the shoreline at **1,000 g/m^2** (km)	39.0
Average shoreline length (km) at **1,000 g/m^2** (km)	13.0

Table 8-10 Summary of oil accumulation on individual shoreline receptors. Results are based on a 77,338 m³ subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days during annual conditions. The results were calculated from 100 spill trajectories.

Shoreline receptor		Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (days)			Load on shoreline (g/m²)	Volume on shoreline (m³)	Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)		
		Low	Moderate	High	Low	Moderate	High	Peak	Peak	Low	Moderate	High	Low	Moderate	High
Estuaries	Bendanore River / VIC	52	27	3	6.75	7.17	8.13	3,560.9	37.0	1.6	1.1	1.0	2.0	2.0	1.0
	Mallacoota Inlet / VIC	37	17	2	7.33	23.29	38.21	1,301.4	14.1	1.4	1.2	1.0	2.0	2.0	1.0
	Seal Creek / VIC	36	10	-	9.71	36.13	-	330.3	3.3	1.0	1.0	-	1.0	1.0	-
	Wingan River / VIC	27	8	-	7.67	15.33	-	435.3	4.4	1.0	1.0	-	1.0	1.0	-
Other	Cape Conran / VIC	63	45	6	7.88	8.29	10.42	11,465.4	225.9	4.6	3.0	3.2	9.0	8.0	4.0
	Marlo Coastal Reserve / VIC	32	18	5	8.54	9.42	10.17	4,532.1	101.6	8.3	5.4	1.2	15.0	11.0	2.0
PP	Point Ricardo / VIC	45	23	5	8.38	9.04	9.75	14,716.6	148.2	1.0	1.0	1.0	1.0	1.0	1.0
	Salmon Beach / Rocks / VIC	40	28	5	8.92	11.04	14.17	11,465.4	115.2	1.0	1.0	1.0	1.0	1.0	1.0
LGA	Babel Island / TAS	11	-	-	39.58	-	-	97.7	3.2	4.6	-	-	8.0	-	-
	Balls Pyramid / CWTH	10	-	-	66.33	-	-	80.1	1.5	1.6	-	-	3.0	-	-
	Bega Valley / NSW / VIC	73	65	19	4.79	5.13	12.04	3,130.6	214.1	70.1	22.7	4.6	162.2	61.1	7.0
	Break O'Day / TAS	14	1	-	37.33	38.46	-	109.8	1.8	2.6	1.0	-	6.0	1.0	-
	Cape Barren Island / TAS	21	-	-	25.29	-	-	81.3	3.6	6.6	-	-	11.0	-	-
	Central Coast / NSW	29	1	-	27.54	28.71	-	193.3	13.3	6.1	6.0	-	18.0	6.0	-
	Circular Head / TAS	1	-	-	118.88	-	-	24.8	0.2	1.0	-	-	1.0	-	-
	Clarke Island / TAS	3	-	-	41.83	-	-	36.8	0.4	1.3	-	-	2.0	-	-
	Dorset / TAS	3	-	-	69.79	-	-	24.9	0.4	1.7	-	-	2.0	-	-
	East Gippsland / NSW / VIC	100	96	53	3.42	3.46	4.13	16,223.8	1,658.1	94.9	41.3	10.3	269.3	176.2	34.0
	Elizabeth Reef / CWTH	3	-	-	79.21	-	-	33.7	0.3	1.0	-	-	1.0	-	-
	Eurobodalla / NSW	59	39	2	13.71	14.96	46.71	1,219.4	95.8	39.1	8.2	1.0	88.1	25.0	1.0
	Flinders Island / TAS	20	-	-	26.71	-	-	82.3	4.8	7.4	-	-	21.0	-	-
	Gabo Island / VIC	86	80	29	4.38	5.29	16.38	15,783.1	317.4	2.0	1.9	1.9	2.0	2.0	2.0
	Glamorgan - Spring Bay / TAS	3	-	-	65.08	-	-	34.4	1.0	2.7	-	-	5.0	-	-
	Gold Coast / QLD	1	-	-	91.04	-	-	10.7	0.1	1.0	-	-	1.0	-	-
	Hogan Island Group / TAS	1	-	-	75.92	-	-	27.4	0.3	1.0	-	-	1.0	-	-
	Inner Sister Island / TAS	3	-	-	87.42	-	-	37.3	0.4	1.3	-	-	2.0	-	-
	Kent Island Group / TAS	5	-	-	73.08	-	-	92.6	1.6	2.6	-	-	5.0	-	-
	Kiama / NSW	40	5	-	26.08	26.63	-	275.5	4.0	3.2	1.2	-	9.0	2.0	-
	Lake Macquarie / NSW	31	1	-	27.79	77.75	-	101.6	4.6	4.0	1.0	-	14.0	1.0	-
	Lord Howe Island / NSW / CWTH	22	-	-	61.79	-	-	49.4	1.1	2.2	-	-	5.0	-	-
	Maria Island / TAS	1	-	-	68.38	-	-	38.8	0.4	1.0	-	-	1.0	-	-
	Mid-Coast / NSW	30	1	-	30.75	31.29	-	135.4	1.7	2.7	1.0	-	7.0	1.0	-
	Middleton Reef / CWTH	5	-	-	71.79	-	-	36.7	0.4	1.0	-	-	1.0	-	-
	Montague Island / NSW	64	47	5	10.79	13.38	15.88	2,442.7	58.5	4.3	2.7	2.0	6.0	5.0	2.0
	Nambuccua / NSW	1	-	-	137.46	-	-	20.6	0.2	1.0	-	-	1.0	-	-
	Newcastle / NSW	16	2	-	28.13	28.79	-	117.2	3.6	4.4	1.5	-	10.0	2.0	-
	North Stradbroke Island / QLD	1	-	-	159.17	-	-	21.4	0.2	1.0	-	-	1.0	-	-

Shoreline receptor		Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (days)			Load on shoreline (g/m²)	Volume on shoreline (m³)	Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)		
		Low	Moderate	High	Low	Moderate	High	Peak	Peak	Low	Moderate	High	Low	Moderate	High
	Northern Beaches / NSW	30	-	-	30.71	-	-	76.9	1.9	2.4	-	-	7.0	-	-
	Outer Sister Island / TAS	7	-	-	50.46	-	-	48.1	1.2	3.0	-	-	4.0	-	-
	Port Macquarie-Hastings / NSW	1	-	-	136.96	-	-	21.4	0.2	1.0	-	-	1.0	-	-
	Port Stephens / NSW	33	-	-	27.92	-	-	85.4	5.2	4.7	-	-	15.0	-	-
	Randwick / NSW	30	2	-	28.17	40.08	-	205.7	6.4	3.5	1.5	-	10.0	2.0	-
	Seal Islands / VIC	3	-	-	42.88	-	-	17.8	0.3	1.0	-	-	1.0	-	-
	Shell Harbour / NSW	32	5	-	27.63	39.00	-	153.8	7.6	3.6	2.0	-	11.0	4.0	-
	Shoal Haven / NSW	56	29	2	18.63	18.79	19.71	1,366.9	175.6	33.5	10.1	1.0	118.1	66.1	1.0
	Southeast Rock / CWTH	2	-	-	90.75	-	-	32.1	0.3	1.0	-	-	1.0	-	-
	Sutherland Shire / NSW	36	5	-	26.58	26.96	-	298.3	19.5	7.2	3.4	-	23.0	9.0	-
	Tasman / TAS	2	-	-	93.21	-	-	28.2	0.3	1.0	-	-	1.0	-	-
	Vansittart Island / TAS	7	-	-	38.50	-	-	60.1	1.1	2.0	-	-	4.0	-	-
	Waverly / NSW	16	2	-	26.79	27.29	-	208.4	2.3	2.4	1.0	-	6.0	1.0	-
	Wellington / VIC	30	6	-	12.38	19.21	-	494.0	41.0	8.6	7.5	-	40.0	12.0	-
	White Rock / TAS	1	-	-	90.67	-	-	10.8	0.1	1.0	-	-	1.0	-	-
	Wollongong / NSW	39	10	-	24.92	27.13	-	256.1	10.4	9.8	1.7	-	32.0	3.0	-
	Woollahra / NSW	7	1	-	39.63	40.25	-	112.6	1.1	1.4	1.0	-	3.0	1.0	-
Sub-LGA	Bega Valley / NSW / VIC	73	65	19	4.79	5.13	12.04	3,130.6	214.1	70.1	22.7	4.6	162.2	61.1	7.0
	Cape Conran / VIC	68	46	6	6.33	8.29	9.50	3,038.9	357.8	11.8	4.7	4.8	24.0	23.0	16.0
	Cape Howe / Mallacoota / NSW / VIC	90	79	50	3.54	3.67	4.13	16,223.8	1,635.0	16.8	12.9	8.2	31.0	28.0	15.0
	Central Coast / NSW	29	1	-	27.54	28.71	-	193.3	13.3	6.1	6.0	-	18.0	6.0	-
	Clonmel Island / VIC	5	-	-	42.58	-	-	43.7	0.5	1.2	-	-	2.0	-	-
	Corringle / VIC	38	17	-	8.54	10.17	-	656.2	41.0	12.3	8.6	-	26.0	14.0	-
	Croajingolong (East) / VIC	81	47	8	3.71	7.13	7.92	3,279.3	55.9	12.0	6.9	1.0	27.0	15.0	1.0
	Croajingolong (West) / VIC	89	68	8	3.42	3.46	8.13	3,560.9	117.4	19.3	10.6	1.6	38.0	32.0	3.0
	Eurobodalla / NSW	59	39	2	13.71	14.96	46.71	1,219.4	95.8	39.1	8.2	1.0	88.1	25.0	1.0
	Golden Beach / VIC	16	-	-	18.83	-	-	93.0	2.2	1.9	-	-	5.0	-	-
	Kiama / NSW	40	5	-	26.08	26.63	-	275.5	4.0	3.2	1.2	-	9.0	2.0	-
	Lake Macquarie / NSW	31	1	-	27.79	77.75	-	101.6	4.6	4.0	1.0	-	14.0	1.0	-
	Lake Tyers Beach / VIC	29	12	1	13.88	24.50	26.58	1,335.8	138.2	13.7	17.6	1.0	32.0	27.0	1.0
	Lakes Entrance / VIC	21	11	-	25.38	25.75	-	601.2	23.9	5.8	4.5	-	14.0	9.0	-
	Lakes Entrance (West) / VIC	13	4	-	28.92	29.00	-	606.4	37.6	5.9	4.0	-	16.0	12.0	-
	Marlo / VIC	52	33	5	8.00	9.00	9.75	14,716.6	531.7	14.3	8.6	5.6	29.0	25.0	7.0
	McLoughlins Beach / VIC	9	3	-	12.38	27.63	-	138.5	2.9	3.6	1.0	-	6.0	1.0	-
	Mid-Coast / NSW	30	1	-	30.75	31.29	-	135.4	1.7	2.7	1.0	-	7.0	1.0	-
	Nambuccua / NSW	1	-	-	137.46	-	-	20.6	0.2	1.0	-	-	1.0	-	-
	Newcastle / NSW	16	2	-	28.13	28.79	-	117.2	3.6	4.4	1.5	-	10.0	2.0	-
	Northern Beaches / NSW	30	-	-	30.71	-	-	76.9	1.9	2.4	-	-	7.0	-	-
	Ocean Grange / VIC	17	2	-	18.75	19.21	-	301.3	11.7	2.7	3.5	-	8.0	6.0	-

Shoreline receptor		Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (days)			Load on shoreline (g/m²)	Volume on shoreline (m³)	Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)		
		Low	Moderate	High	Low	Moderate	High	Peak	Peak	Low	Moderate	High	Low	Moderate	High
	Point Hicks / VIC	95	74	12	4.25	5.96	7.17	7,748.5	265.3	15.1	7.0	3.4	32.0	25.0	8.0
	Port Macquarie-Hastings / NSW	1	-	-	136.96	-	-	21.4	0.2	1.0	-	-	1.0	-	-
	Port Stephens / NSW	33	-	-	27.92	-	-	85.4	5.2	4.7	-	-	15.0	-	-
	Randwick / NSW	30	2	-	28.17	40.08	-	205.7	6.4	3.5	1.5	-	10.0	2.0	-
	Seaspray / VIC	8	3	-	26.75	27.13	-	494.0	30.8	8.3	7.3	-	19.0	11.0	-
	Shell Harbour / NSW	32	5	-	27.63	39.00	-	153.8	7.6	3.6	2.0	-	11.0	4.0	-
	Shoal Haven / NSW	56	29	2	18.63	18.79	19.71	1,366.9	175.6	33.5	10.1	1.0	118.1	66.1	1.0
	Sutherland Shire / NSW	36	5	-	26.58	26.96	-	298.3	19.5	7.2	3.4	-	23.0	9.0	-
	Sydenham Inlet / VIC	82	47	6	5.46	5.92	7.29	4,377.3	230.2	15.5	9.9	2.3	29.0	29.0	4.0
	Waverly / NSW	16	2	-	26.79	27.29	-	208.4	2.3	2.4	1.0	-	6.0	1.0	-
	Wollongong / NSW	39	10	-	24.92	27.13	-	256.1	10.4	9.8	1.7	-	32.0	3.0	-
	Woodside Beach / VIC	9	2	-	27.21	41.88	-	157.6	8.9	4.9	3.0	-	12.0	4.0	-
	Woollahra / NSW	7	1	-	39.63	40.25	-	112.6	1.1	1.4	1.0	-	3.0	1.0	-
TRP	Betka River / VIC	36	12	-	16.21	23.25	-	659.5	7.2	1.2	1.0	-	2.0	1.0	-
	Bittangabee Bay / NSW	47	19	-	12.71	24.13	-	533.8	7.3	2.1	1.1	-	3.0	2.0	-
	Boydtown Creek / NSW	6	-	-	86.13	-	-	92.4	1.4	1.3	-	-	2.0	-	-
	Davis Creek / VIC	40	21	-	16.13	23.25	-	830.7	15.7	1.6	1.4	-	2.0	2.0	-
	Easby Creek / VIC	50	27	-	5.92	7.67	-	807.6	8.1	1.7	1.6	-	2.0	2.0	-
	Fisheries Creek / NSW	11	-	-	19.88	-	-	45.8	0.5	1.2	-	-	2.0	-	-
	Gabo Island / VIC	84	79	25	4.46	5.71	16.38	15,725.4	158.4	1.0	1.0	1.0	1.0	1.0	1.0
	Lake Bunga / VIC	14	8	-	25.29	25.75	-	528.6	5.3	1.0	1.0	-	1.0	1.0	-
	Lake Tyers / VIC	11	10	-	25.46	25.83	-	596.8	8.0	1.9	2.0	-	2.0	2.0	-
	Lakes Entrance / VIC	10	3	-	26.33	27.04	-	436.4	4.9	1.3	1.0	-	3.0	1.0	-
	Mallacoota / VIC	29	8	-	23.33	36.63	-	689.0	6.9	1.0	1.0	-	1.0	1.0	-
	Melrose Road Inlet / TAS	2	-	-	122.54	-	-	24.7	0.2	1.0	-	-	1.0	-	-
	Merriman Creek / VIC	4	1	-	27.08	27.17	-	238.8	2.4	1.3	1.0	-	2.0	1.0	-
	Mueller River / VIC	38	2	-	6.83	27.25	-	122.6	1.2	1.0	1.0	-	1.0	1.0	-
	Nullica River / NSW	4	-	-	85.67	-	-	71.2	1.1	1.8	-	-	2.0	-	-
	Patriarchs Inlet / TAS	3	-	-	77.08	-	-	20.9	0.2	1.0	-	-	1.0	-	-
	Red River / VIC	42	16	-	16.25	23.96	-	558.1	5.6	1.0	1.0	-	1.0	1.0	-
	Shipwreck Creek / VIC	44	23	-	3.79	21.29	-	383.8	4.2	1.6	1.0	-	2.0	2.0	-
	Snowy River / VIC	28	18	5	9.25	13.17	13.96	4,532.1	51.1	2.5	2.0	1.0	3.0	3.0	1.0
	Sydenham Inlet / VIC	52	22	-	5.50	5.92	-	734.1	14.0	1.8	1.8	-	2.0	2.0	-
	Tamboon Inlet / VIC	59	18	-	5.67	9.17	-	662.9	16.7	2.5	2.2	-	3.0	3.0	-
	Thurra River / VIC	61	35	5	5.67	6.79	7.17	2,855.6	28.8	2.0	1.1	1.0	3.0	2.0	1.0
	Towomba River / NSW	11	-	-	29.21	-	-	59.6	0.6	1.0	-	-	1.0	-	-
	Wonboyn River / NSW	28	11	-	23.54	23.83	-	391.5	3.9	1.0	1.0	-	1.0	1.0	-
	Woodburn & Saltwater Creeks / NSW	26	1	-	21.63	42.54	-	164.0	1.7	1.0	1.0	-	1.0	1.0	-
	Yeerung River / VIC	30	7	1	8.50	11.04	11.17	1,239.0	30.2	2.2	1.4	2.0	3.0	3.0	2.0

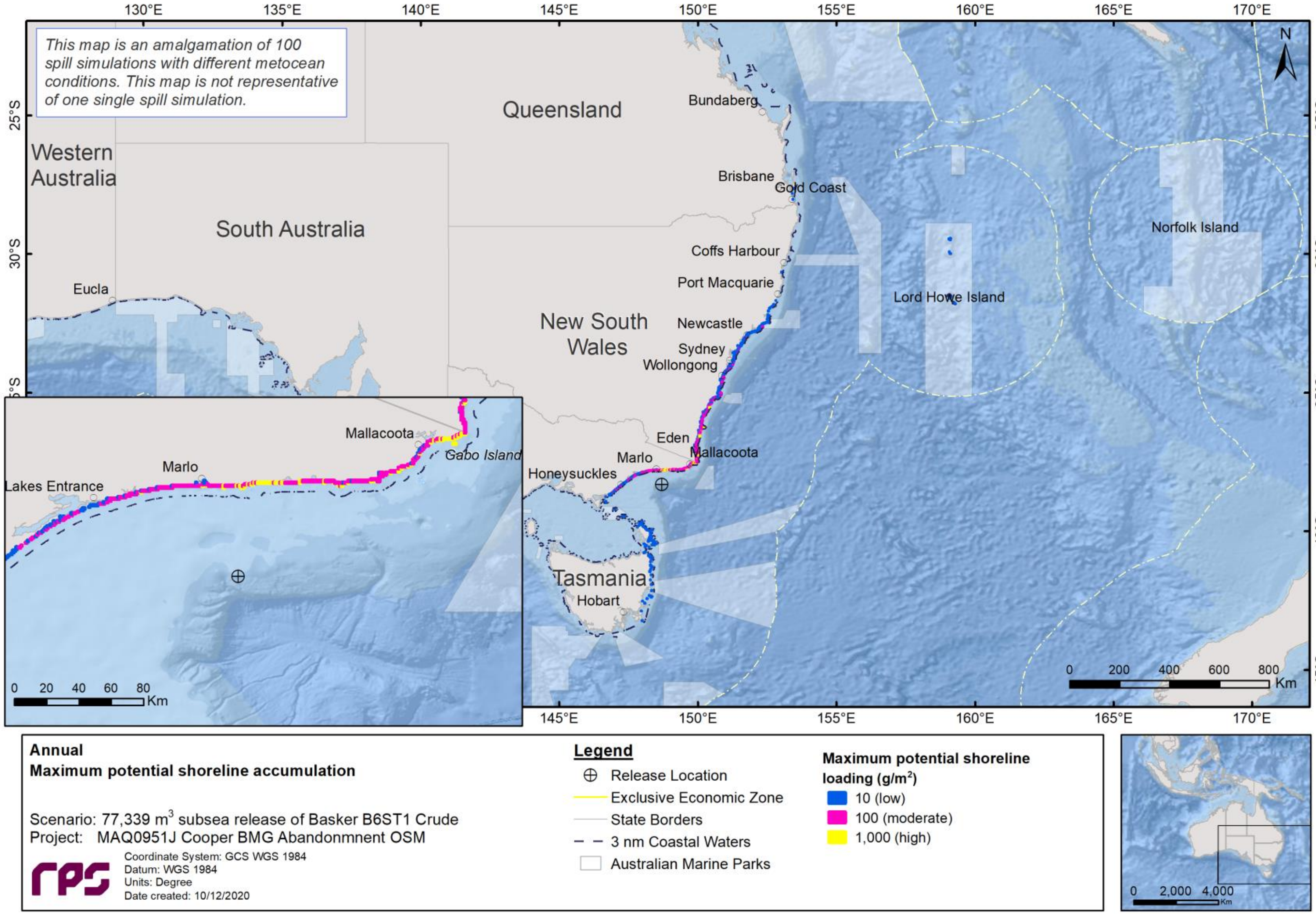


Figure 8-28 Maximum potential shoreline loading, in the event of a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days. The results were calculated from 100 spill trajectories simulated during annual conditions.

8.1.2.3 Water Column Exposure

8.1.2.3.1 Dissolved Hydrocarbons

Table 8-11 summarises the probability of exposure to individual receptors from dissolved hydrocarbons in the 0-10 m depth layers, at the low (10-50 ppb), moderate (50-400 ppb) and high (≥ 400 ppb) exposure thresholds (NOPSEMA, 2019).

In the surface (0-10 m) depth layer, a total of 34 Biologically Important Areas (BIAs) were predicted to be exposed to dissolved hydrocarbons at or above the high threshold during the annualised assessment. Aside from the 11 BIAs that the release location resides within (see Section 6.3), the highest probabilities of exposure to low, moderate and high dissolved hydrocarbons were predicted as 95%, 95% and 29% at the Southern Right Whale – Migration BIA.

Six AMPs were predicted to be exposed to dissolved hydrocarbons at, or above the low threshold with the highest probability predicted at East Gippsland with 85%. Four AMPs were predicted to be exposed to dissolved hydrocarbons at, or above the high threshold with probabilities of 1% (Beagle, Flinders and Freycinet) and 3% (East Gippsland).

A total of seven RSB were predicted to be exposed to dissolved hydrocarbons at, or above the low threshold during the annualised assessment. The New Zealand Star Bank and Beware Reef were the only RSB receptors predicted to be exposed at the low, moderate and high thresholds recording probabilities of 95%, 95% and 8% and 54%, 20% and 1%, respectively.

Dissolved hydrocarbons at, or above the low threshold were predicted to cross into New South Wales, Tasmania and Victoria state waters with probabilities of 95% and 16% and 95%, respectively.

Figure 8-29 presents the zones of potential exposure from dissolved hydrocarbon for the 0-10 m.

In water stochastic results were assessed up to a depth of 100 m using the following intervals 0-10 m, 10-20 m, 20-30 m, 30-40 m, 40-60 m, 60-80 m and 80-100 m. Results for the depth layers below 20 m are presented in Appendix A.

Table 8-11 Predicted probability and maximum dissolved hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days. The results were calculated from 100 spill trajectories during annual conditions.

Receptor		Maximum instantaneous exposure to dissolved aromatics (ppb)	Probability of instantaneous exposure to dissolved aromatics (%)		
			Low	Moderate	High
AMP	Beagle / CWTH	473	18	7	1
	Central Eastern / CWTH	49	1	-	-
	East Gippsland / CWTH	1,072	85	44	3
	Flinders / CWTH	952	27	8	1
	Freycinet / CWTH	484	9	2	1
	Jervis / CWTH	96	5	2	-
BIA	Antipodean Albatross - Foraging / CWTH **	2,609	95	95	29
	Black Petrel - Foraging / CWTH	1,389	65	26	2
	Black-browed Albatross - Foraging / VIC / TAS / CWTH **	2,609	95	95	29
	Black-faced Cormorant - Foraging / TAS / CWTH	104	7	1	-
	Bullers Albatross - Foraging / VIC / TAS / CWTH **	2,609	95	95	29
	Campbell Albatross - Foraging / VIC / TAS / CWTH **	2,609	95	95	29
	Common Diving-petrel - Foraging / VIC / TAS / CWTH **	2,609	95	95	29
	Crested Tern - Breeding / NSW / QLD / CWTH	476	51	14	1
	Crested Tern - Foraging / NSW / QLD / CWTH	1,389	62	24	2
	Flesh-footed Shearwater - Foraging / NSW / CWTH	1,389	65	26	2
	Great-winged Petrel - Foraging / CWTH	1,389	61	23	2
	Grey Nurse Shark - Foraging / NSW / QLD / CWTH	2,254	94	74	6
	Grey Nurse Shark - Migration / NSW / QLD / CWTH	1,732	93	68	4
	Humpback Whale - Foraging / NSW / CWTH	2,254	95	86	7
	Humpback Whale - Migration / QLD / CWTH	53	1	1	-
	Indian Yellow-nosed Albatross - Foraging / VIC / TAS / CWTH **	2,609	95	95	29
	Indo-Pacific/Spotted Bottlenose Dolphin - Breeding / NSW / QLD / CWTH	2,254	95	89	9
	Little Penguin - Breeding / NSW / VIC / TAS / CWTH	558	53	16	1
	Little Penguin - Foraging / VIC / TAS / CWTH	3,239	95	94	25
	Northern Giant Petrel - Foraging / CWTH	1,389	61	23	2
	Pygmy Blue Whale - Distribution / NSW / VIC / TAS / CWTH **	3,239	95	95	29
	Pygmy Blue Whale - Foraging / NSW / VIC / TAS / CWTH **	3,239	95	95	29

Receptor		Maximum instantaneous exposure to dissolved aromatics (ppb)	Probability of instantaneous exposure to dissolved aromatics (%)		
			Low	Moderate	High
	Short-tailed Shearwater - Breeding / NSW / VIC / TAS	65	3	1	-
	Short-tailed Shearwater - Foraging / NSW / VIC / TAS / CWTH	2,254	95	91	6
	Shy Albatross - Foraging / NSW / VIC / TAS / CWTH **	3,239	95	95	29
	Sooty Shearwater - Foraging / NSW / TAS / CWTH	1,778	90	57	4
	Southern Giant Petrel - Foraging / CWTH	1,389	61	23	2
	Southern Right Whale - Connecting Habitat / TAS / CWTH	79	5	1	-
	Southern Right Whale - Migration / NSW / VIC / TAS / CWTH	3,239	95	95	29
	Wandering Albatross - Foraging / VIC / TAS / CWTH **	2,609	95	95	29
	Wedge-tailed Shearwater - Foraging / NSW / VIC / QLD / TAS / CWTH	3,239	95	94	25
	White Shark - Breeding / VIC / CWTH	673	54	16	1
	White Shark - Distribution / NSW / VIC / QLD / TAS / CWTH **	2,609	95	95	29
	White Shark - Foraging / VIC / TAS / CWTH	2,152	95	95	11
	White-capped Albatross - Foraging / CWTH	1,389	61	23	2
	White-faced Storm-petrel - Breeding / NSW / CWTH	1,778	77	34	3
	White-faced Storm-petrel - Foraging / NSW / VIC / TAS / CWTH	3,239	95	95	25
	White-fronted Tern - Foraging / TAS / CWTH	56	4	1	-
	Wilsons Storm Petrel - Migration / CWTH	1,389	61	23	2
EEZ	Australian Exclusive Economic Zone / NSW / VIC / QLD / TAS / CWTH	3,239	95	95	29
IBRA	Bateman / NSW	513	40	11	1
	East Gippsland Lowlands / NSW / VIC	3,239	95	90	25
	Flinders / TAS / CWTH	338	13	5	-
	Gippsland Plain / VIC	149	8	1	-
	Jervis / NSW	78	10	2	-
	South East Coastal Ranges / NSW	714	44	11	1
	Tasmanian South East / TAS	12	1	-	-
	Wilsons Promontory / VIC	73	4	1	-
IMCRA	Batemans Shelf / NSW / CWTH	1,778	74	33	3
	Boags / TAS / CWTH	20	1	-	-
	Central Bass Strait / CWTH	181	3	1	-
	Central Victoria / VIC / CWTH	51	1	1	-
	Flinders / VIC / TAS / CWTH	955	75	40	2
	Freycinet / TAS / CWTH	153	11	3	-
	Hawkesbury Shelf / NSW / CWTH	17	1	-	-

Receptor		Maximum instantaneous exposure to dissolved aromatics (ppb)	Probability of instantaneous exposure to dissolved aromatics (%)		
			Low	Moderate	High
	Twofold Shelf / NSW / VIC / TAS / CWTH	3,239	95	95	29
	Victorian Embayments / VIC	107	1	1	-
KEF	Big Horseshoe Canyon / CWTH	1,991	95	92	8
	Canyons on the eastern continental slope / CWTH	1,189	50	14	2
	Seamounts South and east of Tasmania / CWTH	67	4	1	-
	Shelf rocky reefs / CWTH	1,084	56	20	1
	Tasman Front and eddy field / CWTH	48	2	-	-
	Tasmantid seamount chain / CWTH	33	1	-	-
	Upwelling East of Eden / NSW / VIC / CWTH **	3,239	95	95	29
MNP	Cape Howe / VIC	2,568	95	91	23
	Corner Inlet / VIC	13	1	-	-
	Ninety Mile Beach / VIC	85	3	1	-
	Point Hicks / VIC	867	95	82	4
	Wilsons Promontory / VIC	65	1	1	-
MP	Batemans / NSW	513	51	14	1
	Jervis Bay / NSW	37	3	-	-
MS	Beware Reef / VIC	461	54	20	1
NP	Kent Group / TAS	365	16	5	-
	Booderee / NSW	15	1	-	-
	Corner Inlet Marine and Coastal Park / VIC	13	1	-	-
	Nooramunga Marine and Coastal Park / VIC	107	1	1	-
	Wilsons Promontory Marine Park / VIC	56	1	1	-
Ramsar	Corner Inlet / VIC	107	1	1	-
	East Coast Cape Barren Island Lagoons / TAS	22	3	-	-
	Gippsland Lakes / VIC	68	4	1	-
RSB	Beware Reef / VIC	461	54	20	1
	Cutter Rock / CWTH	20	1	-	-
	Endeavour Reef / TAS	75	7	2	-
	New Zealand Star Bank / CWTH	911	95	95	8
	Wakitipu Rock / CWTH	107	7	1	-
	Warrego Rock / CWTH	21	3	-	-
	Wright Rock / TAS	89	10	2	-
LGA	Anser Island / VIC	31	1	-	-
	Babel Island / TAS	32	3	-	-
	Bega Valley / NSW / VIC	2,254	95	84	11
	Break O'Day / TAS	12	1	-	-
	Cape Barren Osland / TAS	28	4	-	-
	Craggy Island / TAS	94	7	2	-

Receptor		Maximum instantaneous exposure to dissolved aromatics (ppb)	Probability of instantaneous exposure to dissolved aromatics (%)		
			Low	Moderate	High
	Curtis Island / TAS	128	4	1	-
	East Gippsland / NSW / VIC	3,239	95	87	23
	Eurobodalla / NSW	513	33	9	1
	Flinders Island / TAS	44	3	-	-
	Gabo Island / VIC	2,051	95	90	21
	Glennie Group / VIC	16	1	-	-
	Hogan Island Group / TAS	274	9	5	-
	Inner Sister Island / TAS	51	3	1	-
	Kanowna Island / VIC	48	1	-	-
	Kent Island Group / TAS	338	13	4	-
	Moncoeur Islands / VIC	73	4	1	-
	Montague Island / NSW	318	40	11	-
	Outer Sister Island / TAS	93	5	1	-
	Pasco Group / TAS	12	1	-	-
	Prime Seal Island / TAS	19	1	-	-
	Pyramid Island / CWTH	37	4	-	-
	Rodondo Island / VIC	71	1	1	-
	Seal Islands / VIC	57	3	1	-
	Shoal Haven / NSW	78	9	2	-
	Skull Rock / VIC	48	1	-	-
	South Gippsland / VIC	65	1	1	-
	Wellington / VIC	149	4	1	-
Sub-LGA	Bega Valley / NSW / VIC	2,254	95	84	11
	Cape Conran / VIC	750	56	22	1
	Cape Howe / Mallacoota / NSW / VIC	3,239	95	87	25
	Clonmel Island / VIC	85	1	1	-
	Corner Inlet / VIC	56	1	1	-
	Corringle / VIC	245	30	7	-
	Croajingolong (East) / VIC	1,420	92	64	4
	Croajingolong (West) / VIC	1,431	94	68	4
	Eurobodalla / NSW	513	33	9	1
	Golden Beach / VIC	75	4	1	-
	Lake Tyers Beach / VIC	138	13	3	-
	Lakes Entrance / VIC	127	8	1	-
	Lakes Entrance (West) / VIC	57	4	1	-
	Marlo / VIC	464	47	15	1
	McLoughlins Beach / VIC	149	2	1	-
	Ocean Grange / VIC	68	4	1	-
	Point Hicks / VIC	949	93	63	4
	Seaspray / VIC	57	3	1	-
	Shoal Haven / NSW	78	9	2	-

Receptor		Maximum instantaneous exposure to dissolved aromatics (ppb)	Probability of instantaneous exposure to dissolved aromatics (%)		
			Low	Moderate	High
	Snake Island / VIC	91	1	1	-
	Sydenham Inlet / VIC	670	73	36	3
	Wilsons Promontory (East) / VIC	34	1	-	-
	Wilsons Promontory (NE) / VIC	65	1	1	-
	Wilsons Promontory (West) / VIC	29	1	-	-
	Woodside Beach / VIC	85	3	1	-
State Waters	New South Wales	2,254	95	89	9
	Tasmania State Waters	482	16	5	1
	Victoria State Waters	3,239	95	94	25
Estuaries	Gippsland Lakes / VIC	14	1	-	-
	Mallacoota Inlet / VIC	457	75	38	1
	Seal Creek / VIC	473	82	52	2
	Wingan River / VIC	431	77	36	1
Other	Cape Conran / VIC	420	39	9	1
	Marlo Coastal Reserve / VIC	546	44	13	1
PP	Salmon Beach / Rocks / VIC	250	42	10	-
TRP	Beware Reef / VIC	461	49	15	1
	Boat Harbour Creek / TAS	18	1	-	-
	Corner Inlet / VIC	30	1	-	-
	Davis Creek / VIC	1,044	82	35	1
	Gabo Island / VIC	2,051	94	83	17
	Kent Group Islands / TAS	134	10	4	-
	Lake Bunga / VIC	68	3	1	-
	Lakes Entrance / VIC	29	7	-	-
	Mallacoota / VIC	448	76	30	1
	Merriman Creek / VIC	48	2	-	-
	Mueller River / VIC	623	82	45	2
	North East River / TAS	13	3	-	-
	Point Hicks / VIC	573	92	66	3
	Red River / VIC	315	85	41	-
	Shipwreck Creek / VIC	718	86	47	4
	Tamboon Inlet / VIC	670	64	29	1
	The Skerries / VIC	751	85	47	1
	Thurra River / VIC	452	85	53	1
	Towomba River / NSW	33	7	-	-
	Tullaburga Island / VIC	1,228	90	63	13
	Wingan Inlet / VIC	400	85	43	1
	Woodburn & Saltwater Creeks / NSW	175	59	12	-

**The release location resides within the receptor boundaries.

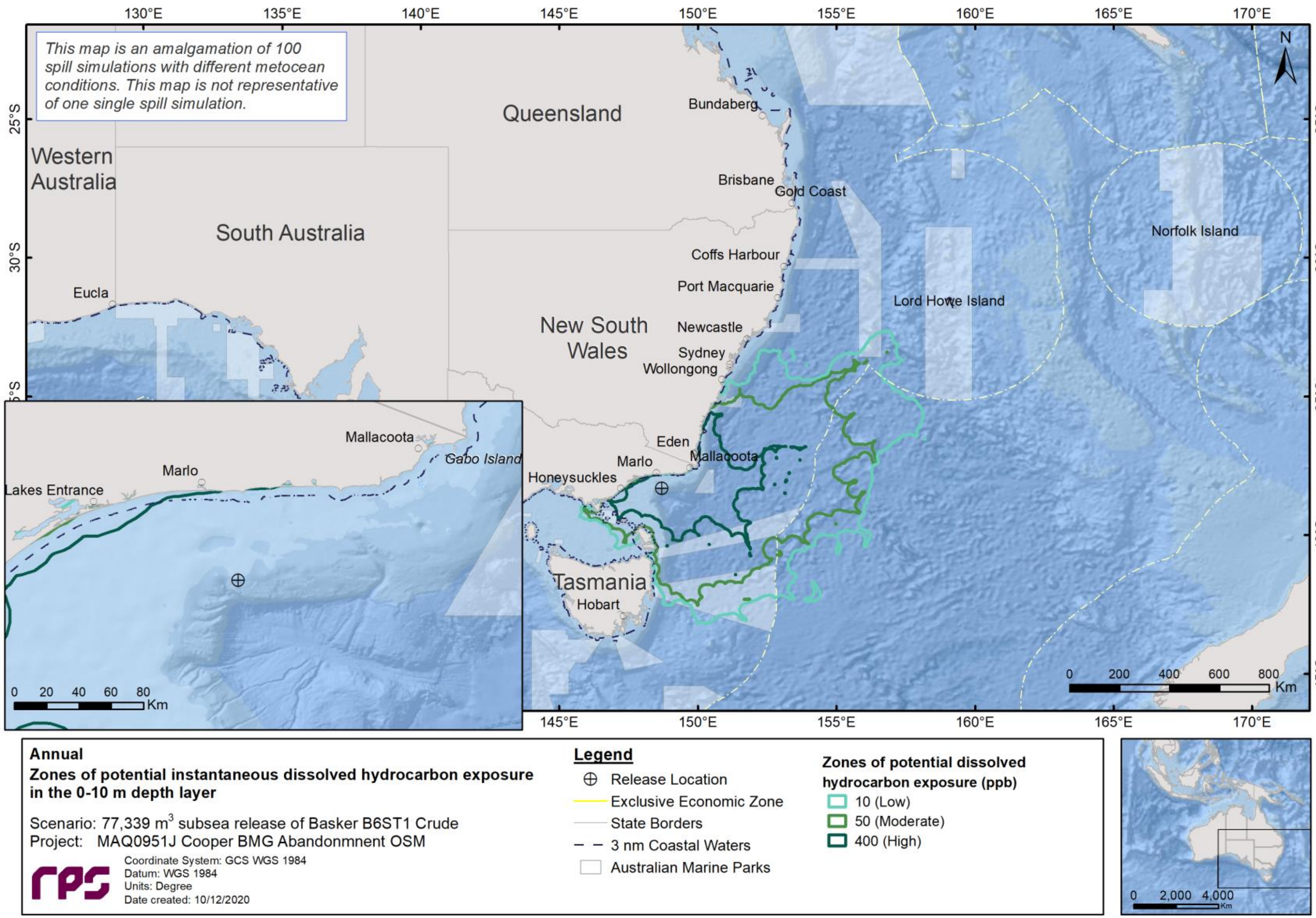


Figure 8-29 Zones of potential instantaneous dissolved hydrocarbon exposure at 0-10 m below the sea surface in the event of a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days. The results were calculated from 100 spill trajectories simulated during annual conditions.

8.1.2.3.2 Entrained Hydrocarbons

Table 8-12 summarises the probability of exposure to individual receptors from entrained hydrocarbons in the 0-10 m depth layer, at the low (10-100 ppb) and high (≥ 100 ppb) entrained hydrocarbon exposure thresholds (NOPSEMA, 2019.

In the surface (0-10 m) depth layer, a total of 54 BIAs were predicted to be exposed to entrained oil at or above the low and high thresholds during the annualised assessment. Aside from the 11 BIAs that the release location resides within (see Section 6.3), the highest probability of high entrained exposure was 95%, predicted at 8 BIAs (Humpback Whale – Foraging, Indo-Pacific/Spotted Bottlenose Dolphin – Breeding, Little Penguin – Foraging, Short-tailed Shearwater – Foraging, Southern Right Whale – Migration, Wedge-tailed Shearwater – Foraging, White Shark – Foraging, White-faced Storm-petrel – Foraging).

A total of 18 AMPs were predicted to be exposed to entrained hydrocarbons at, or above the low threshold during the annualised conditions. East Gippsland and Flinders recorded the highest probability of low entrained exposure with 95% while East Gippsland recorded a 76% probability of exposure to entrained hydrocarbons at, or above the high threshold.

A total of 11 RSB were predicted to be exposed to entrained hydrocarbons at, or above the low threshold. The New Zealand Star Bank and Beware Reef recorded the highest probabilities of exposure to low and high entrained hydrocarbons with 95% and 90% probabilities at the low threshold and 95% and 46% at the high threshold, respectively.

Entrained hydrocarbons at, or above the low threshold were predicted to cross into New South Wales, Tasmania and Victoria state waters with probabilities of 95% and 51% and 95%, respectively.

Figure 8-30 illustrates the zones of potential entrained hydrocarbon exposure in the 0-10 m depth layer.

In water stochastic results were assessed up to a depth of 100 m using the following intervals 0-10 m, 10-20 m, 20-30 m, 30-40 m, 40-60 m, 60-80 m and 80-100 m. Results for the depth layers below 20 m are presented in Appendix A.

Table 8-12 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days, during annual conditions.

Receptor		Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Probability of instantaneous exposure to entrained hydrocarbons (%)	
			Low	High
AMP	Apollo / CWTH	24	1	-
	Beagle / CWTH	589	46	20
	Boags / CWTH	16	1	-
	Central Eastern / CWTH	181	50	6
	Cod Grounds / CWTH	17	2	-
	Coral Sea / CWTH	11	1	-
	East Gippsland / CWTH	1,676	95	76
	Flinders / CWTH	450	95	23
	Freycinet / CWTH	305	73	5
	Gifford / CWTH	14	1	-
	Hunter / CWTH	112	35	1
	Huon / CWTH	26	5	-
	Jervis / CWTH	204	81	4
	Lord Howe / CWTH	138	43	2
	Norfolk / CWTH	14	1	-
	Solitary Islands / CWTH	14	1	-
	South Tasman Rise / CWTH	24	2	-
	Tasman Fracture / CWTH	13	1	-
AQR	Boat Harbour / NSW	61	40	-
	North Sydney Harbour / NSW	28	34	-
	Towra Point / NSW	51	38	-
BIA	Antipodean Albatross - Foraging / CWTH **	17,024	95	95
	Australasian Gannet - Foraging / VIC / TAS / CWTH	50	1	-
	Black Noddy - Breeding / NSW / QLD / CWTH	51	27	-
	Black Noddy - Foraging / QLD / CWTH	105	30	1
	Black Petrel - Foraging / CWTH	1,498	95	44
	Black-browed Albatross - Foraging / VIC / TAS / CWTH **	17,024	95	95
	Black-faced Cormorant - Breeding / TAS	191	14	3
	Black-faced Cormorant - Foraging / TAS / CWTH	358	46	5
	Black-naped Tern - Breeding / QLD / CWTH	10	1	-
	Black-winged Petrel - Breeding / NSW / CWTH	51	27	-
	Black-winged Petrel - Foraging / CWTH	107	34	1
	Bullers Albatross - Foraging / VIC / TAS / CWTH **	17,024	95	95
	Campbell Albatross - Foraging / VIC / TAS / CWTH **	17,024	95	95

Receptor	Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Probability of instantaneous exposure to entrained hydrocarbons (%)	
		Low	High
Common Diving-petrel - Breeding / VIC / TAS	191	14	3
Common Diving-petrel - Foraging / VIC / TAS / CWTH **	17,024	95	95
Common Noddy - Breeding / NSW / QLD / CWTH	51	27	-
Common Noddy - Foraging / QLD / CWTH	107	34	1
Crested Tern - Breeding / NSW / QLD / CWTH	538	95	14
Crested Tern - Foraging / NSW / QLD / CWTH	1,064	95	39
Flesh-footed Shearwater - Breeding / NSW / CWTH	51	27	-
Flesh-footed Shearwater - Foraging / NSW / CWTH	1,498	95	44
Goulds Petrel - Foraging / NSW	92	37	-
Great-winged Petrel - Foraging / CWTH	1,498	95	40
Green Turtle - Internesting / QLD / CWTH	10	1	-
Green Turtle - Nesting / QLD / CWTH	10	1	-
Grey Nurse Shark - Foraging / NSW / QLD / CWTH	1,239	95	91
Grey Nurse Shark - Migration / NSW / QLD / CWTH	1,549	95	90
Grey Ternlet - Breeding / NSW / CWTH	51	27	-
Grey Ternlet - Foraging / CWTH	107	34	1
Humpback Whale - Breeding/Calving / QLD / CWTH	10	1	-
Humpback Whale - Foraging / NSW / CWTH	1,573	95	95
Humpback Whale - Migration / QLD / CWTH	181	54	6
Humpback Whale - Resting / NSW / QLD / CWTH	11	1	-
Indian Yellow-nosed Albatross - Foraging / VIC / TAS / CWTH **	17,024	95	95
Indo-Pacific/Spotted Bottlenose Dolphin - Breeding / NSW / QLD / CWTH	1,584	95	95
Indo-Pacific/Spotted Bottlenose Dolphin - Foraging / NSW	47	27	-
Kermadec Petrel - Breeding / CWTH	38	26	-
Kermadec Petrel - Foraging / NSW / CWTH	107	34	1
Little Penguin - Breeding / NSW / VIC / TAS / CWTH	650	95	21
Little Penguin - Foraging / VIC / TAS / CWTH	3,860	95	95
Little Shearwater - Breeding / NSW / CWTH	51	27	-
Little Shearwater - Foraging / CWTH	107	34	1
Loggerhead Turtle - Internesting / NSW / QLD / CWTH	14	1	-
Loggerhead Turtle - Nesting / NSW / QLD / CWTH	11	1	-

Receptor	Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Probability of instantaneous exposure to entrained hydrocarbons (%)	
		Low	High
Masked Booby - Breeding / NSW / CWTH	51	27	-
Masked Booby - Foraging / CWTH	107	34	1
Northern Giant Petrel - Foraging / CWTH	1,498	95	40
Providence Petrel - Breeding / NSW / CWTH	51	27	-
Providence Petrel - Foraging / CWTH	107	34	1
Pygmy Blue Whale - Distribution / NSW / VIC / TAS / CWTH **	17,024	95	95
Pygmy Blue Whale - Foraging / NSW / VIC / TAS / CWTH **	17,024	95	95
Red-tailed Tropicbird - Breeding / NSW / CWTH	51	27	-
Red-tailed Tropicbird - Foraging / CWTH	107	34	1
Short-tailed Shearwater - Breeding / NSW / VIC / TAS	256	35	6
Short-tailed Shearwater - Foraging / NSW / VIC / TAS / CWTH	2,324	95	95
Shy Albatross - Foraging / NSW / VIC / TAS / CWTH **	17,024	95	95
Soft-plumaged Petrel - Foraging / TAS / CWTH	58	22	-
Sooty Shearwater - Foraging / NSW / TAS / CWTH	1,547	95	83
Sooty Tern - Breeding / NSW / CWTH	41	22	-
Sooty Tern - Foraging / NSW / CWTH	107	34	1
Southern Giant Petrel - Foraging / CWTH	1,498	95	40
Southern Right Whale - Breeding / TAS / CWTH	58	21	-
Southern Right Whale - Connecting Habitat / TAS / CWTH	371	42	9
Southern Right Whale - Migration / NSW / VIC / TAS / CWTH	11,285	95	95
Wandering Albatross - Foraging / VIC / TAS / CWTH **	17,024	95	95
Wedge-tailed Shearwater - Breeding / NSW / QLD / CWTH	72	28	-
Wedge-tailed Shearwater - Foraging / NSW / VIC / QLD / TAS / CWTH	3,860	95	95
White Shark - Aggregation / NSW / QLD / CWTH	112	38	1
White Shark - Breeding / VIC / CWTH	949	76	46
White Shark - Distribution / NSW / VIC / QLD / TAS / CWTH **	17,024	95	95
White Shark - Foraging / VIC / TAS / CWTH	2,873	95	95
White Tern - Breeding / NSW / CWTH	42	24	-
White Tern - Foraging / CWTH	107	34	1
White-bellied Storm Petrel - Breeding / NSW / CWTH	47	24	-
White-bellied Storm Petrel - Foraging / CWTH	107	34	1
White-capped Albatross - Foraging / CWTH	1,498	95	40

Receptor		Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Probability of instantaneous exposure to entrained hydrocarbons (%)	
			Low	High
	White-faced Storm-petrel - Breeding / NSW / CWTH	1,498	95	50
	White-faced Storm-petrel - Foraging / NSW / VIC / TAS / CWTH	6,398	95	95
	White-fronted Tern - Foraging / TAS / CWTH	299	43	6
	White-necked Petrel - Foraging / CWTH	12	1	-
	Wilsons Storm Petrel - Migration / CWTH	1,498	95	40
CA	Arthur Bay / TAS	145	20	2
	George Town / TAS	34	4	-
	Lillico Beach / TAS	23	2	-
	Marriott Reef / TAS	88	24	-
	Pardoe Northdown / TAS	46	3	-
EEZ	Australian Exclusive Economic Zone	17,024	95	95
	New Caledonian Exclusive Economic Zone	14	1	-
	New Zealand Exclusive Economic Zone	14	1	-
	Norfolk Island Exclusive Economic Zone	18	2	-
IBRA	Bateman / NSW	650	92	13
	Clarence Lowlands / NSW	17	1	-
	Coffs Coast and Escarpment / NSW	16	2	-
	East Gippsland Lowlands / NSW / VIC	3,860	95	93
	Flinders / TAS / CWTH	630	43	17
	Gippsland Plain / VIC	662	49	10
	Hunter / NSW	42	26	-
	Illawarra / NSW	53	58	-
	Jervis / NSW	571	81	8
	Karuah Manning / NSW	94	34	-
	King Island / TAS	19	2	-
	Lord Howe Island / NSW / CWTH	48	27	-
	Macleay Hastings / NSW	18	4	-
	Pittwater / NSW	89	48	-
	South East Coastal Ranges / NSW	650	90	17
	Strzelecki Ranges / VIC	111	3	1
	Sydney Cataract / NSW	88	50	-
	Tasmanian Northern Slopes / TAS	37	4	-
	Tasmanian South East / TAS	341	29	5
	Wilsons Promontory / VIC	293	25	10
	Wyong / NSW	60	37	-
	Yuraygir / NSW	18	2	-
IMCRA	Batemans Shelf / NSW / CWTH	1,270	95	50
	Boags / TAS / CWTH	341	28	5
	Bruny / TAS / CWTH	32	6	-
	Central Bass Strait / CWTH	478	28	9

Receptor		Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Probability of instantaneous exposure to entrained hydrocarbons (%)	
			Low	High
	Central Victoria / VIC / CWTH	162	4	1
	Davey / TAS / CWTH	18	2	-
	Flinders / VIC / TAS / CWTH	1,829	95	48
	Freycinet / TAS / CWTH	219	62	5
	Hawkesbury Shelf / NSW / CWTH	225	63	4
	Mackay-Capricorn / QLD / CWTH	10	1	-
	Manning Shelf / NSW / CWTH	112	38	1
	Otway / VIC / TAS / CWTH	14	1	-
	Tweed-Moreton / NSW / QLD / CWTH	18	2	-
	Twofold Shelf / NSW / VIC / TAS / CWTH	11,285	95	95
	Victorian Embayments / VIC	617	19	4
KEF	Big Horseshoe Canyon / CWTH	2,240	95	95
	Canyons on the eastern continental slope / CWTH	1,368	95	33
	Elizabeth and Middleton reefs / CWTH	30	12	-
	Lord Howe seamount chain / CWTH	104	31	1
	Norfolk Ridge / CWTH	13	1	-
	Seamounts South and east of Tasmania / CWTH	233	64	1
	Shelf rocky reefs / CWTH	982	95	28
	Tasman Front and eddy field / CWTH	170	55	5
	Tasmantid seamount chain / CWTH	172	47	5
	Upwelling East of Eden / NSW / VIC / CWTH **	17,024	95	95
	Upwelling off Fraser Island / QLD / CWTH	11	1	-
MNP	Bunurong / VIC	46	1	-
	Cape Howe / VIC	3,832	95	95
	Corner Inlet / VIC	130	11	1
	Ninety Mile Beach / VIC	412	29	4
	Point Hicks / VIC	2,741	95	85
	Wilsons Promontory / VIC	261	15	1
MP	Batemans / NSW	650	95	14
	Great Barrier Reef / QLD / CWTH	10	1	-
	Great Barrier Reef Coast / QLD / CWTH	10	1	-
	Jervis Bay / NSW	152	77	4
	Lord Howe Island / NSW / CWTH	51	27	-
	Port Stephens - Great Lakes / NSW	102	38	1
	Solitary Islands / NSW	18	2	-
MS	Beware Reef / VIC	1,769	88	46
	Mushroom Reef / VIC	11	1	-
NP	Kent Group / TAS	630	41	18
	Booderee / NSW	144	64	1
	Bunurong Marine Park / VIC	26	1	-

Receptor		Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Probability of instantaneous exposure to entrained hydrocarbons (%)	
			Low	High
	Corner Inlet Marine and Coastal Park / VIC	171	11	1
	Nooramunga Marine and Coastal Park / VIC	653	21	4
	Shallow Inlet Marine and Coastal Park / VIC	62	3	-
	Wilsons Promontory Marine Park / VIC	293	14	1
	Wilsons Promontory Marine Reserve / VIC	229	15	1
NR	Chappell Islands / TAS	153	20	2
Ramsar	Corner Inlet / VIC	653	21	4
	East Coast Cape Barren Island Lagoons / TAS	190	34	4
	Elizabeth and Middleton Reefs Marine National Nature Reserve / CWTH	30	14	-
	Flood Plain Lower Ringarooma River / TAS	183	11	3
	Gippsland Lakes / VIC	463	48	7
	Hunter Estuary Wetlands / NSW	29	20	-
	Moulting Lagoon / TAS	19	4	-
	Myall Lakes / NSW	89	28	-
	Towra Point Nature Reserve / NSW	40	34	-
RSB	Beware Reef / VIC	1,769	90	46
	Cody Bank / CWTH	88	2	-
	Cutter Rock / CWTH	132	15	3
	Endeavour Reef / TAS	374	38	10
	New Zealand Star Bank / CWTH	1,445	95	95
	Wakitipu Rock / CWTH	429	34	10
	Warrego Rock / CWTH	407	30	8
	Wright Rock / TAS	445	37	10
LGA	Albatross Island / TAS	10	1	-
	Anser Island / VIC	178	9	1
	Babel Island / TAS	211	43	9
	Badger Island / TAS	249	22	4
	Ballina / NSW	11	1	-
	Balls Pyramid / CWTH	30	21	-
	Bass Coast / VIC	35	1	-
	Bega Valley / NSW / VIC	1,755	95	92
	Bellingen / NSW	16	1	-
	Big green Island / TAS	137	23	2
	Boxen Island / TAS	206	20	3
	Break O'Day / TAS	76	30	-
	Bruny Island / TAS	11	1	-
	Burnie / TAS	29	4	-
	Cape Barren Osland / TAS	190	41	5
	Central Coast / NSW	60	37	-
	Central Coast / TAS	37	3	-

Receptor	Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Probability of instantaneous exposure to entrained hydrocarbons (%)	
		Low	High
Chalky Island / TAS	141	23	2
Circular Head / TAS	175	22	3
Clarence Valley / NSW	17	1	-
Clarke Island / TAS	204	28	4
Coffs Harbour / NSW	18	2	-
Craggy Island / TAS	238	38	10
Curtis Island / TAS	270	19	3
Devenport / TAS	40	4	-
Dorset / TAS	341	25	5
East Gippsland / NSW / VIC	3,860	95	92
East Kangaroo Island / TAS	133	23	2
Elizabeth Reef / CWTH	30	12	-
Eurobodalla / NSW	650	90	12
Flinders Island / TAS	369	37	9
Gabo Island / VIC	3,291	95	93
George Town / TAS	171	12	2
Glamorgan - Spring Bay / TAS	50	11	-
Glennie Group / VIC	240	4	1
Goose Island / TAS	358	21	4
Hogan Island Group / TAS	459	38	13
Hunter Island / TAS	14	1	-
Inner Sister Island / TAS	322	37	8
Kanowna Island / VIC	184	9	1
Kempsey / NSW	18	4	-
Kent Island Group / TAS	630	37	17
Kiama / NSW	52	46	-
Lake Macquarie / NSW	47	27	-
Latrobe / TAS	55	6	-
Lord Howe Island / NSW / CWTH	48	27	-
Maria Island / TAS	33	6	-
Martins Island / VIC	88	7	-
Mid-Coast / NSW	98	34	-
Middleton Reef / CWTH	22	13	-
Moncoeur Islands / VIC	252	15	3
Montague Island / NSW	421	92	13
Mornington Peninsula / VIC	16	1	-
Mount Chappell Island / TAS	138	21	2
Nambuccua / NSW	12	1	-
Newcastle / NSW	42	26	-
Ninth Island / TAS	208	15	4
Norman Island / VIC	273	4	1

Receptor		Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Probability of instantaneous exposure to entrained hydrocarbons (%)	
			Low	High
	North West Solitary Island / NSW	12	2	-
	Northern Beaches / NSW	50	34	-
	Outer Sister Island / TAS	254	39	10
	Pasco Group / TAS	108	28	1
	Phillip Island / VIC	25	1	-
	Port Macquarie-Hastings / NSW	15	2	-
	Port Stephens / NSW	86	32	-
	Preservation Island / TAS	215	22	3
	Prime Seal Island / TAS	354	28	6
	Pyramid Island / CWTH	251	28	6
	Randwick / NSW	81	46	-
	Reef Island / TAS	136	24	2
	Richmond Valley / NSW	12	1	-
	Robbins Island / TAS	16	1	-
	Rodondo Island / VIC	196	14	1
	Seal Islands / VIC	209	25	10
	Shell Harbour / NSW	53	51	-
	Shellback Island / VIC	229	3	1
	Shoal Haven / NSW	571	81	8
	Skull Rock / VIC	184	8	1
	Sorell / TAS	15	2	-
	South Gippsland / VIC	293	16	1
	South Solitary Island / NSW	14	1	-
	Southeast Rock / CWTH	29	24	-
	Sutherland Shire / NSW	89	48	-
	Tasman / TAS	24	4	-
	Three Hummock Island / TAS	17	1	-
	Vansittart Island / TAS	151	34	5
	Waratah-Wynyard / TAS	19	2	-
	Waverly / NSW	40	39	-
	Wellington / VIC	662	36	5
	West Tamar / TAS	61	7	-
	White Rock / TAS	25	4	-
	Wollongong / NSW	55	58	-
	Woollahra / NSW	29	39	-
Sub-LGA	Ballina / NSW	11	1	-
	Bega Valley / NSW / VIC	1,755	95	92
	Bellingen / NSW	16	1	-
	Cape Conran / VIC	2,046	88	43
	Cape Howe / Mallacoota / NSW / VIC	3,860	95	92
	Cape Liptrap (NW) / VIC	99	2	-

Receptor	Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Probability of instantaneous exposure to entrained hydrocarbons (%)	
		Low	High
Central Coast / NSW	60	37	-
Clarence Valley / NSW	17	1	-
Clonmel Island / VIC	662	19	4
Coffs Harbour / NSW	18	2	-
Corner Inlet / VIC	182	13	1
Corringle / VIC	901	67	21
Croajingolong (East) / VIC	2,374	95	78
Croajingolong (West) / VIC	2,142	95	81
Eurobodalla / NSW	650	90	12
Golden Beach / VIC	572	29	4
Kempsey / NSW	18	4	-
Kiama / NSW	52	46	-
Kilcunda / VIC	19	1	-
Lake Macquarie / NSW	47	27	-
Lake Tyers Beach / VIC	532	56	16
Lakes Entrance / VIC	476	49	10
Lakes Entrance (West) / VIC	470	43	5
Marlo / VIC	1,768	86	43
McLoughlins Beach / VIC	662	23	5
Mid-Coast / NSW	98	34	-
Mornington Peninsula (S) / VIC	17	1	-
Mornington Peninsula (SW) / VIC	13	1	-
Nambuccua / NSW	12	1	-
Newcastle / NSW	42	26	-
Northern Beaches / NSW	50	34	-
Ocean Grange / VIC	576	33	5
Point Hicks / VIC	2,873	95	79
Port Macquarie-Hastings / NSW	15	2	-
Port Stephens / NSW	86	32	-
Port Welshpool / VIC	169	9	1
Randwick / NSW	81	46	-
Richmond Valley / NSW	12	1	-
Seaspray / VIC	397	23	4
Shell Harbour / NSW	53	51	-
Shoal Haven / NSW	571	81	8
Snake Island / VIC	253	13	2
Sutherland Shire / NSW	89	48	-
Sydenham Inlet / VIC	2,562	92	62
Venus Bay / VIC	35	1	-
Waratah Bay / VIC	174	4	1
Waverly / NSW	40	39	-

Receptor		Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Probability of instantaneous exposure to entrained hydrocarbons (%)	
			Low	High
	Westernport / VIC	13	1	-
	Wilsons Promontory (East) / VIC	293	16	1
	Wilsons Promontory (NE) / VIC	279	14	1
	Wilsons Promontory (West) / VIC	293	12	1
	Wollongong / NSW	55	58	-
	Woodside Beach / VIC	465	23	4
	Woollahra / NSW	29	39	-
State Waters	New South Wales	1,513	95	94
	Tasmania State Waters	630	51	18
	Victoria State Waters	3,860	95	95
Estuaries	Agnes River / VIC	116	8	1
	Albert River / VIC	114	7	1
	Chinaman Creek / VIC	88	8	-
	Franklin River / VIC	91	7	-
	Freshwater Creek / VIC	125	13	1
	Gippsland Lakes / VIC	148	15	1
	Mallacoota Inlet / VIC	1,148	94	68
	Mitchell River / VIC	66	8	-
	Seal Creek / VIC	1,686	94	76
	Sealers Creek / VIC	236	10	1
	Shallow Inlet / VIC	54	2	-
	Tambo River / VIC	95	13	-
	Wingan River / VIC	1,080	95	71
Other	Cape Conran / VIC	1,733	84	26
	Marlo Coastal Reserve / VIC	1,490	83	29
PP	Salmon Beach / Rocks / VIC	1,624	84	30
TRP	Arthur Bay / TAS	120	19	2
	Beware Reef / VIC	1,769	87	41
	Boat Harbour Creek / TAS	173	29	3
	Cameron Inlet / TAS	134	23	3
	Corner Inlet / VIC	146	11	1
	Davis Creek / VIC	1,220	95	69
	Edens Creek / TAS	344	33	4
	Gabo Island / VIC	3,179	95	90
	Kent Group Islands / TAS	503	34	15
	Killiecranky Creek / TAS	198	27	4
	Lake Bunga / VIC	417	48	7
	Lakes Entrance / VIC	343	47	6
	Lughrata Salt Marsh / TAS	97	23	-
	Mallacoota / VIC	1,131	94	67
	Melrose Road Inlet / TAS	169	25	2

Receptor	Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Probability of instantaneous exposure to entrained hydrocarbons (%)	
		Low	High
Merriman Creek / VIC	375	20	4
Mines Creek / TAS	88	24	-
Mueller River / VIC	1,421	94	69
Nalinga Creek / TAS	130	19	2
North East River / TAS	257	35	4
Patriarchs Inlet / TAS	103	29	1
Pats River / TAS	112	19	1
Point Hicks / VIC	1,946	95	79
Red River / VIC	1,540	95	71
Reddins Creek / TAS	64	20	-
Shipwreck Creek / VIC	1,452	95	75
Tamboon Inlet / VIC	2,114	90	54
The Skerries / VIC	1,324	95	76
Thurra River / VIC	1,630	94	72
Towomba River / NSW	184	56	6
Tullaburga Island / VIC	2,637	95	81
Wingan Inlet / VIC	1,127	95	74
Woodburn & Saltwater Creeks / NSW	336	94	19

**The release location resides within the receptor boundaries.

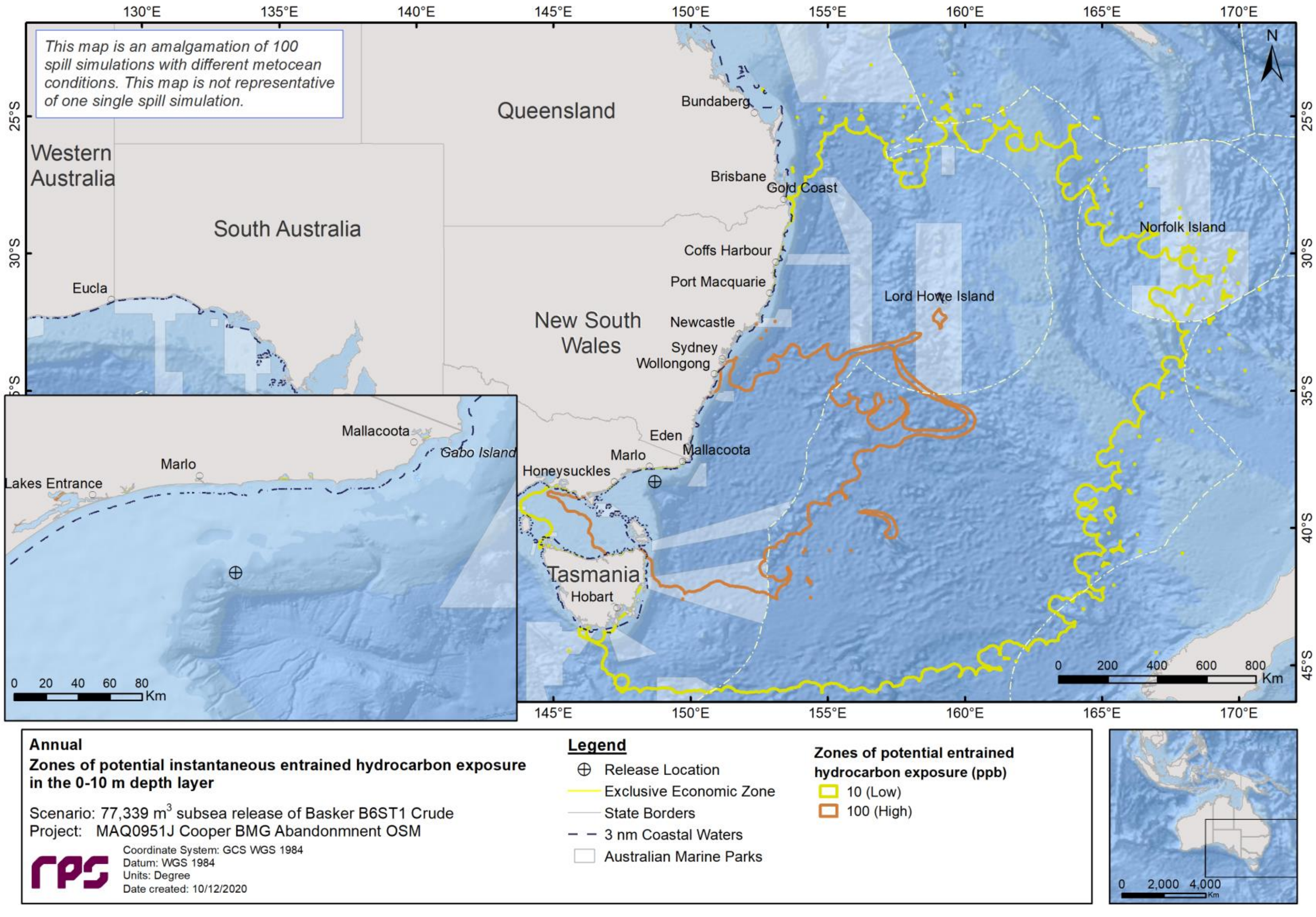


Figure 8-30 Zones of potential instantaneous entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days. The results were calculated from 100 spill trajectories simulated during annual conditions.

8.2 Scenario 2 – Vessel collision – 500 m^3 surface release of MDO over 5 hours

This scenario examined a 500 m^3 surface release of MDO over 5 hours, tracked for 30 days, representing a fuel tank rupture after a vessel collision at the Manta-2A (M2A) well location. A total of 200 spill trajectories were simulated across two seasons; summer and winter (i.e. 100 spills per season).

Section 8.2.1 presents the deterministic results and Section 8.2.2 presents the seasonal stochastic analysis.

8.2.1 Deterministic Analysis

8.2.1.1 Deterministic Case: Largest volume of oil ashore and longest length of shoreline accumulation above 100 g/m^2

The deterministic trajectory that resulted in the largest volume of oil ashore (64.8 m^3) and the longest length of shoreline accumulation above 100 g/m^2 (5.4 km) was identified in winter, as run number 100, which commenced at 11 am 26th May 2016.

Zones of exposure from floating oil (swept area) and shoreline loading over the entire simulation is presented in Figure 8-31. Floating oil was predicted to travel northeast of the release location towards Gabo Island where shoreline accumulation was predicted to occur as well as on the mainland approximately 6.5 km southwest of the New South Wales and Victoria state border.

Figure 8-32 displays the time series of the area of visible (1 g/m^2) and actionable (50 g/m^2) floating oil along with actionable shoreline accumulation (100 g/m^2) over the 30-day simulation. The maximum area of coverage of visible floating oil was predicted to occur 3 days after the spill started and covered approximately 1.2 km^2. While the maximum length of actionable shoreline oil at any given time was predicted as 5.4 km, approximately 4 days into the simulation. Figure 8-33 is a time series of the volume on shore at the low (10 g/m^2), moderate (100 g/m^2) and high (1,000 g/m^2) thresholds.

Figure 8-34 presents the fates and weathering graph for the corresponding single spill trajectory and Table 8-13 summarises the mass balance at the end of the simulation. At the conclusion of the simulation, approximately 37% spilled oil was lost to the atmosphere through evaporation. Approximately 34% of the oil was predicted to have decayed, while 17% was predicted to remain within the water column and approximately 12% was predicted to remain ashore.

Table 8-13 Summary of the mass balance at day 30, for the trajectory that resulted in the largest volume of oil ashore and longest length of shoreline accumulation above 100 g/m^2. Results are based on a 500 m^3 surface release of MDO at the M2A well location over 5 hours, 11 am 26th May 2016.

Exposure Metrics	End of the simulation (day 30)
Surface (%)	0.0
Ashore (%)	11.7
Entrained (%)	17.3
Evaporated (%)	37.0
Decay (%)	34.0

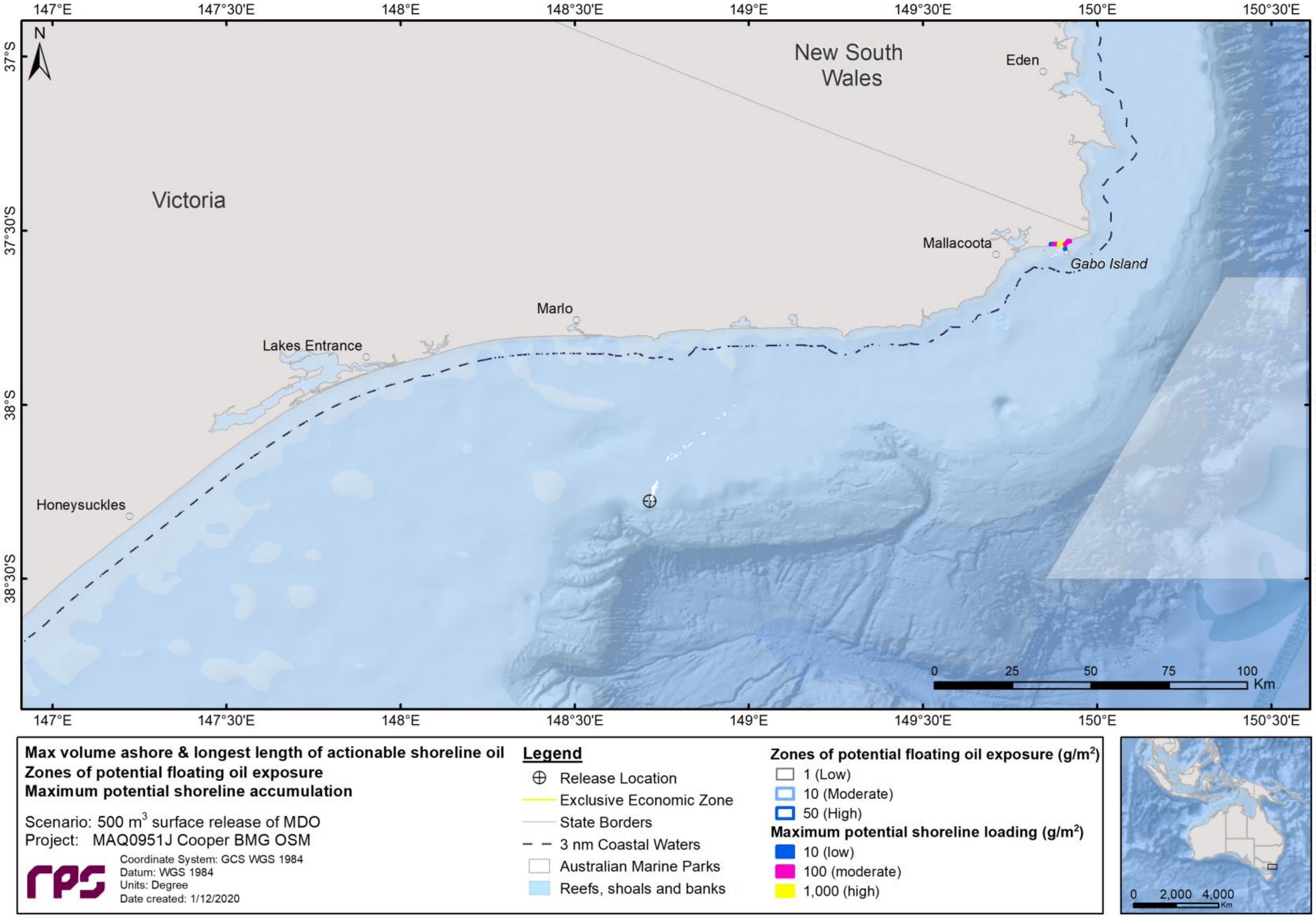


Figure 8-31 Exposure from floating oil and shoreline accumulation for the trajectory with the largest volume of oil ashore and longest length of shoreline accumulation above 100 g/m^2. Results are based on a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days, 11 am 26th May 2016.

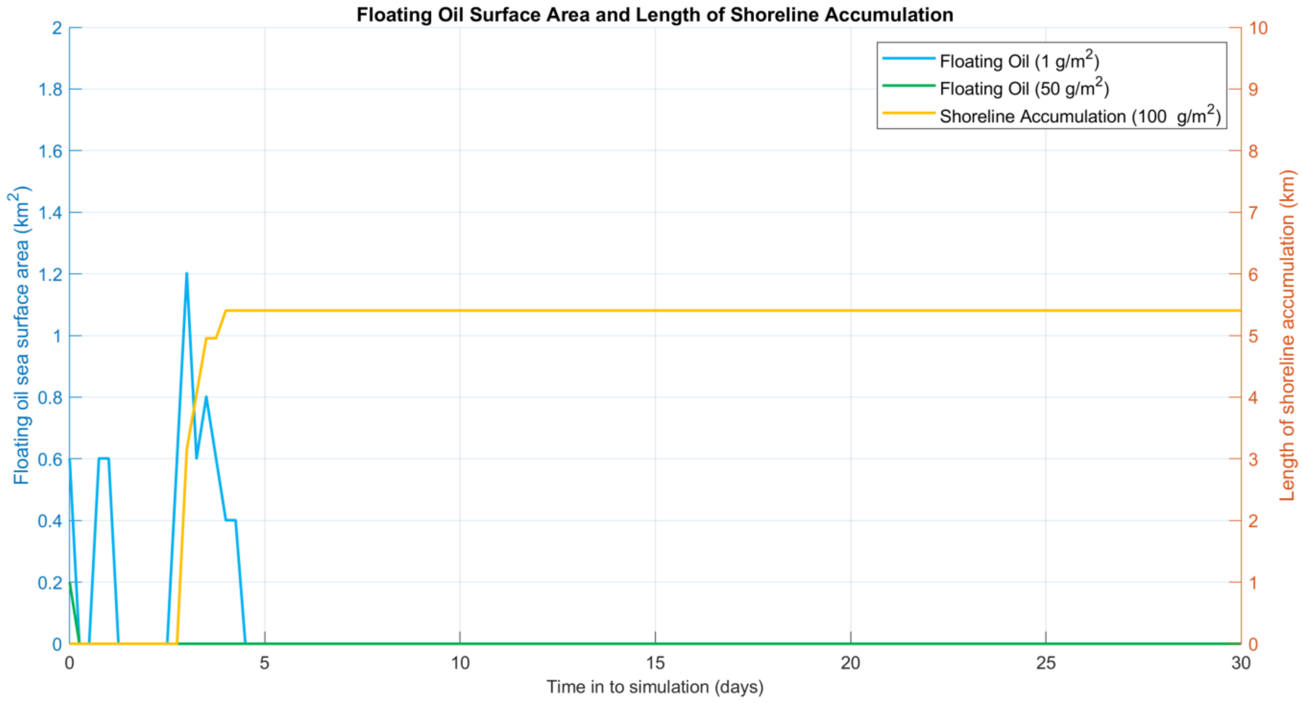


Figure 8-32 Time series of the area of low exposure (1 g/m²) and actionable (50 g/m²) floating oil (left axis) and length of actionable shoreline oil (100 g/m²) (right axis) for the trajectory with the largest volume of oil ashore and longest length of shoreline accumulation above 100 g/m². Results are based on a 500 m³ surface release of MDO at the M2A well location over 5 hours, tracked for 30 days, 11 am 26th May 2016.

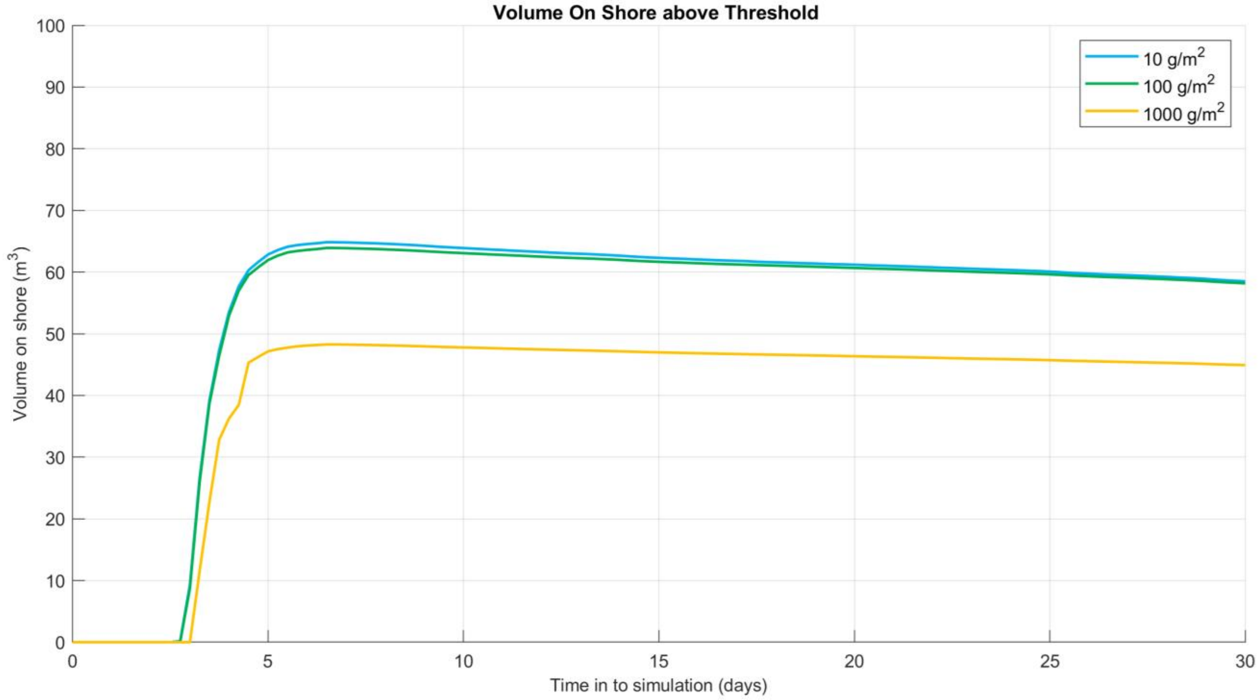


Figure 8-33 Time series of the mass on shore at the low (10 g/m²), moderate (100 g/m²) and high (1,000 g/m²) thresholds for the trajectory with the largest volume of oil ashore and longest length of shoreline accumulation above 100 g/m². Results are based on a 500 m³ surface release of MDO at the M2A well location over 5 hours, tracked for 30 days, 11 am 26th May 2016.

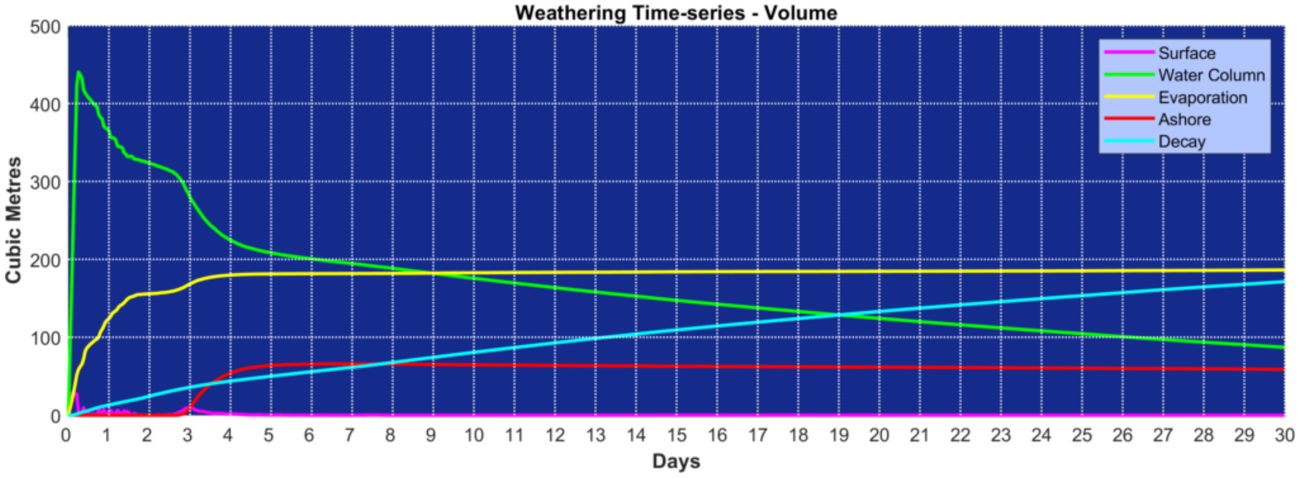


Figure 8-34 Predicted weathering and fates graph for the trajectory with the largest volume of oil ashore and longest length of shoreline accumulation above 100 g/m². Results are based on a 500 m³ surface release of MDO at the M2A well location over 5 hours, tracked for 30 days, 11 am 26th May 2016.

8.2.1.2 Deterministic Case: Minimum time before shoreline accumulation

The deterministic trajectory that resulted in the minimum time before low shoreline accumulation (above 10 g/m²) 1.9 days after the release started was identified in winter, as run number 10, which commenced at 7 am 13th May 2015.

Zones of exposure from floating oil (swept area) and shoreline loading over the entire simulation is presented in Figure 8-35. Floating oil was predicted to travel northeast of the release location towards the New South Wales and Victoria state border where shoreline accumulation was predicted to occur approximately 9 km southwest of the border.

Figure 8-36 displays the time series of the area of visible (1 g/m²) and actionable (50 g/m²) floating oil along with actionable shoreline accumulation (100 g/m²) over the 30-day simulation. The maximum area of coverage of visible floating oil was predicted to occur 2.5 days after the spill started and covered approximately 8.5 km². While the maximum length of actionable shoreline oil at any given time was predicted as 4.5 km, approximately 2.5 days into the simulation. Figure 8-37 is a time series of the mass on shore at the low (10 g/m²), moderate (100 g/m²) and high (1,000 g/m²) thresholds.

Figure 8-38 presents the fates and weathering graph for the corresponding single spill trajectory and Table 8-14 summarises the mass balance at the end of the simulation. At the conclusion of the simulation, approximately 47% spilled oil was lost to the atmosphere through evaporation. Approximately 33% of the oil was predicted to have decayed, while approximately 17 % was predicted to remain within the water column and 2% was predicted to remain ashore.

Table 8-14 Summary of the mass balance at day 30, for the trajectory that resulted in the minimum time before shoreline accumulation above the low threshold (10 g/m²). Results are based on a 500 m³ surface release of MDO at the M2A well location over 5 hours, 7 am 13th May 2015.

Exposure Metrics	End of the simulation (day 30)
Surface (%)	0.0
Ashore (%)	2.3
Entrained (%)	17.5
Evaporated (%)	46.7
Decay (%)	33.4

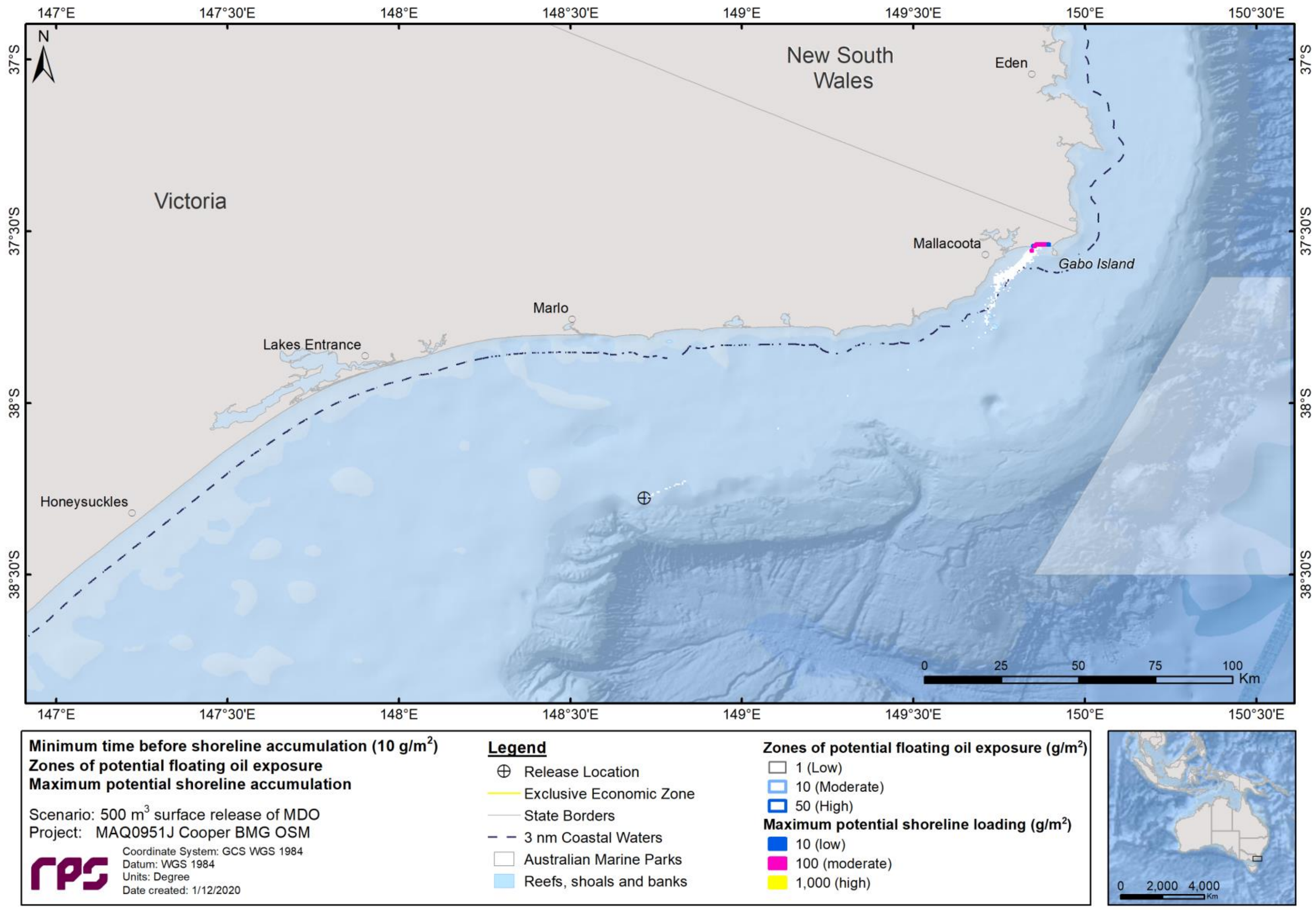


Figure 8-35 Exposure from floating oil and shoreline accumulation for the trajectory with the minimum time before shoreline accumulation at, or above the low threshold. Results are based on a 500 m³ surface release of MDO at the M2A well location over 5 hours, tracked for 30 days, 7 am 13th May 2015.

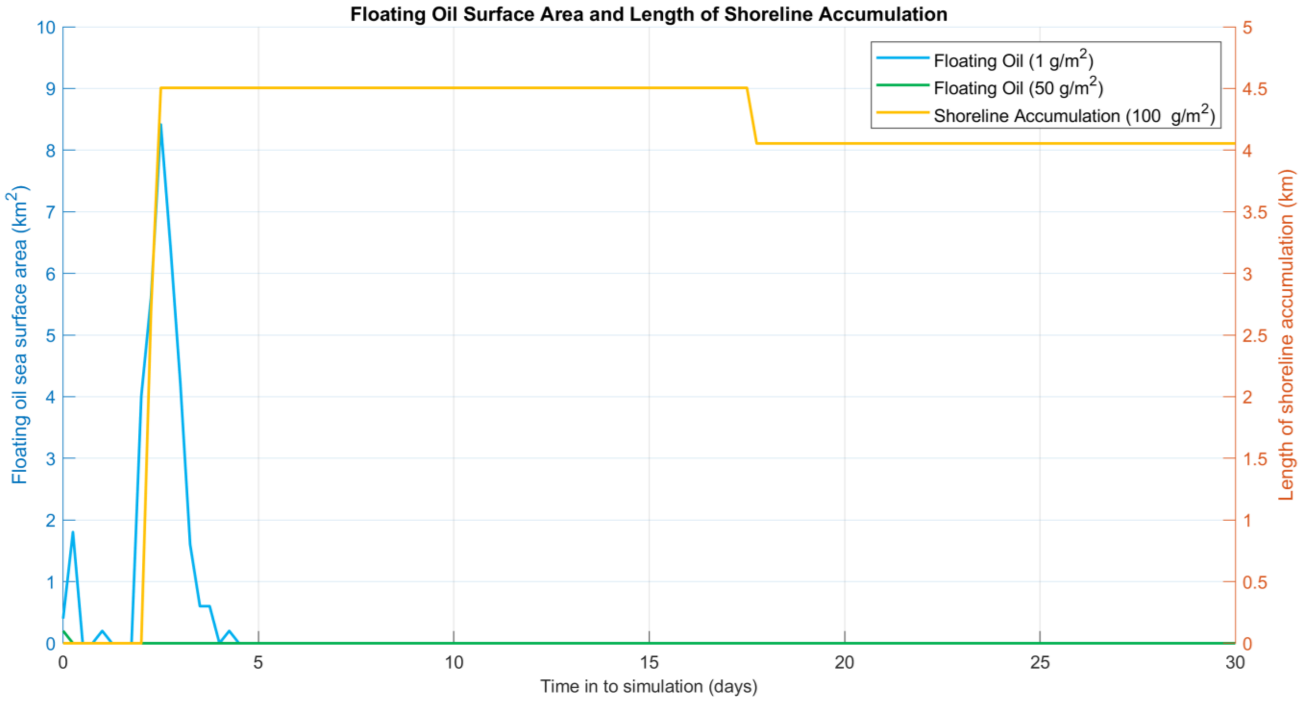


Figure 8-36 Time series of the area of low exposure (1 g/m²) and actionable (50 g/m²) floating oil (left axis) and length of actionable shoreline oil (100 g/m²) (right axis) for the trajectory with the minimum time before shoreline accumulation at, or above the low threshold. Results are based on a 500 m³ surface release of MDO at the M2A well location over 5 hours, tracked for 30 days, 7 am 13th May 2015.

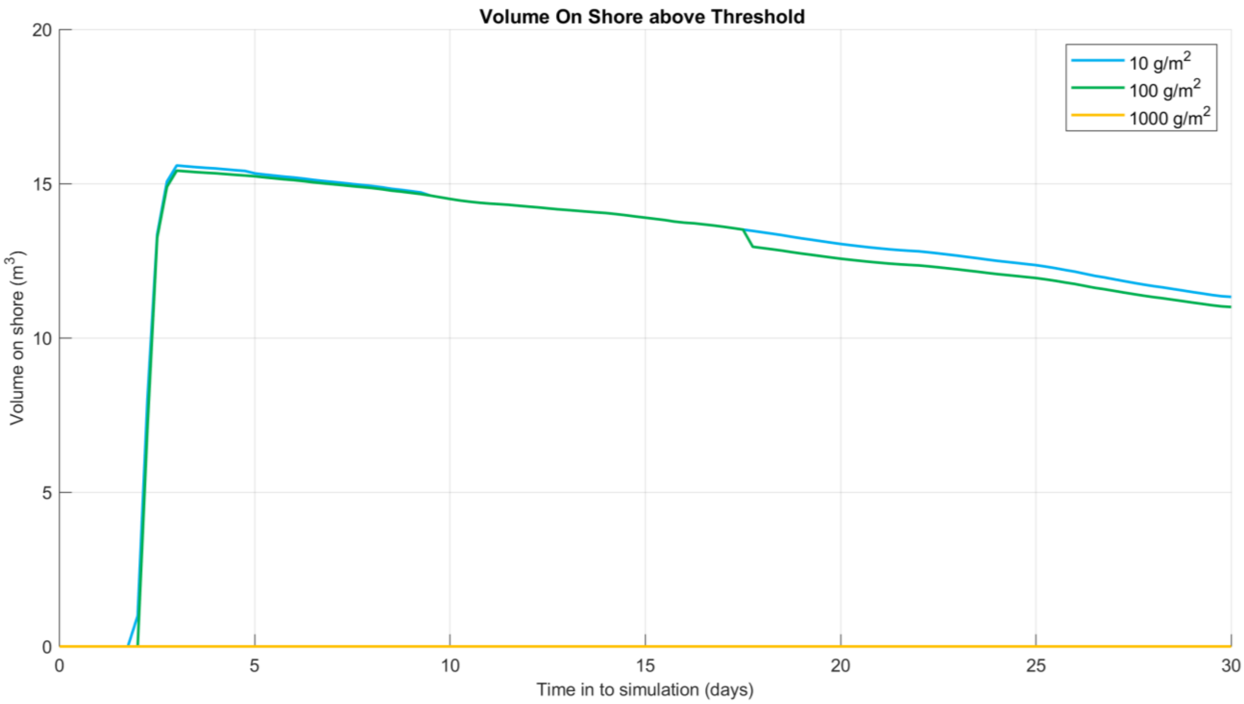


Figure 8-37 Time series of the mass on shore at the low (10 g/m²), moderate (100 g/m²) and high (1,000 g/m²) thresholds for the trajectory with the minimum time before shoreline accumulation at, or above the low threshold. Results are based on a 500 m³ surface release of MDO at the M2A well location over 5 hours, tracked for 30 days, 7 am 13th May 2015.

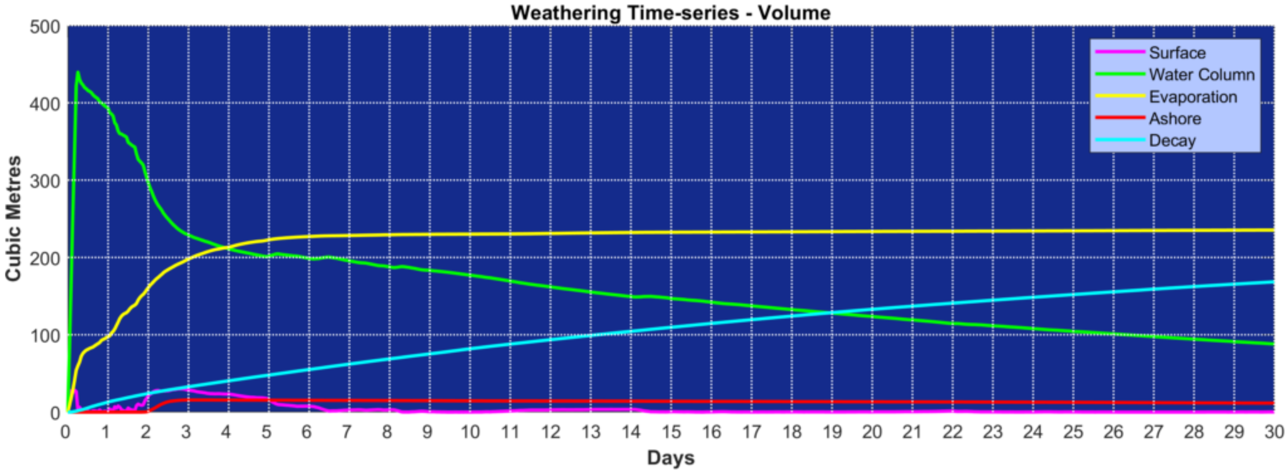


Figure 8-38 Predicted weathering and fates graph for the trajectory with the minimum time before shoreline accumulation at, or above the low threshold. Results are based on a 500 m³ surface release of MDO at the M2A well location over 5 hours, tracked for 30 days, 7 am 13th May 2015.

8.2.1.3 Deterministic Case: Largest area of floating oil above 1 g/m²

The deterministic trajectory that resulted in the largest area of floating oil above 1 g/m² (visible floating oil) was identified in winter, as run number 65 which commenced at 9 am 13th May 2017.

Zones of exposure from floating oil (swept area) over the entire simulation is presented in Figure 8-39. Floating oil at, or above the low threshold was initially predicted to travel north towards the Gippsland coast and then drift west-southwest, extending a maximum distance of approximately 75 km west from the release location.

Figure 8-40 displays the time series of the area of visible floating oil (1 g/m²) and actionable floating oil (50 g/m²) over the 30-day simulation. The maximum area of coverage of visible floating oil was predicted to occur 4.25 days after the spill started and covered approximately 54 km². No actionable floating oil and actionable shoreline accumulation was predicted for this simulation.

Figure 8-41 presents the fates and weathering graph for the corresponding single spill trajectory and Table 8-15 summarises the mass balance at the end of the simulation. At the conclusion of the simulation, approximately 69% spilled oil was lost to the atmosphere through evaporation. Approximately 17% of the oil was predicted to have decayed, while approximately 14% was predicted to remain within the water column and <1% was predicted to remain ashore.

Table 8-15 Summary of the mass balance at day 30, for the trajectory that resulted in the largest swept area of floating oil above 1 g/m². Results are based on a 500 m³ surface release of MDO at the M2A well location over 5 hours, 9 am 13th May 2017.

Exposure Metrics	End of the simulation (day 30)
Surface (%)	0.0
Ashore (%)	0.3
Entrained (%)	13.6
Evaporated (%)	69.2
Decay (%)	16.7

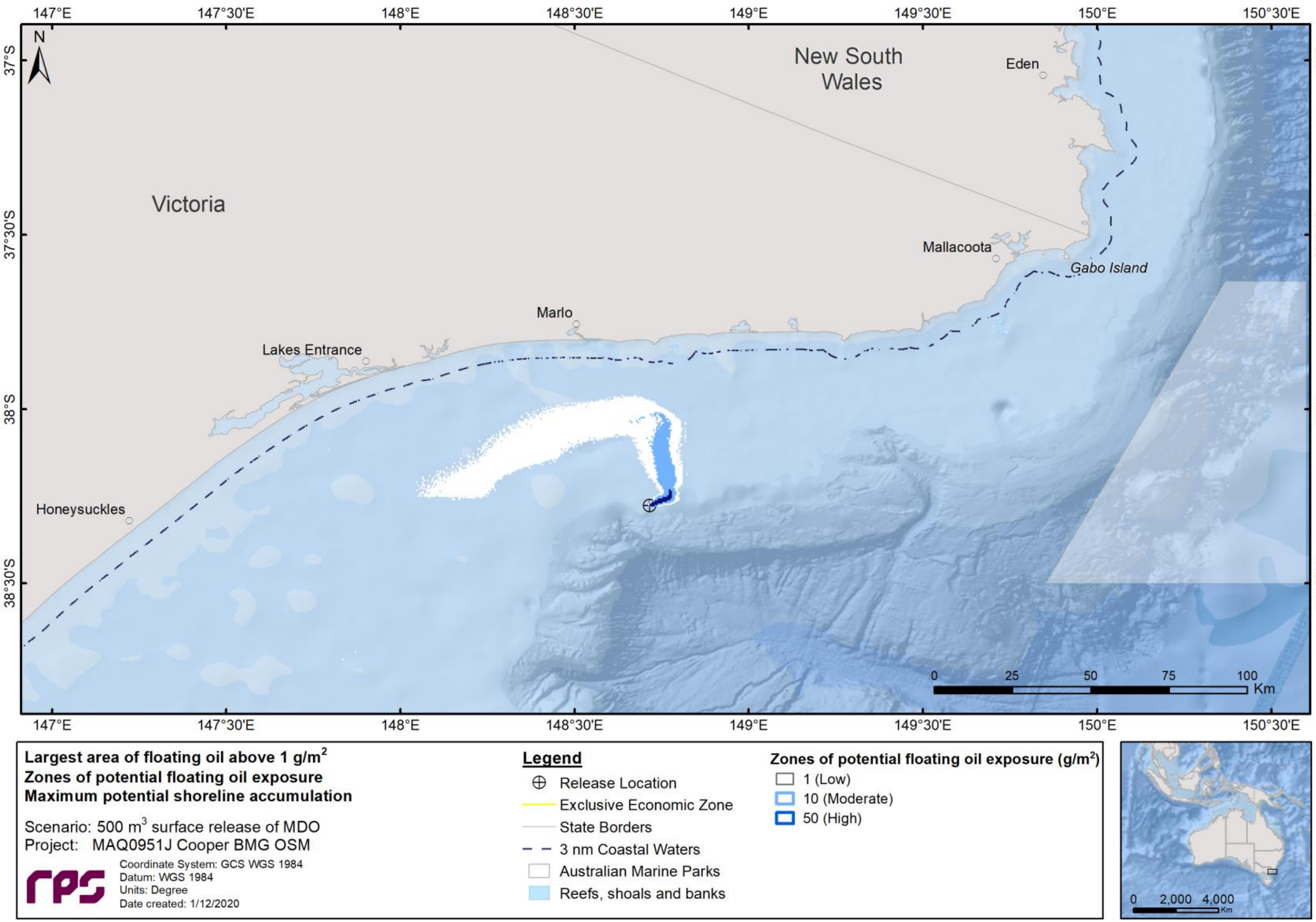


Figure 8-39 Exposure from floating oil for the trajectory with largest swept area of floating oil above 1 g/m^2 (low threshold and visible floating oil). Results are based on a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days, 9 am 13th May 2017.

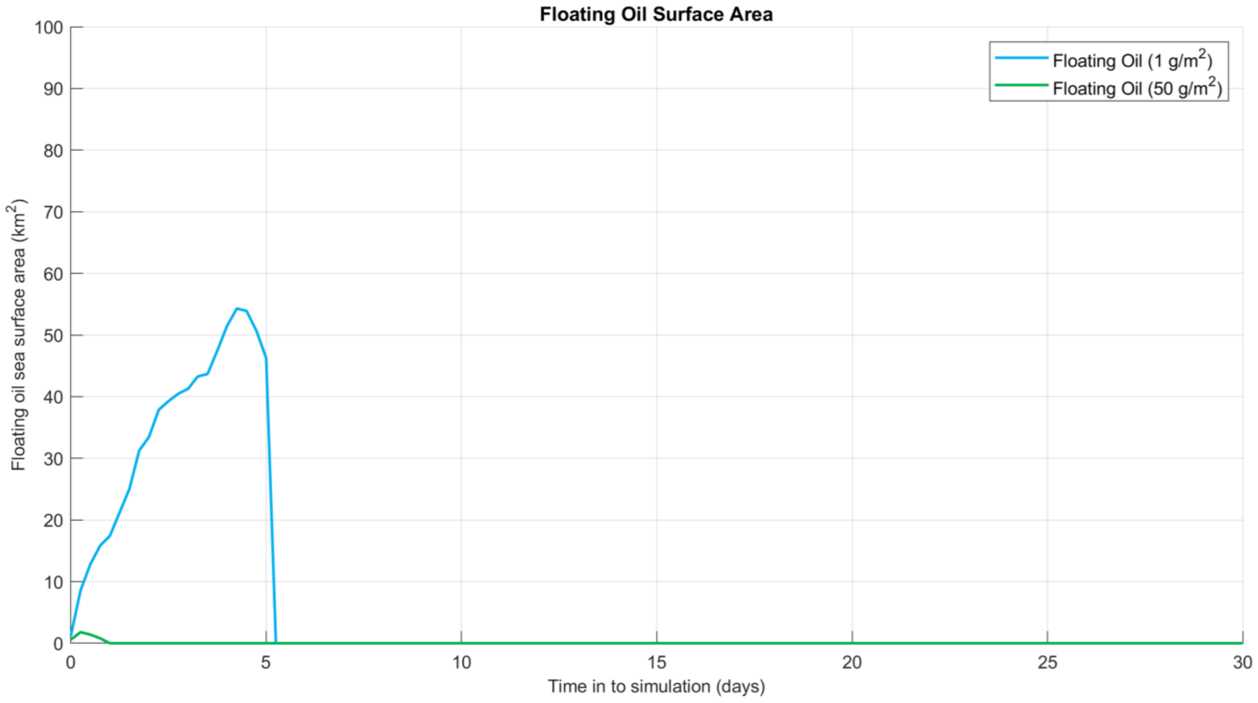


Figure 8-40 Time series of the area of low exposure (1 g/m²) and actionable (10 g/m²) floating oil on for the trajectory with the largest swept area of floating oil above 1 g/m². Results are based on a 500 m³ surface release of MDO at the M2A well location over 5 hours, tracked for 30 days, 9 am 13th May 2017.

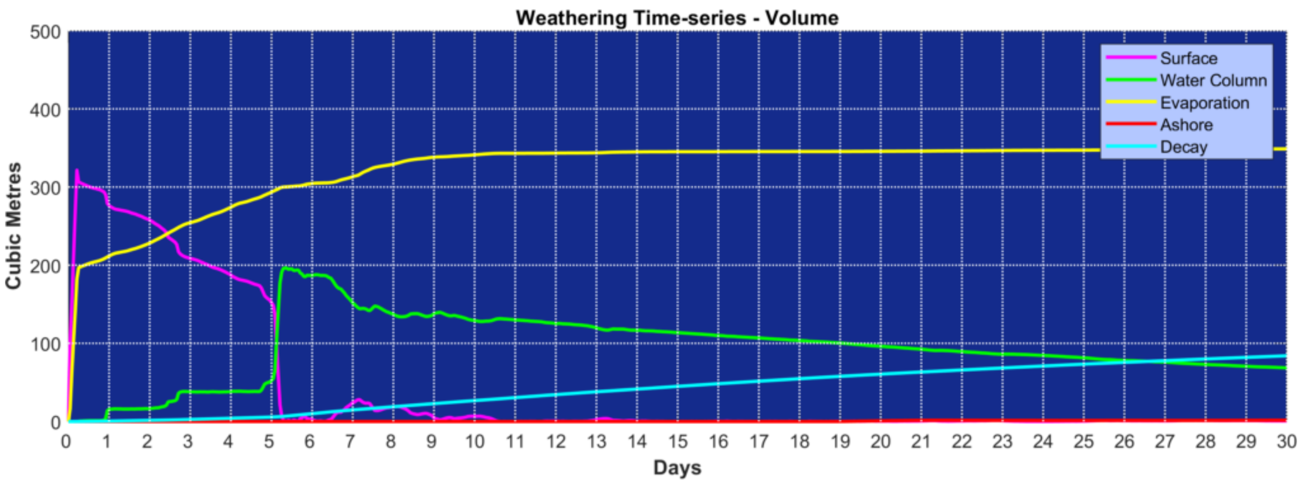


Figure 8-41 Predicted weathering and fates graph for the trajectory with the largest swept area of floating oil above 1 g/m². Results are based on a 500 m³ surface release of MDO at the M2A well location over 5 hours, tracked for 30 days, 9 am 13th May 2017.

8.2.1.4 Deterministic Case: Largest swept area of entrained oil above 10 ppb

The deterministic trajectory that resulted in the largest swept area of entrained oil above 10 ppb was identified in summer, as run number 80 which commenced at 8 am 10th April 2009.

Zones of exposure from entrained oil (swept area) over the entire simulation is presented in Figure 8-42. Entrained oil at, or above the low threshold was initially predicted to travel east and then northeast from the release location before taking a southerly turn and reaching a maximum distance of approximately 315 km south-southeast of the release location.

Figure 8-43 displays the time series of the area of entrained oil at the low (10 ppb) and moderate (100 ppb) thresholds over the 30-day simulation. The maximum area of coverage of low entrained oil was predicted to occur 11 days after the spill started and covered approximately 2,700 km^2.

Figure 8-44 presents the fates and weathering graph for the corresponding single spill trajectory and Table 8-16 summarises the mass balance at the end of the simulation. At the conclusion of the simulation, approximately 43% spilled oil was lost to the atmosphere through evaporation. Approximately 34% of the oil was predicted to have decayed, while approximately 23% was predicted to remain within the water column and no oil was predicted to arrive ashore.

Table 8-16 Summary of the mass balance at day 30, for the trajectory that resulted in largest swept area of entrained oil exposure above 10 ppb. Results are based on a 500 m^3 surface release of MDO at the M2A well location over 5 hours, 8 am 10th April 2009.

Exposure Metrics	End of the simulation (day 30)
Surface (%)	0.0
Ashore (%)	0.0
Entrained (%)	22.6
Evaporated (%)	43.4
Decay (%)	34.0

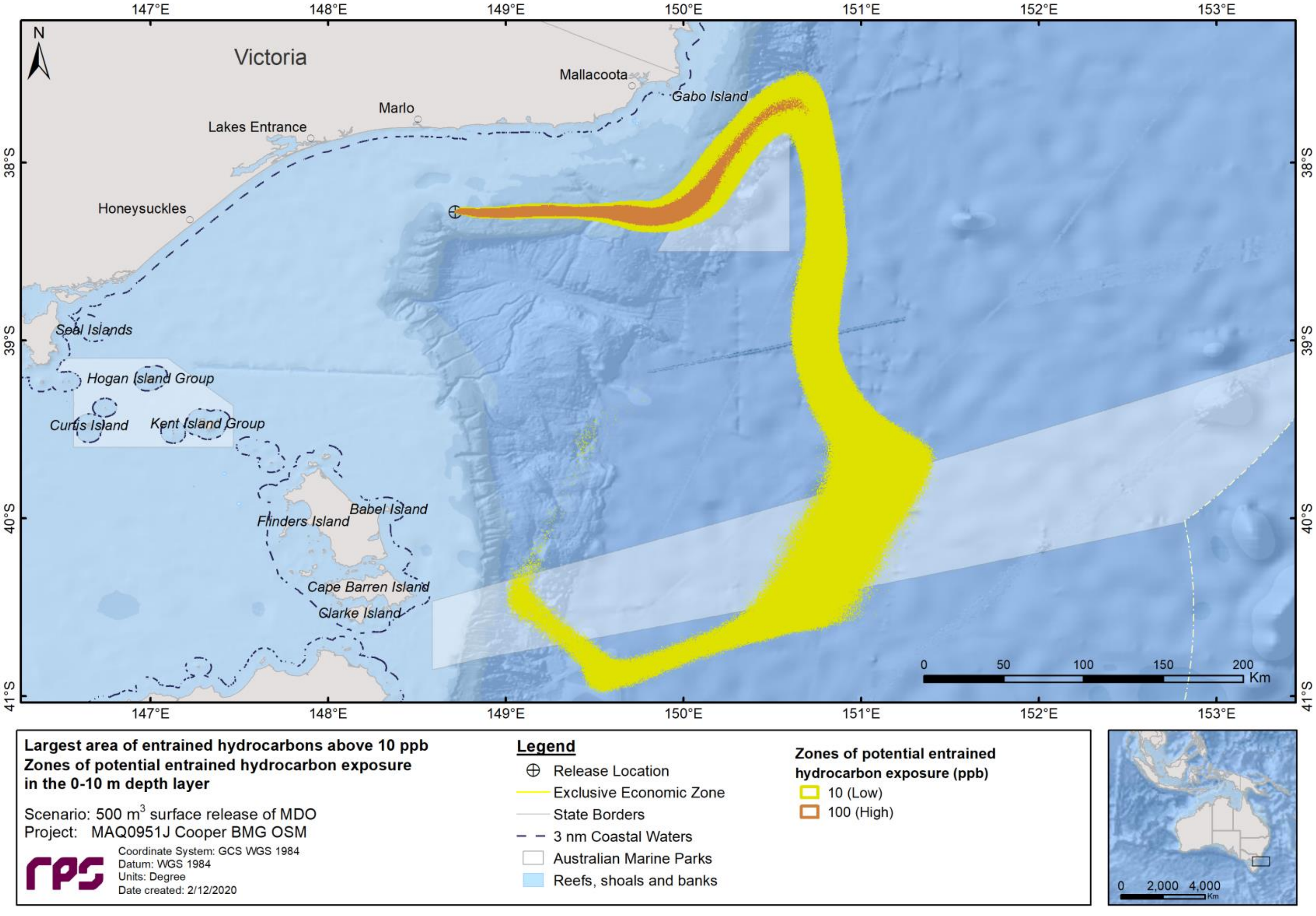


Figure 8-42 Exposure from entrained oil for the trajectory with the largest swept area of entrained oil above 10 ppb. Results are based on a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days, 8 am 10th April 2009.

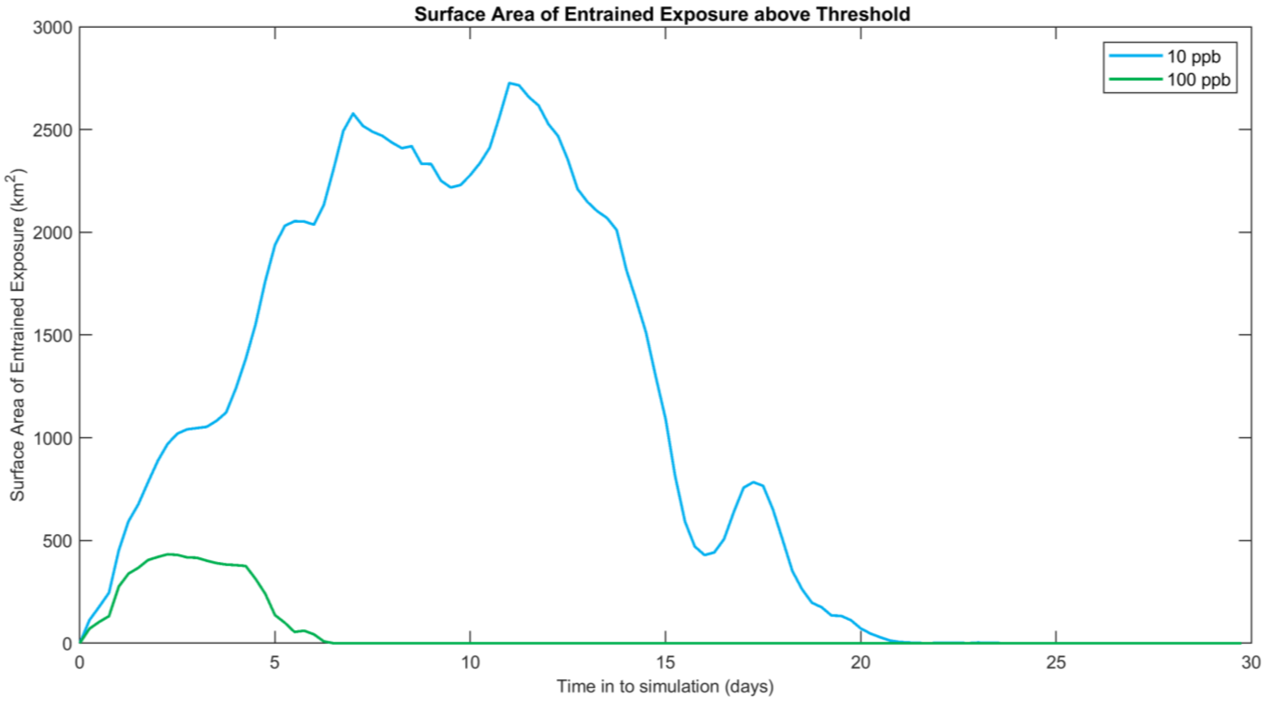


Figure 8-43 Time series of the area of low (10 ppb) and high(100 ppb) exposure to entrained oil for the trajectory with the largest swept area of entrained oil above 10 ppb. Results are based on a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days, 8 am 10th April 2009.

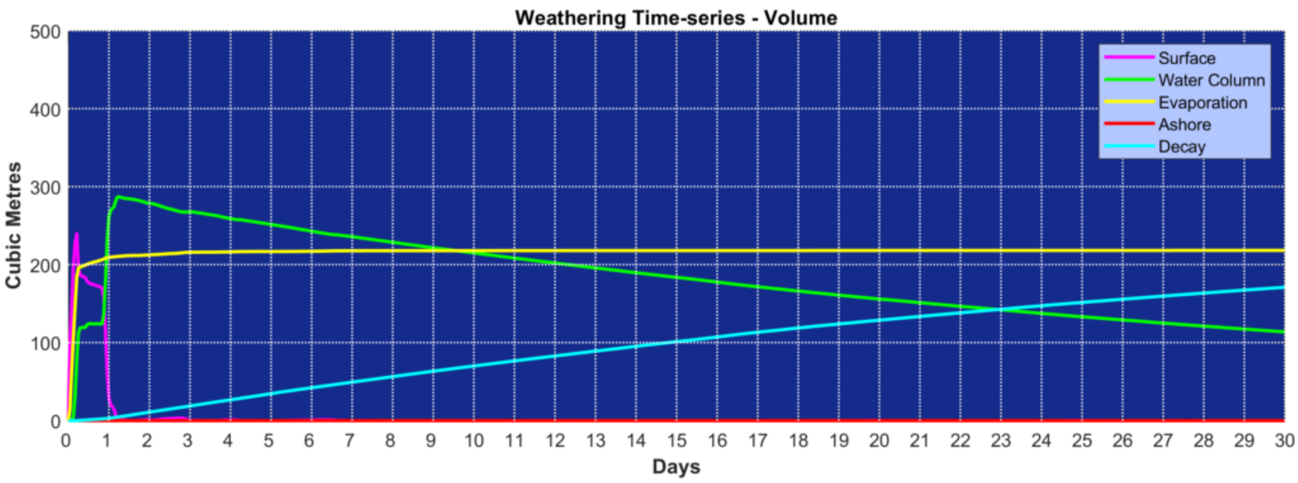


Figure 8-44 Predicted weathering and fates graph for the trajectory with the largest swept area of entrained oil above 10 ppb. Results are based on a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days, 8 am 10th April 2009.

8.2.1.5 Deterministic Case: Largest swept area of dissolved hydrocarbons above 10 ppb

The deterministic trajectory that resulted in the largest swept area of dissolved hydrocarbons above 10 ppb was identified in winter, as run number 6 which commenced at 11 pm 24th May 2012.

Zones of exposure from dissolved hydrocarbons (swept area) over the entire simulation is presented in Figure 8-45. Dissolved hydrocarbons at, or above the low threshold were initially predicted to travel northeast towards Gabo Island and then north into New South Wales coastal waters.

Figure 8-46 displays the time series of the area of dissolved hydrocarbons at the low (10 ppb), moderate (50 ppb) and high (400 ppb) thresholds over the 30-day simulation. The maximum area of coverage of low dissolved hydrocarbons was predicted to occur 12 hours after the spill started and covered approximately 61 km^2.

Figure 8-47 presents the fates and weathering graph for the corresponding single spill trajectory and Table 8-17 summarises the mass balance at the end of the simulation. At the conclusion of the simulation, approximately 45% spilled oil was lost to the atmosphere through evaporation. Approximately 36% of the oil was predicted to have decayed, while approximately 18% was predicted to remain within the water column and no oil was predicted to arrive ashore.

Table 8-17 Summary of the mass balance at day 30, for the trajectory that resulted in largest swept area of dissolved hydrocarbon exposure above 10 ppb. Results are based on a 500 m^3 surface release of MDO at the M2A well location over 5 hours, 11 pm 24th May 2012.

Exposure Metrics	End of the simulation (day 30)
Surface (%)	0.0
Ashore (%)	0.0
Entrained (%)	18.4
Evaporated (%)	45.1
Decay (%)	36.5

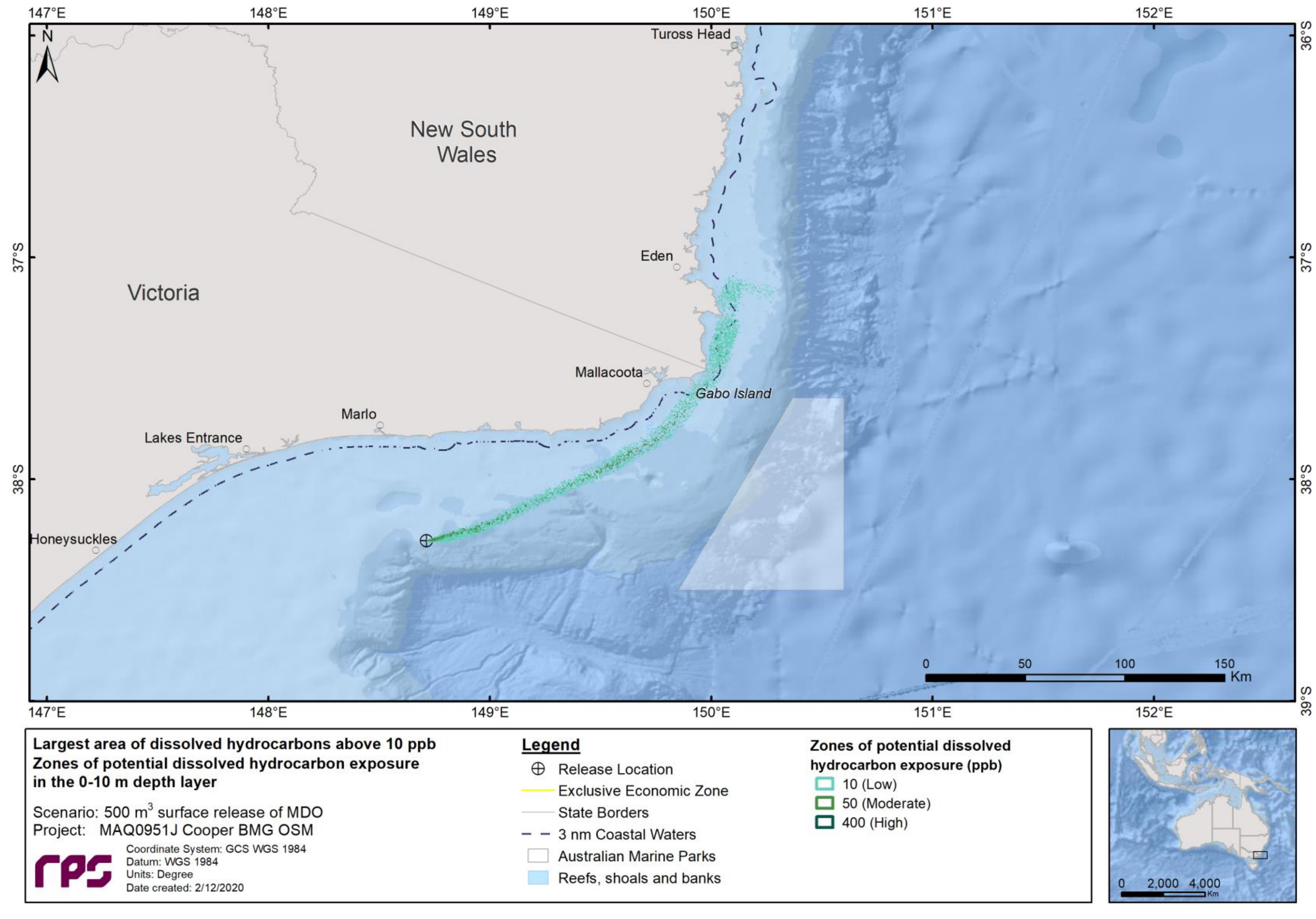


Figure 8-45 Exposure from dissolved hydrocarbons for the trajectory with the largest swept area of dissolved hydrocarbons above 10 ppb. Results are based on a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days, 11 pm 24th May 2012.

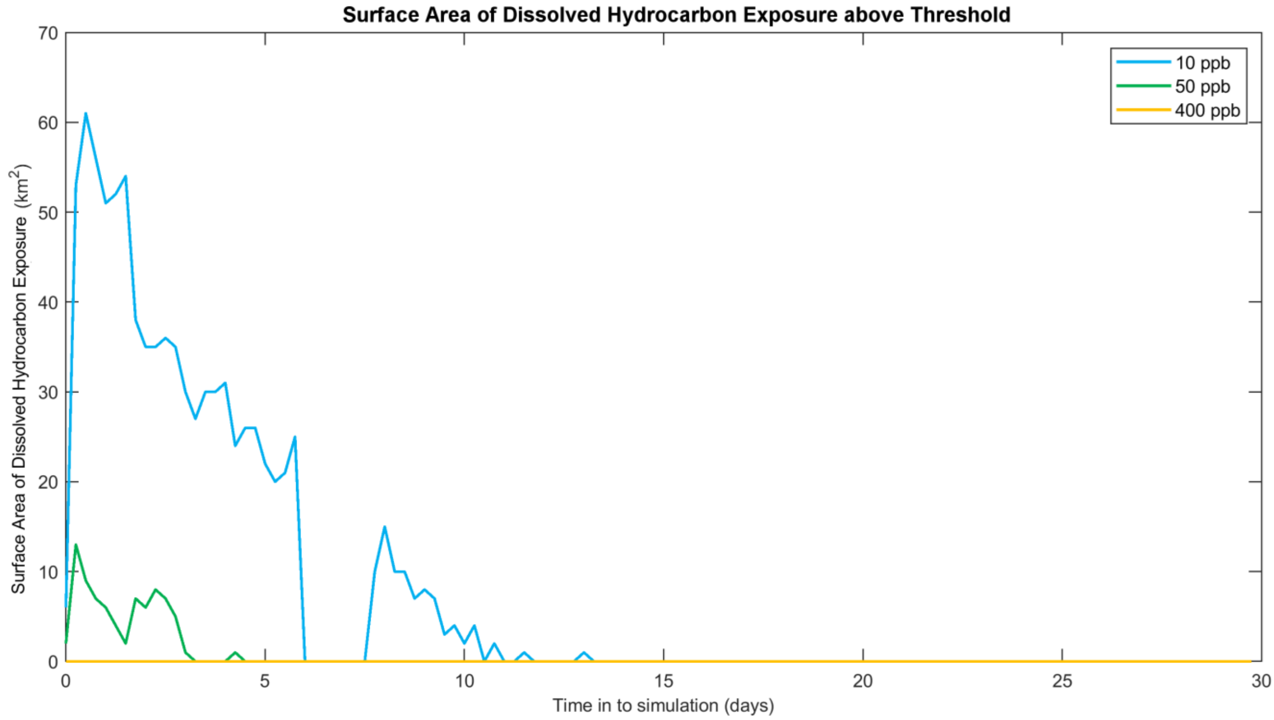


Figure 8-46 Time series of the area of low (10 ppb), moderate (50 ppb) and high(100 ppb) dissolved hydrocarbon for the trajectory with the largest swept area of dissolved hydrocarbons above 10 ppb. Results are based on a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days, 11 pm 24th May 2012.

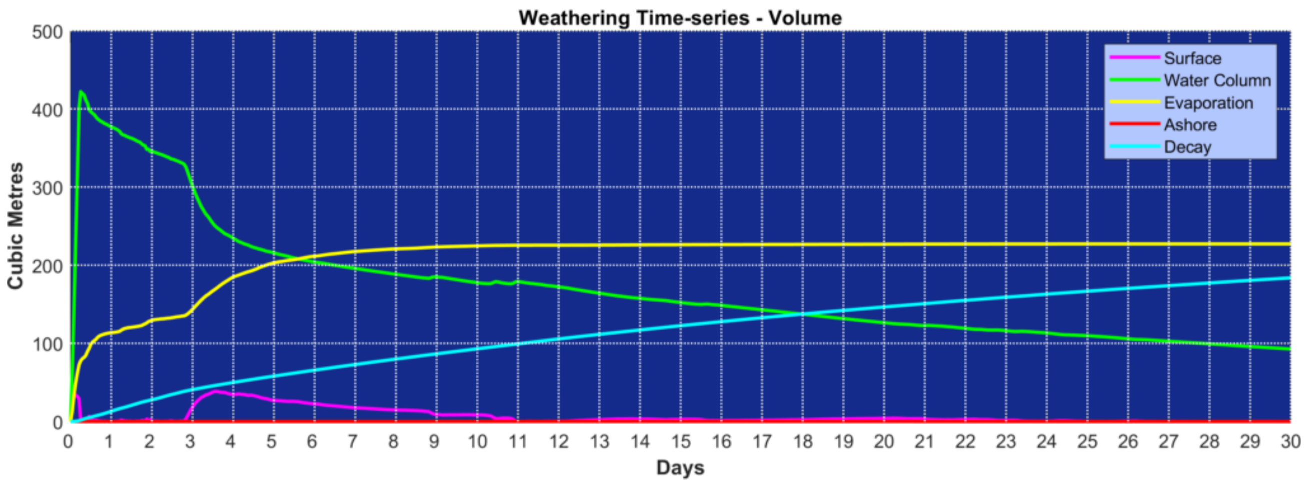


Figure 8-47 Predicted weathering and fates graph for the trajectory with the largest swept area of dissolved hydrocarbons above 10 ppb. Results are based on a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days, 11 pm 24th May 2012.

8.2.2 Stochastic Analysis

8.2.2.1 Floating Oil Exposure

Table 8-18 summarises the maximum distances from the release location to floating oil exposure zones for each season.

The maximum distance from the release location to the low (≥ 1 g/m^2), moderate (≥ 10 g/m^2) and high (≥ 50 g/m^2) exposure thresholds was 194 km east (summer), 132 km east northeast (winter) and 11 km north northwest (summer), respectively.

Table 8-19 presents the potential floating oil exposure to individual receptors during summer and winter conditions.

A total of 19 and 21 Biologically Important Areas (BIAs) were predicted to be exposed to floating oil at or above the low threshold during summer and winter conditions, respectively. Aside from the 12 BIAs that the release location resides within (see Section 6.3), the highest probability of low floating oil exposure and the minimum time before low floating oil exposure was predicted at the White-faced Storm-petrel - Foraging BIA with 55% and 56% during summer and winter conditions respectively and 0.25 days (6 hours) and 0.21 days (5.0 hours) minimum time, respectively.

The rest of the receptors exposed to floating oil at or above the low threshold showed probabilities under 10% in all cases and none of these receptors were exposed to the moderate or high exposure thresholds.

Figure 8-48 and Figure 8-49 present the zones of potential floating oil exposure for the NOPSEMA thresholds during summer and winter conditions.

Table 8-18 Maximum distance and direction from the release location to floating oil exposure thresholds. Results are based on a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.

Season	Distance and direction	Zones of potential floating oil exposure		
		Low	Moderate	High
Summer	Max. distance from release site (km)	194	32	11
	Max distance from release site (km) (99th percentile)	167	30	10
	Direction	E	WSW	NNW
Winter	Max. distance from release site (km)	177	132	7
	Max distance from release site (km) (99th percentile)	167	29	7
	Direction	NE	ENE	NE

Table 8-19 Summary of the potential floating oil exposure to individual receptors. Results are based on a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.

Season	Receptor		Probability of floating oil exposure (%)			Minimum time before floating oil exposure (days)		
			Low	Moderate	High	Low	Moderate	High
Summer	AMP	East Gippsland / CWTH	1	-	-	2.83	-	-
	BIA	Antipodean Albatross - Foraging / CWTH **	100	100	100	0.04	0.04	0.04
		Black-browed Albatross - Foraging / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.04
		Bullers Albatross - Foraging / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.04
		Campbell Albatross - Foraging / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.04
		Common Diving-petrel - Foraging / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.04
		Indian Yellow-nosed Albatross - Foraging / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.04
		Little Penguin - Breeding / NSW / VIC / TAS / CWTH	1	-	-	4.38	-	-
		Little Penguin - Foraging / VIC / TAS / CWTH	3	-	-	3.25	-	-
		Pygmy Blue Whale - Distribution / NSW / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.04
		Pygmy Blue Whale - Foraging / NSW / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.04
		Short-tailed Shearwater - Foraging / NSW / VIC / TAS / CWTH	5	-	-	1.50	-	-
		Shy Albatross - Foraging / NSW / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.04
		Southern Right Whale - Migration / NSW / VIC / TAS / CWTH	100	100	100	0.04	0.04	0.04
		Wandering Albatross - Foraging / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.04
		Wedge-tailed Shearwater - Foraging / NSW / VIC / QLD / TAS / CWTH	4	-	-	2.00	-	-
		White Shark - Distribution / NSW / VIC / QLD / TAS / CWTH **	100	100	100	0.04	0.04	0.04
		White Shark - Foraging / VIC / TAS / CWTH	5	-	-	1.13	-	-
		White-faced Storm-petrel - Breeding / NSW / CWTH	1	-	-	4.38	-	-
		White-faced Storm-petrel - Foraging / NSW / VIC / TAS / CWTH	55	10	-	0.25	0.25	-

Season	Receptor		Probability of floating oil exposure (%)			Minimum time before floating oil exposure (days)		
			Low	Moderate	High	Low	Moderate	High
	EEZ	Australian Exclusive Economic Zone **	100	100	100	0.04	0.04	0.04
	IBRA	East Gippsland Lowlands / NSW / VIC	2	-	-	3.25	-	-
	IMCRA	Twofold Shelf / NSW / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.04
	KEF	Upwelling East of Eden / NSW / VIC / CWTH **	100	100	100	0.04	0.04	0.04
	MNP	Cape Howe / VIC	1	-	-	3.46	-	-
	LGA	East Gippsland / NSW / VIC	1	-	-	3.42	-	-
		Gabo Island / VIC	2	-	-	3.25	-	-
	Sub-LGA	Cape Howe / Mallacoota / NSW / VIC	1	-	-	3.38	-	-
	State Waters	Victoria State Waters	3	-	-	2.67	-	-
Winter	BIA	Antipodean Albatross - Foraging / CWTH **	100	100	100	0.04	0.04	0.04
		Black-browed Albatross - Foraging / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.04
		Bullers Albatross - Foraging / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.04
		Campbell Albatross - Foraging / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.04
		Common Diving-petrel - Foraging / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.04
		Grey Nurse Shark - Foraging / NSW / QLD / CWTH	2	-	-	3.58	-	-
		Grey Nurse Shark - Migration / NSW / QLD / CWTH	2	-	-	3.42	-	-
		Humpback Whale - Foraging / NSW / CWTH	5	-	-	2.46	-	-
		Indian Yellow-nosed Albatross - Foraging / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.04
		Indo-Pacific/Spotted Bottlenose Dolphin - Breeding / NSW / QLD / CWTH	4	-	-	2.33	-	-
		Little Penguin - Foraging / VIC / TAS / CWTH	9	-	-	1.83	-	-
		Pygmy Blue Whale - Distribution / NSW / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.04
		Pygmy Blue Whale - Foraging / NSW / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.04
		Short-tailed Shearwater - Foraging / NSW / VIC / TAS / CWTH	6	-	-	2.08	-	-

Season	Receptor		Probability of floating oil exposure (%)			Minimum time before floating oil exposure (days)		
			Low	Moderate	High	Low	Moderate	High
		Shy Albatross - Foraging / NSW / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.04
		Southern Right Whale - Migration / NSW / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.04
		Wandering Albatross - Foraging / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.04
		Wedge-tailed Shearwater - Foraging / NSW / VIC / QLD / TAS / CWTH	10	-	-	1.83	-	-
		White Shark - Distribution / NSW / VIC / QLD / TAS / CWTH **	100	100	100	0.04	0.04	0.04
		White Shark - Foraging / VIC / TAS / CWTH	7	-	-	1.25	-	-
		White-faced Storm-petrel - Foraging / NSW / VIC / TAS / CWTH	56	5	-	0.21	0.42	-
	EEZ	Australian Exclusive Economic Zone **	100	100	100	0.04	0.04	0.04
	IBRA	East Gippsland Lowlands / NSW / VIC	5	1	-	1.96	3.04	-
	IMCRA	Twofold Shelf / NSW / VIC / TAS / CWTH **	100	100	100	0.04	0.04	0.04
	KEF	Big Horseshoe Canyon / CWTH	3	-	-	2.04	-	-
		Upwelling East of Eden / NSW / VIC / CWTH **	100	100	100	0.04	0.04	0.04
	MNP	Cape Howe / VIC	6	-	-	2.21	-	-
	RSB	New Zealand Star Bank / CWTH	2	-	-	2.96	-	-
	LGA	East Gippsland / NSW / VIC	5	1	-	1.96	3.04	-
	Sub-LGA	Cape Howe / Mallacoota / NSW / VIC	5	1	-	1.96	3.04	-
		Croajingolong (East) / VIC	1	-	-	5.38	-	-
	State Waters	New South Wales	4	-	-	2.38	-	-
		Victoria State Waters	9	1	-	1.83	3.04	-
	TRP	Betka River / VIC	1	-	-	5.50	-	-
		Tullaburga Island / VIC	1	-	-	2.21	-	-

**The release location resides within the receptor boundaries.

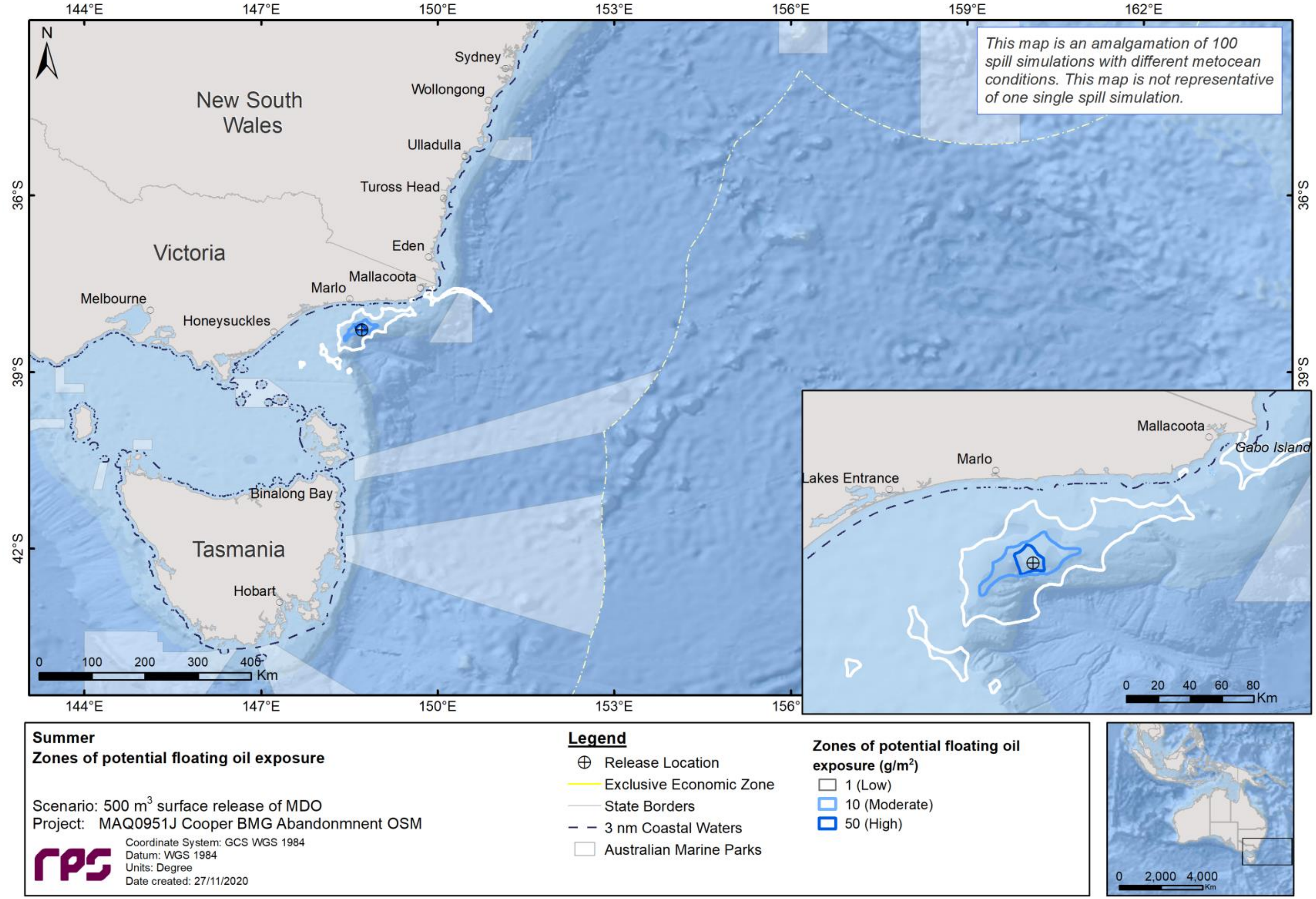


Figure 8-48 Zones of potential floating oil exposure, in the event of a 500 m³ surface release of MDO at the M2A well location over 5 hours, tracked for 30 days. The results were calculated from 100 spill trajectories simulated during summer (October to April) wind and current conditions.

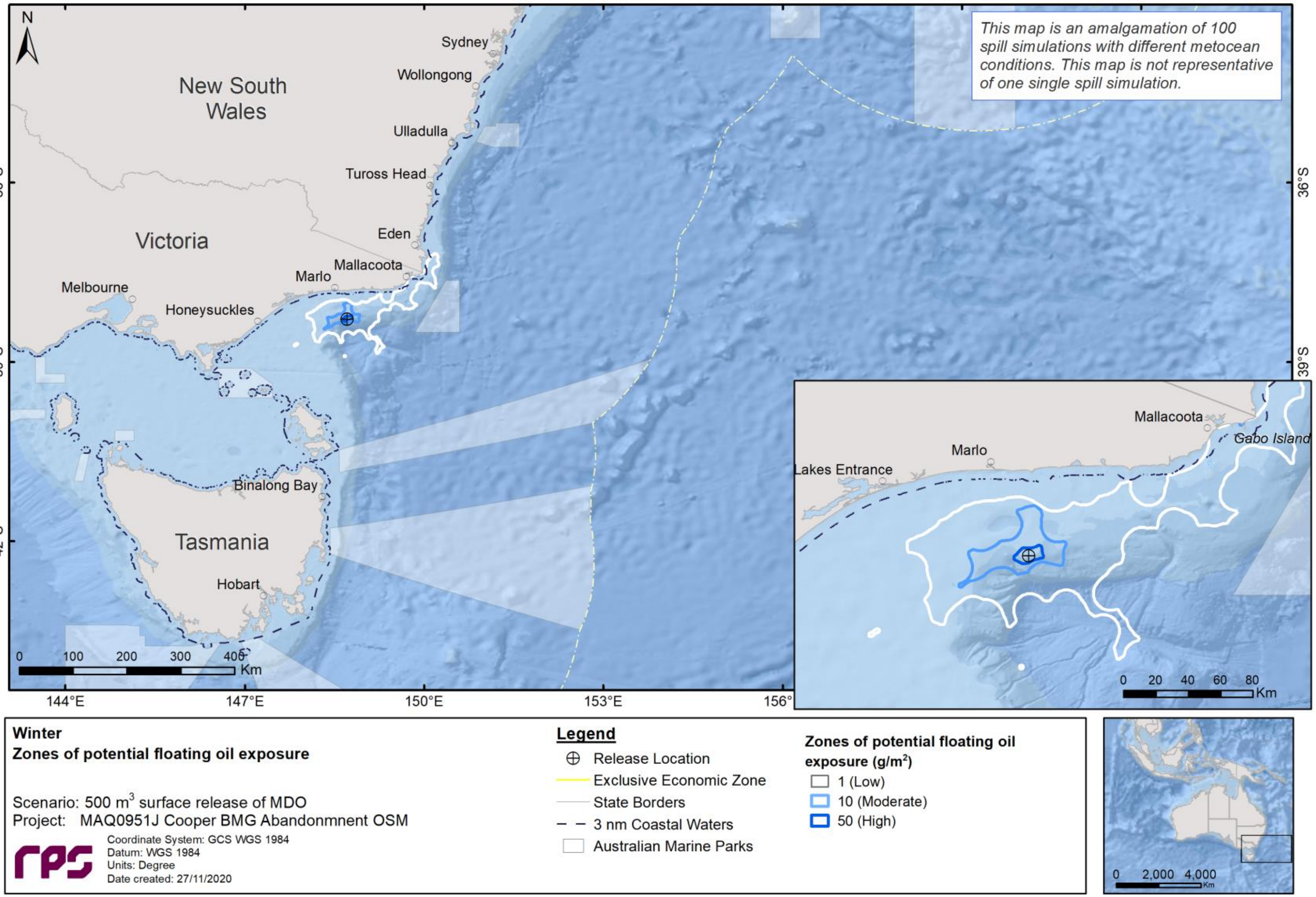


Figure 8-49 Zones of potential floating oil exposure, in the event of a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days. The results were calculated from 100 spill trajectories simulated during summer (May to September) wind and current conditions.

8.2.2.2 Shoreline Accumulation

Table 8-20 presents a summary of the predicted shoreline accumulation during summer and winter conditions. The probability of accumulation on any shoreline at, or above, the low threshold (10-100 g/m^2) was 4%, and 8% in summer and winter months, respectively. The minimum time before shoreline contact was approximately 1.9 days (~46 hours) and the maximum volume of oil ashore was 64.8 m^3, both predicted during winter conditions.

Table 8-21 summarises the shoreline accumulation at individual receptors during summer and winter conditions. Only two receptors, East Gippsland and Cape Howe / Mallacoota recorded exposure values at or above the high threshold and only during the winter season. No receptors were exposed at the high threshold during the summer season.

Gabo Island recorded the highest probability of shoreline accumulation at the low threshold during summer conditions with 3%, while East Gippsland and Cape Howe / Mallacoota recorded the highest probability at the low accumulation threshold during winter conditions with 7%.

The minimum time recorded before low shoreline accumulation was 1.92 days at Cape Howe / Mallacoota and East Gippsland under winter conditions while the maximum volume to reach the shoreline was 64.6 m^3, recorded at East Gippsland and Cape Howe / Mallacoota.

Figure 8-50 and Figure 8-51 presents the maximum potential shoreline loading above the low, moderate and high shoreline thresholds for summer and winter conditions, respectively.

Table 8-20 Summary of oil accumulation across all shorelines. Results are based on a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.

Shoreline Statistics	Summer	Winter
Probability of contact to any shoreline (%)	4	8
Absolute minimum time for visible oil to shore (days)	3.0	1.9
Maximum volume of hydrocarbons ashore (m^3)	14.9	64.8
Average volume of hydrocarbons ashore (m^3)	4.5	23.1
Maximum length of the shoreline at **10 g/m^2** (km)	8.0	12.5
Average shoreline length (km) at **10 g/m^2** (km)	3.1	6.3
Maximum length of the shoreline at **100 g/m^2** (km)	5.0	6.0
Average shoreline length (km) at **100 g/m^2** (km)	2.0	4.3
Maximum length of the shoreline at **1,000 g/m^2** (km)	-	2.5
Average shoreline length (km) at **1,000 g/m^2** (km)	-	2.0

Table 8-21 Summary of oil accumulation on individual shoreline receptors. Results are based on a 500 m³ surface release of MDO at the M2A well location over 5 hours, tracked for 30 days during all seasonal conditions. The results were calculated from 100 spill trajectories per season.

Season	Shoreline receptor		Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (days)			Load on shoreline (g/m^2)	Volume on shoreline (m^3)	Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)		
			Low	Moderate	High	Low	Moderate	High	Peak	Peak	Low	Moderate	High	Low	Moderate	High
Summer	LGA	East Gippsland / NSW / VIC	2	1	-	3.08	3.46	-	581.9	10.4	3.0	3.5	-	5.5	3.5	-
		Gabo Island / VIC	3	3	-	3.13	3.50	-	282.6	4.6	2.2	0.8	-	2.5	1.5	-
	Sub-LGA	Cape Howe / Mallacoota / NSW / VIC	1	1	-	3.29	3.46	-	581.9	10.4	5.5	3.5	-	5.5	3.5	-
		Croajingolong (West) / VIC	1	-	-	3.08	-	-	19.9	0.1	0.5	-	-	0.5	-	-
Winter	ESTUARIES	Seal Creek / VIC	1	-	-	5.75	-	-	37.8	0.2	0.5	-	-	0.5	-	-
	LGA	Bega Valley / NSW / VIC	2	-	-	3.96	-	-	49.3	0.7	1.3	-	-	2.0	-	-
		East Gippsland / NSW / VIC	7	6	3	1.92	2.04	3.21	2,761.5	64.6	6.4	4.3	2.0	11.0	6.0	2.5
		Gabo Island / VIC	3	1	-	2.79	4.46	-	221.5	1.8	0.8	0.5	-	1.5	0.5	-
	Sub-LGA	Bega Valley / NSW / VIC	2	-	-	3.96	-	-	49.3	0.7	1.3	-	-	2.0	-	-
		Cape Howe / Mallacoota / NSW / VIC	7	5	3	1.92	2.04	3.21	2,761.5	64.6	5.0	4.2	2.0	11.0	6.0	2.5
		Croajingolong (East) / VIC	2	1	-	5.38	5.54	-	225.8	10.4	5.0	4.5	-	9.0	4.5	-
	TRP	Betka River / VIC	1	1	-	5.42	5.63	-	182.2	1.7	1.5	1.0	-	1.5	1.0	-
		Davis Creek / VIC	1	-	-	5.38	-	-	85.4	0.4	0.5	-	-	0.5	-	-
		Tullaburga Island / VIC	3	1	-	2.25	2.46	-	377.4	2	0.5	0.5	-	0.5	0.5	-

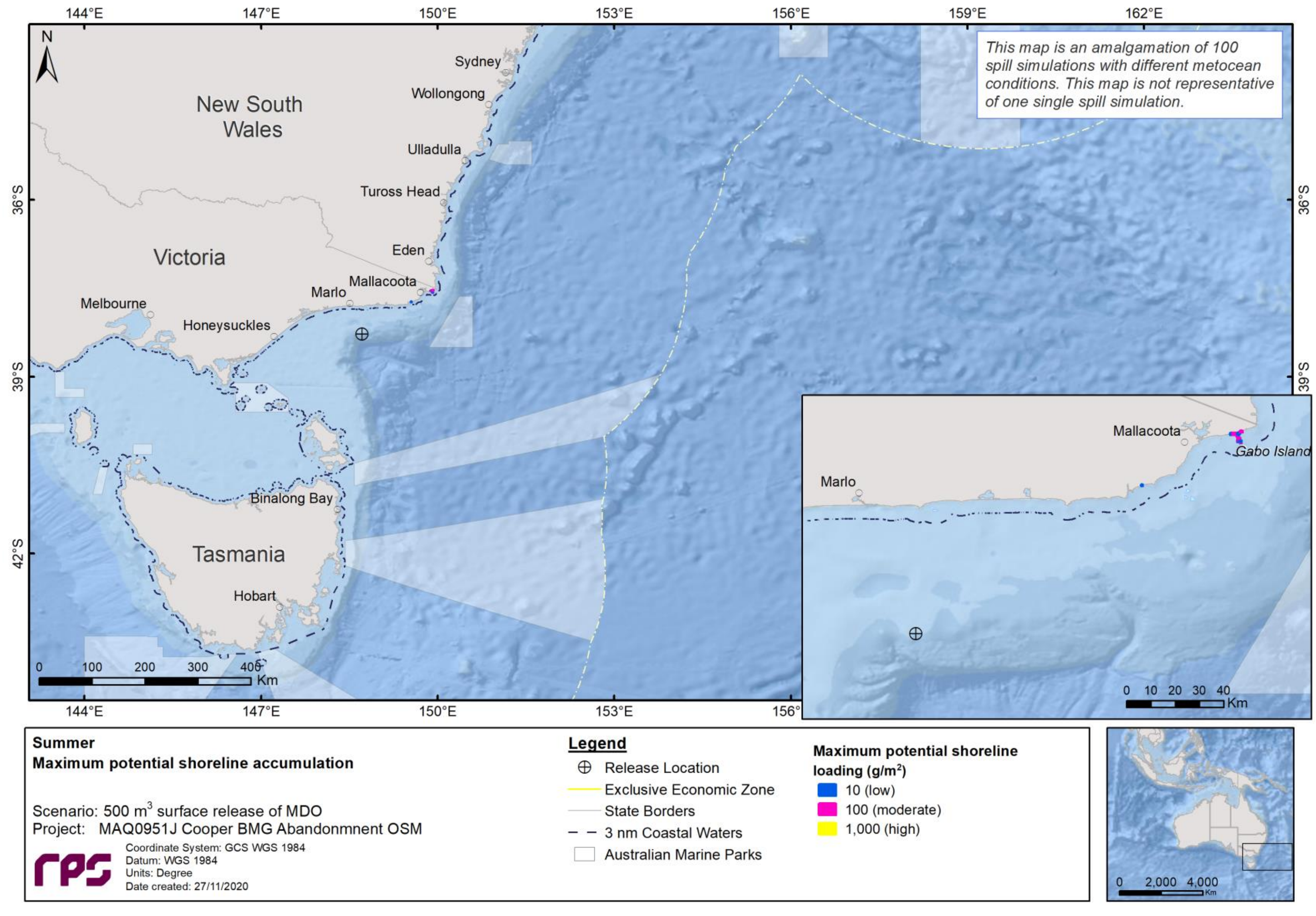


Figure 8-50 Maximum potential shoreline loading, in the event of a 500 m³ surface release of MDO at the M2A well location over 5 hours, tracked for 30 days. The results were calculated from 100 spill trajectories simulated during summer (October to April) wind and current conditions.

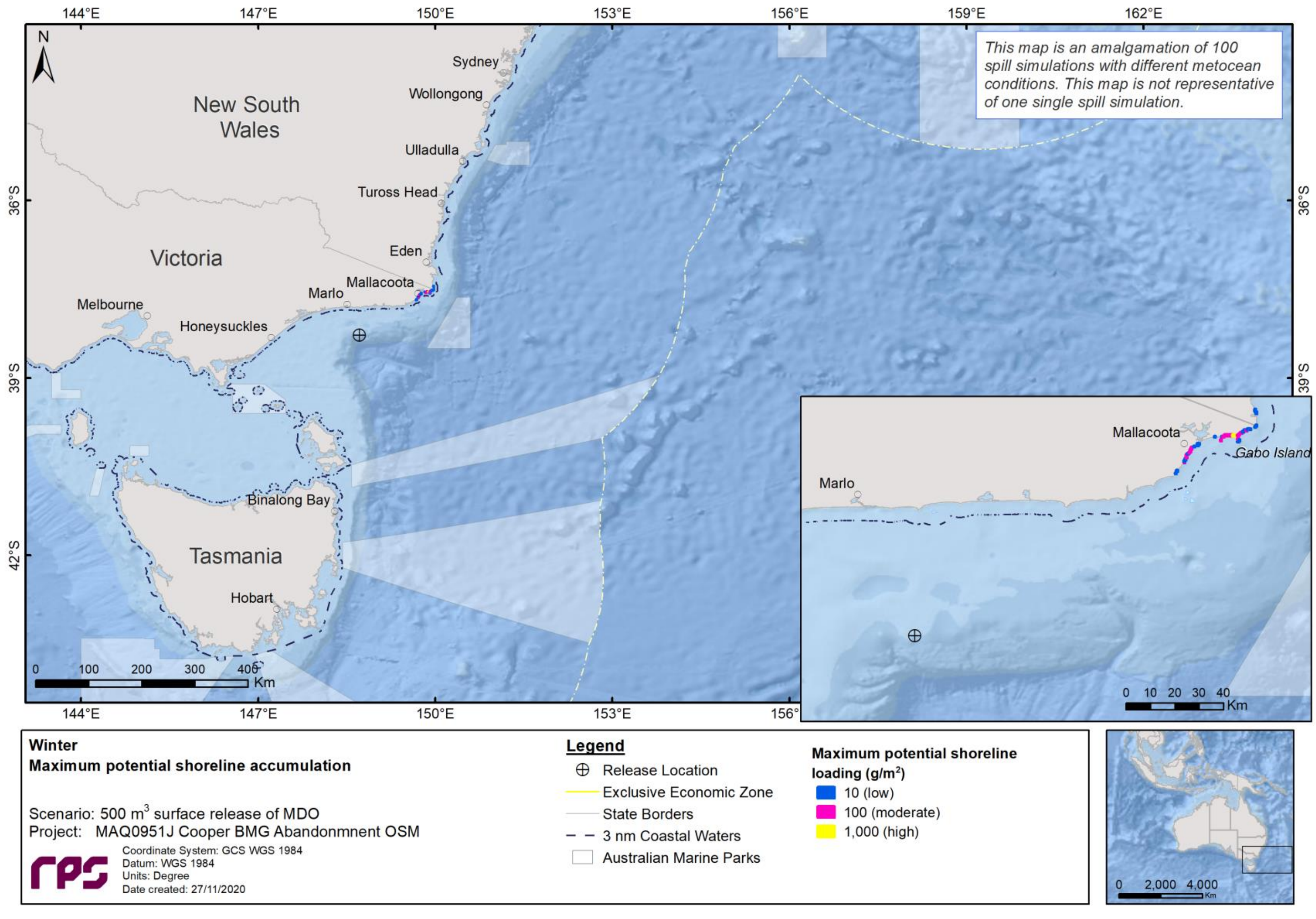


Figure 8-51 Maximum potential shoreline loading, in the event of a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days. The results were calculated from 100 spill trajectories simulated during winter (May to September) wind and current conditions.

8.2.2.3 Water Column Exposure

8.2.2.3.1 Dissolved Hydrocarbons

Table 8-22 and Table 8-23 summarise the probability of exposure to individual receptors from dissolved hydrocarbons in the 0-10 m depth layer for summer and winter conditions respectively, at the low (10-50 ppb), moderate (50-400 ppb) and high (≥ 400 ppb) exposure thresholds (NOPSEMA, 2019).

In the surface (0-10 m) depth layer, a total of 12 Biologically Important Areas (BIAs) were predicted to be exposed to dissolved hydrocarbons at or above the low and moderate thresholds during summer and winter conditions, and the greatest probabilities of 72% and 36% and 69% and 50% respectively. Aside from the 12 BIAs that the release location resides within (see Section 6.3), all the other BIAs recorded probabilities of less than 10% except the White-faced Storm-petrel – Foraging BIA which recorded a 17%. No receptors were exposed at or above the high exposure threshold for either season.

Two AMPs (East Gippsland and Flinders) were predicted to be exposed to dissolved hydrocarbons at the low threshold during summer conditions and one AMP (East Gippsland) during winter conditions, with all recording a 1% probability of exposure.

Only one RSB (New Zealand Star Bank) was predicted to be exposed to dissolved hydrocarbons at the low threshold, recording a 5% and 4% probability of exposure during summer and winter conditions, respectively.

Dissolved hydrocarbons at, or above the low threshold were predicted to cross into both New South Wales and Victoria state waters with probabilities of 1% and 4% and 3% and 5% during summer and winter conditions, respectively.

Figure 8-52 and Figure 8-53 present the zones of potential instantaneous dissolved hydrocarbon exposure for the 0-10 m depth layer for the summer and winter periods, respectively.

Additional in-water stochastic result maps for 10-20 m and 20-30 m depth layers are presented in Appendix B.

Table 8-22 Predicted probability and maximum dissolved hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 500 m³ surface release of MDO at the M2A well location over 5 hours, tracked for 30 days. The results were calculated from 100 spill trajectories during summer (October to April) wind and current conditions.

Receptor		Maximum instantaneous exposure to dissolved aromatics (ppb)	Probability of instantaneous exposure to dissolved aromatics (%)		
			Low	Moderate	High
AMP	East Gippsland / CWTH	36.1	1	-	-
	Flinders / CWTH	18.7	1	-	-
BIA	Antipodean Albatross - Foraging / CWTH **	291.8	72	36	-
	Black-browed Albatross - Foraging / VIC / TAS / CWTH **	291.8	72	36	-
	Bullers Albatross - Foraging / VIC / TAS / CWTH **	291.8	72	36	-
	Campbell Albatross - Foraging / VIC / TAS / CWTH **	291.8	72	36	-
	Common Diving-petrel - Foraging / VIC / TAS / CWTH **	291.8	72	36	-
	Grey Nurse Shark - Foraging / NSW / QLD / CWTH	31.1	1	-	-
	Grey Nurse Shark - Migration / NSW / QLD / CWTH	19.5	1	-	-
	Humpback Whale - Foraging / NSW / CWTH	31.1	2	-	-
	Indian Yellow-nosed Albatross - Foraging / VIC / TAS / CWTH **	291.8	72	36	-
	Indo-Pacific/Spotted Bottlenose Dolphin - Breeding / NSW / QLD / CWTH	17.9	1	-	-
	Little Penguin - Foraging / VIC / TAS / CWTH	32.0	3	-	-
	Pygmy Blue Whale - Distribution / NSW / VIC / TAS / CWTH **	291.8	72	36	-
	Pygmy Blue Whale - Foraging / NSW / VIC / TAS / CWTH **	291.8	72	36	-
	Short-tailed Shearwater - Foraging / NSW / VIC / TAS / CWTH	164.0	4	1	-
	Shy Albatross - Foraging / NSW / VIC / TAS / CWTH **	291.8	72	36	-
	Sooty Shearwater - Foraging / NSW / TAS / CWTH	19.5	1	-	-
	Southern Right Whale - Migration / NSW / VIC / TAS / CWTH **	291.8	72	36	-
	Wandering Albatross - Foraging / VIC / TAS / CWTH **	291.8	72	36	-
	Wedge-tailed Shearwater - Foraging / NSW / VIC / QLD / TAS / CWTH	40.9	3	-	-
	White Shark - Distribution / NSW / VIC / QLD / TAS / CWTH **	291.8	72	36	-
	White Shark - Foraging / VIC / TAS / CWTH	158.3	7	1	-
	White-faced Storm-petrel - Breeding / NSW / CWTH	17.4	1	-	-
	White-faced Storm-petrel - Foraging / NSW / VIC / TAS / CWTH	198.1	17	6	-

Receptor		Maximum instantaneous exposure to dissolved aromatics (ppb)	Probability of instantaneous exposure to dissolved aromatics (%)		
			Low	Moderate	High
EEZ	Australian Exclusive Economic Zone	291.8	72	36	-
IBRA	East Gippsland Lowlands / NSW / VIC	20.9	2	-	-
IMCRA	Batemans Shelf / NSW / CWTH	17.4	1	-	-
	Flinders / CWTH	24.7	1	-	-
	Twofold Shelf / NSW / VIC / TAS / CWTH **	291.8	72	36	-
KEF	Big Horseshoe Canyon / CWTH	78.5	3	1	-
	Upwelling East of Eden / NSW / VIC / CWTH **	291.8	72	36	-
MNP	Cape Howe / VIC	20.9	3	-	-
	Point Hicks / VIC	38.8	2	-	-
RSB	New Zealand Star Bank / CWTH	109.6	5	1	-
LGA	Bega Valley / NSW / VIC	13.6	1	-	-
	East Gippsland / NSW / VIC	20.9	2	-	-
	Gabo Island / VIC	16.3	2	-	-
Sub-LGA	Bega Valley / NSW / VIC	13.6	1	-	-
	Cape Howe / Mallacoota / NSW / VIC	20.9	2	-	-
	Croajingolong (East) / VIC	18.6	2	-	-
	Croajingolong (West) / VIC	14.6	1	-	-
	Point Hicks / VIC	12.1	1	-	-
State Waters	New South Wales	17.9	1	-	-
	Victoria State Waters	53.9	4	1	-
Estuaries	Seal Creek / VIC	11.1	1	-	-
TRP	Betka River / VIC	10.2	1	-	-
	Point Hicks / VIC	24.5	2	-	-
	Shipwreck Creek / VIC	11.4	1	-	-

**The release location resides within the receptor boundaries.

Table 8-23 Predicted probability and maximum dissolved hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days. The results were calculated from 100 spill trajectories during winter (May to September) wind and current conditions.

Receptor		Maximum instantaneous exposure to dissolved aromatics (ppb)	Probability of instantaneous exposure to dissolved aromatics (%)		
			Low	Moderate	High
AMP	East Gippsland / CWTH	18.5	1	-	-
BIA	Antipodean Albatross - Foraging / CWTH **	279.4	69	50	-
	Black Petrel - Foraging / CWTH	13.2	1	-	-
	Black-browed Albatross - Foraging / VIC / TAS / CWTH **	279.4	69	50	-
	Bullers Albatross - Foraging / VIC / TAS / CWTH **	279.4	69	50	-
	Campbell Albatross - Foraging / VIC / TAS / CWTH **	279.4	69	50	-
	Common Diving-petrel - Foraging / VIC / TAS / CWTH **	279.4	69	50	-
	Crested Tern - Foraging / NSW / QLD / CWTH	13.2	1	-	-
	Flesh-footed Shearwater - Foraging / NSW / CWTH	13.2	1	-	-
	Great-winged Petrel - Foraging / CWTH	10.1	1	-	-
	Grey Nurse Shark - Foraging / NSW / QLD / CWTH	53.4	3	1	-
	Grey Nurse Shark - Migration / NSW / QLD / CWTH	62.4	2	1	-
	Humpback Whale - Foraging / NSW / CWTH	76.1	3	1	-
	Indian Yellow-nosed Albatross - Foraging / VIC / TAS / CWTH **	279.4	69	50	-
	Indo-Pacific/Spotted Bottlenose Dolphin - Breeding / NSW / QLD / CWTH	75.2	3	1	-
	Little Penguin - Breeding / NSW / VIC / TAS / CWTH	42.9	3	-	-
	Little Penguin - Foraging / VIC / TAS / CWTH	88.8	5	2	-
	Northern Giant Petrel - Foraging / CWTH	10.1	1	-	-
	Pygmy Blue Whale - Distribution / NSW / VIC / TAS / CWTH **	279.4	69	50	-
	Pygmy Blue Whale - Foraging / NSW / VIC / TAS / CWTH **	279.4	69	50	-
	Short-tailed Shearwater - Foraging / NSW / VIC / TAS / CWTH	88.8	3	1	-
	Shy Albatross - Foraging / NSW / VIC / TAS / CWTH **	279.4	69	50	-
	Sooty Shearwater - Foraging / NSW / TAS / CWTH	42.8	2	-	-
	Southern Giant Petrel - Foraging / CWTH	10.1	1	-	-
	Southern Right Whale - Migration / NSW / VIC / TAS / CWTH **	279.4	69	50	-

Receptor		Maximum instantaneous exposure to dissolved aromatics (ppb)	Probability of instantaneous exposure to dissolved aromatics (%)		
			Low	Moderate	High
	Wandering Albatross - Foraging / VIC / TAS / CWTH **	279.4	69	50	-
	Wedge-tailed Shearwater - Foraging / NSW / VIC / QLD / TAS / CWTH	88.8	5	2	-
	White Shark - Distribution / NSW / VIC / QLD / TAS / CWTH **	279.4	69	50	-
	White Shark - Foraging / VIC / TAS / CWTH	173.3	6	2	-
	White-capped Albatross - Foraging / CWTH	10.1	1	-	-
	White-faced Storm-petrel - Breeding / NSW / CWTH	42.9	3	-	-
	White-faced Storm-petrel - Foraging / NSW / VIC / TAS / CWTH	240.9	19	6	-
	Wilsons Storm Petrel - Migration / CWTH	10.1	1	-	-
EEZ	Australian Exclusive Economic Zone **	279.4	69	50	-
IBRA	East Gippsland Lowlands / NSW / VIC	88.8	4	2	-
IMCRA	Batemans Shelf / NSW / CWTH	21.9	1	-	-
	Flinders / CWTH	20.5	1	-	-
	Twofold Shelf / NSW / VIC / TAS / CWTH **	279.4	69	50	-
KEF	Big Horseshoe Canyon / CWTH	127.7	5	1	-
	Upwelling East of Eden / NSW / VIC / CWTH **	279.4	69	50	-
MNP	Cape Howe / VIC	84.6	4	1	-
	Point Hicks / VIC	19.5	1	-	-
RSB	New Zealand Star Bank / CWTH	49.7	4	-	-
LGA	Bega Valley / NSW / VIC	35.2	2	-	-
	East Gippsland / NSW / VIC	48.2	4	-	-
	Gabo Island / VIC	88.8	4	2	-
Sub-LGA	Bega Valley / NSW / VIC	35.2	2	-	-
	Cape Howe / Mallacoota / NSW / VIC	76.5	4	1	-
	Croajingolong (East) / VIC	40.3	4	-	-
	Croajingolong (West) / VIC	29.5	2	-	-
	Point Hicks / VIC	15.2	1	-	-
	Sydenham Inlet / VIC	15.4	1	-	-
State Waters	New South Wales	75.2	3	1	-
	Victoria State Waters	88.8	5	2	-
Estuaries	Seal Creek / VIC	14.7	1	-	-
TRP	Davis Creek / VIC	10.6	1	-	-
	Gabo Island / VIC	40.4	4	-	-
	Shipwreck Creek / VIC	13.7	2	-	-
	Tullaburga Island / VIC	29.6	3	-	-

**The release location resides within the receptor boundaries.

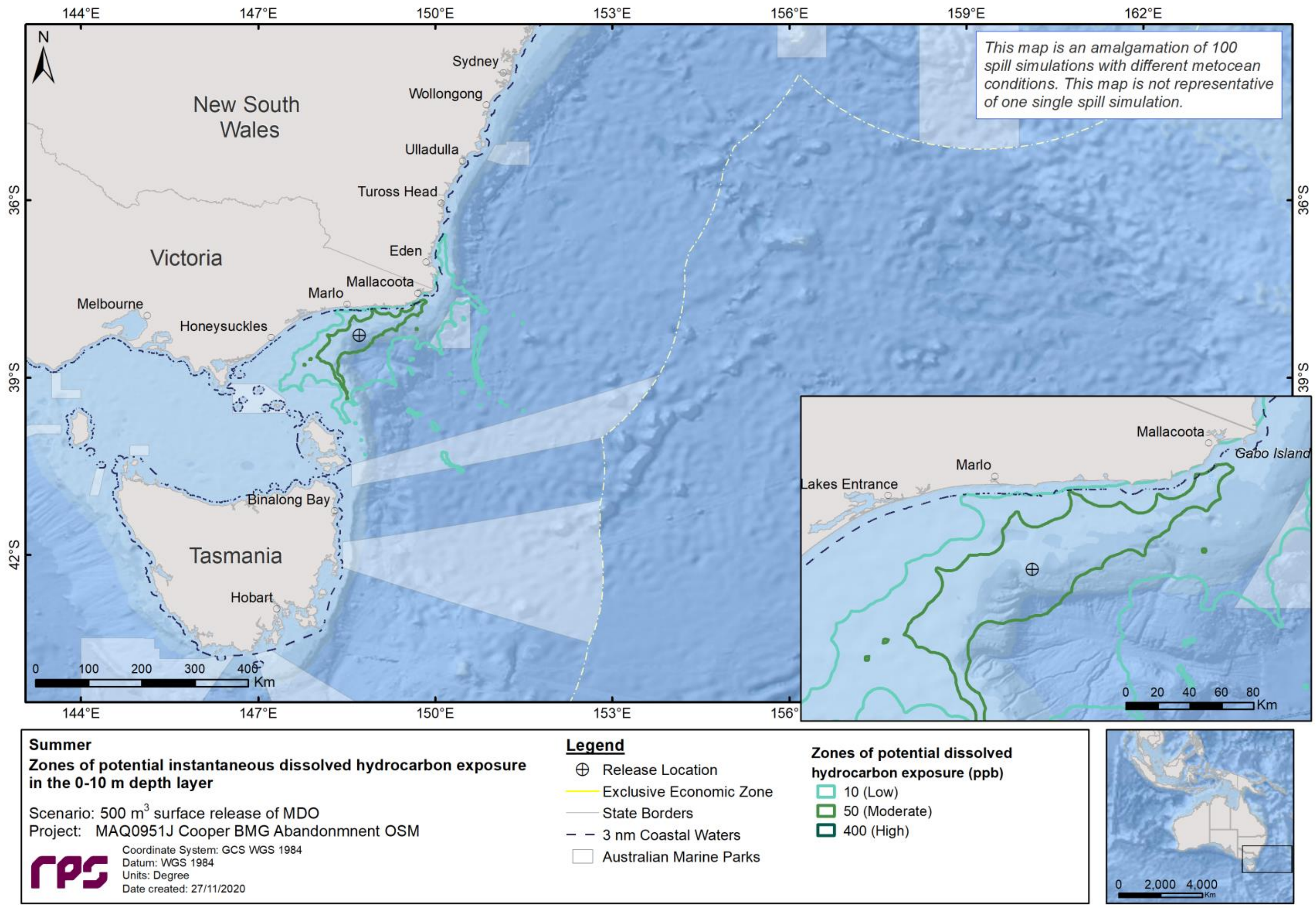


Figure 8-52 Zones of potential instantaneous dissolved hydrocarbon exposure at 0-10 m below the sea surface in the event of a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days. The results were calculated from 100 spill trajectories simulated during summer (October to April) wind and current conditions.

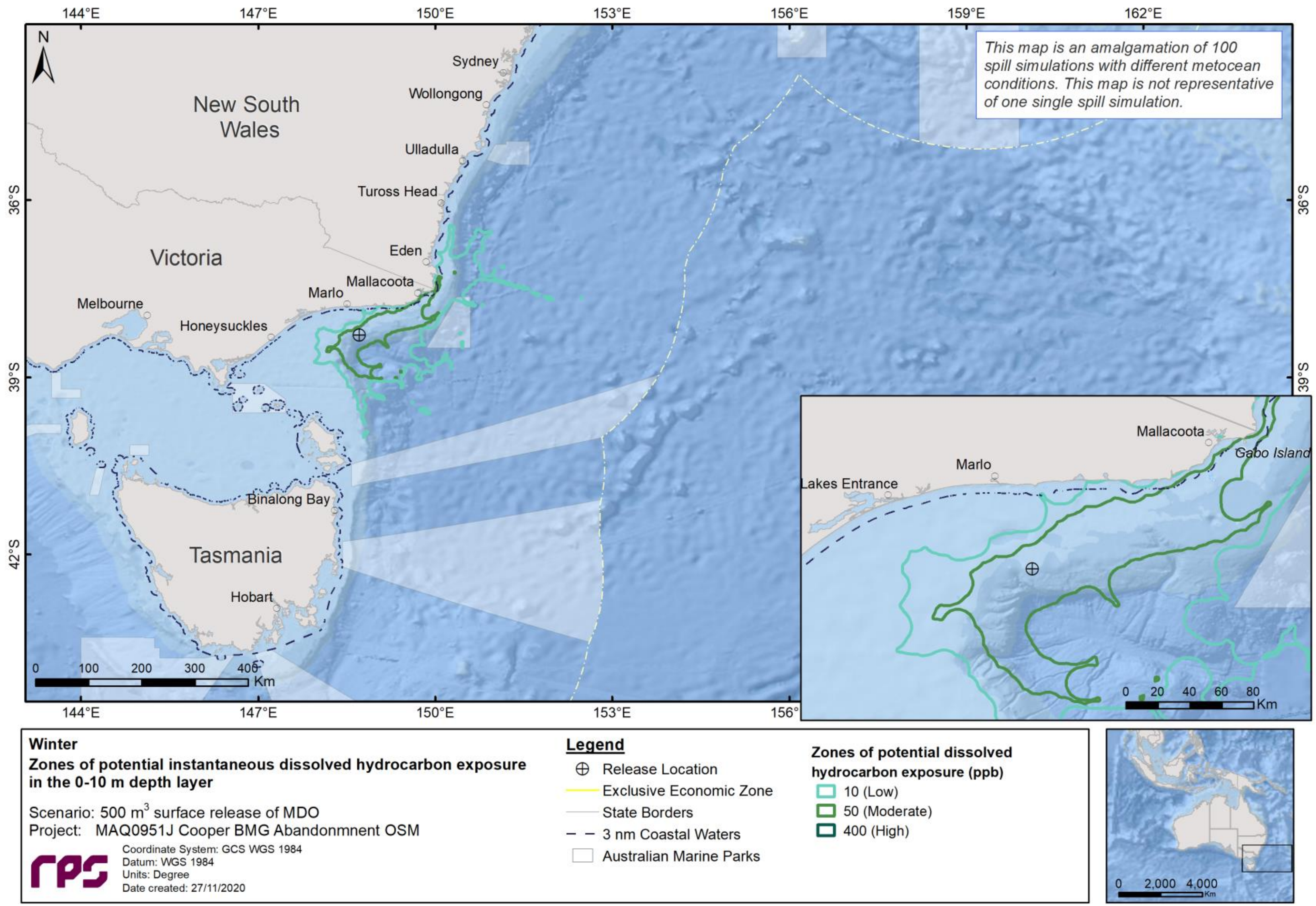


Figure 8-53 Zones of potential instantaneous dissolved hydrocarbon exposure at 0-10 m below the sea surface in the event of a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days. The results were calculated from 100 spill trajectories simulated during winter (May to September) wind and current conditions.

8.2.2.3.2 Entrained Hydrocarbons

Table 8-24 and Table 8-25 summarise the probability of exposure to individual receptors from entrained hydrocarbons in the 0-10 m depth layer, in summer and winter conditions, at the low (10-100 ppb) and high (≥ 100 ppb) entrained hydrocarbon exposure thresholds (NOPSEMA, 2019.

In the surface (0-10 m) depth layer, a total of 12 Biologically Important Areas (BIAs) were predicted to be exposed to entrained oil at or above the low and high thresholds during summer and winter conditions, and the highest probabilities were 94% and 89% and 98% and 89% respectively. Aside from the 12 BIAs that the release location resides within (see Section 6.3), 13 and 12 additional BIAs recorded probabilities of exposure to entrained hydrocarbons at the high threshold during summer and winters conditions, respectively. The greatest probabilities of high exposure during summer and winter conditions were predicted at the White-faced Storm-petrel – Foraging BIA with 36% and 37%, respectively.

A total of four and three AMPs were predicted to be exposed to entrained hydrocarbons at, or above the low threshold during summer and winter conditions, respectively, with the highest probability predicted at East Gippsland (15%) during summer conditions.

A total of six and two RSB were predicted to be exposed to entrained hydrocarbons at, or above the low threshold during summer and winter conditions, respectively. The New Zealand Star Bank recorded the highest probability of low entrained hydrocarbon exposure during both summer and winter conditions with 41% and 42%, respectively.

Entrained hydrocarbons at, or above the low threshold were predicted to cross into New South Wales, Tasmania and Victoria state waters during summer conditions with probabilities of 26%, 5% and 37%, respectively. During winter conditions, entrained hydrocarbons at or above the low threshold were predicted to cross into New South Wales and Victoria state waters with probabilities of 28% and 33%, respectively.

Figure 8-54 and Figure 8-55 illustrates the zones of potential entrained hydrocarbon exposure for the 0-10 m depth layer for the summer and winter periods, respectively.

Additional in-water stochastic result maps for 10-20 m and 20-30 m depth layers are presented in Appendix B.

Table 8-24 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days, during summer (October to April) wind and current conditions.

Receptor		Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Probability of instantaneous exposure to entrained hydrocarbons (%)	
			Low	High
AMP	Beagle / CWTH	50	6	-
	East Gippsland / CWTH	218	15	2
	Flinders / CWTH	77	6	-
	Freycinet / CWTH	33	2	-
BIA	Antipodean Albatross - Foraging / CWTH **	23,406	94	89
	Black Petrel - Foraging / CWTH	72	5	-
	Black-browed Albatross - Foraging / VIC / TAS / CWTH **	23,406	94	89
	Black-faced Cormorant - Foraging / TAS / CWTH	11	1	-
	Bullers Albatross - Foraging / VIC / TAS / CWTH **	23,406	94	89
	Campbell Albatross - Foraging / VIC / TAS / CWTH **	23,406	94	89
	Common Diving-petrel - Foraging / VIC / TAS / CWTH **	23,406	94	89
	Crested Tern - Breeding / NSW / QLD / CWTH	19	2	-
	Crested Tern - Foraging / NSW / QLD / CWTH	64	4	-
	Flesh-footed Shearwater - Foraging / NSW / CWTH	72	5	-
	Great-winged Petrel - Foraging / CWTH	72	3	-
	Grey Nurse Shark - Foraging / NSW / QLD / CWTH	241	13	1
	Grey Nurse Shark - Migration / NSW / QLD / CWTH	258	12	3
	Humpback Whale - Foraging / NSW / CWTH	371	24	3
	Indian Yellow-nosed Albatross - Foraging / VIC / TAS / CWTH **	23,406	94	89
	Indo-Pacific/Spotted Bottlenose Dolphin - Breeding / NSW / QLD / CWTH	247	26	3
	Little Penguin - Breeding / NSW / VIC / TAS / CWTH	353	30	7
	Little Penguin - Foraging / VIC / TAS / CWTH	394	37	11
	Northern Giant Petrel - Foraging / CWTH	72	3	-
	Pygmy Blue Whale - Distribution / NSW / VIC / TAS / CWTH **	23,406	94	89
	Pygmy Blue Whale - Foraging / NSW / VIC / TAS / CWTH **	23,406	94	89
	Short-tailed Shearwater - Breeding / NSW / VIC / TAS	30	3	-
	Short-tailed Shearwater - Foraging / NSW / VIC / TAS / CWTH	874	23	7
	Shy Albatross - Foraging / NSW / VIC / TAS / CWTH **	23,406	94	89

Receptor		Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Probability of instantaneous exposure to entrained hydrocarbons (%)	
			Low	High
	Sooty Shearwater - Foraging / NSW / TAS / CWTH	206	9	1
	Southern Giant Petrel - Foraging / CWTH	72	3	-
	Southern Right Whale - Connecting Habitat / TAS / CWTH	38	3	-
	Southern Right Whale - Migration / NSW / VIC / TAS / CWTH **	23,406	94	89
	Wandering Albatross - Foraging / VIC / TAS / CWTH **	23,406	94	89
	Wedge-tailed Shearwater - Foraging / NSW / VIC / QLD / TAS / CWTH	394	38	11
	White Shark - Breeding / VIC / CWTH	107	6	1
	White Shark - Distribution / NSW / VIC / QLD / TAS / CWTH **	23,406	94	89
	White Shark - Foraging / VIC / TAS / CWTH	831	42	14
	White-capped Albatross - Foraging / CWTH	72	3	-
	White-faced Storm-petrel - Breeding / NSW / CWTH	353	30	7
	White-faced Storm-petrel - Foraging / NSW / VIC / TAS / CWTH	3,953	55	36
	Wilsons Storm Petrel - Migration / CWTH	72	3	-
EEZ	Australian Exclusive Economic Zone **	23,406	94	89
IBRA	Bateman / NSW	13	1	-
	East Gippsland Lowlands / NSW / VIC	406	33	10
	Flinders / CWTH	44	4	-
	Jervis / CWTH	14	1	-
	South East Coastal Ranges / NSW	55	3	-
IMCRA	Batemans Shelf / NSW / CWTH	72	7	-
	Central Bass Strait / CWTH	15	1	-
	Flinders / CWTH	94	7	-
	Twofold Shelf / NSW / VIC / TAS / CWTH **	23,406	94	89
KEF	Big Horseshoe Canyon / CWTH	828	34	8
	Canyons on the eastern continental slope / CWTH	30	2	-
	Shelf rocky reefs / CWTH	44	3	-
	Upwelling East of Eden / NSW / VIC / CWTH **	23,406	94	89
MNP	Cape Howe / VIC	308	33	7
	Point Hicks / VIC	336	28	5
MP	Batemans / NSW	19	3	-
	Jervis Bay / NSW	14	1	-
MS	Beware Reef / VIC	39	9	-
NP	Kent Group / TAS	31	5	-
NPC	Booderee / NSW	12	1	-
RSB	Beware Reef / VIC	41	9	-
	Endeavour Reef / TAS	51	4	-

Receptor		Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Probability of instantaneous exposure to entrained hydrocarbons (%)	
			Low	High
	New Zealand Star Bank / CWTH	401	41	12
	Wakitipu Rock / CWTH	13	2	-
	Warrego Rock / CWTH	11	1	-
	Wright Rock / TAS	51	4	-
LGA	Bega Valley / NSW / VIC	176	25	3
	Craggy Island / TAS	44	3	-
	East Gippsland / NSW / VIC	406	33	7
	Flinders Island / TAS	22	2	-
	Gabo Island / VIC	366	31	10
	Hogan Island Group / TAS	44	3	-
	Inner Sister Island / TAS	34	3	-
	Kent Island Group / TAS	30	4	-
	Montague Island / NSW	13	1	-
	Outer Sister Island / TAS	38	3	-
	Prime Seal Island / TAS	11	1	-
	Shoal Haven / NSW	14	1	-
Sub-LGA	Bega Valley / NSW / VIC	176	25	3
	Cape Conran / VIC	79	8	-
	Cape Howe / Mallacoota / NSW / VIC	406	31	7
	Corringle / VIC	15	3	-
	Croajingolong (East) / VIC	153	33	2
	Croajingolong (West) / VIC	262	29	4
	Marlo / VIC	37	7	-
	Point Hicks / VIC	164	26	4
	Shoal Haven / NSW	14	1	-
	Sydenham Inlet / VIC	89	15	-
State Waters	New South Wales	241	26	2
	Tasmania State Waters	60	5	-
	Victoria State Waters	406	37	11
Estuaries	Bemm River / VIC	66	5	-
	Bendanore River / VIC	102	25	1
	Cann River / VIC	37	6	-
	Double Creek / VIC	16	2	-
	Dowell Creek / VIC	43	9	-
	Mallacoota Inlet / VIC	62	15	-
	Seal Creek / VIC	134	27	1
	Teal Creek / VIC	38	5	-
	Wingan River / VIC	146	22	1
Other	Cape Conran / VIC	32	6	-
	Marlo Coastal Reserve / VIC	34	6	-
PP	Point Ricardo / VIC	26	6	-

Receptor		Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Probability of instantaneous exposure to entrained hydrocarbons (%)	
			Low	High
	Salmon Beach / Rocks / VIC	31	7	-
TRP	Betka River / VIC	69	15	-
	Beware Reef / VIC	37	8	-
	Bittangabee Bay / NSW	160	6	1
	Davis Creek / VIC	62	15	-
	Easby Creek / VIC	211	23	1
	Gabo Island / VIC	351	31	7
	Kent Group Islands / TAS	28	3	-
	Mallacoota / VIC	64	15	-
	Mueller River / VIC	130	22	2
	North East River / TAS	15	2	-
	Point Hicks / VIC	186	25	3
	Red River / VIC	246	25	1
	Shipwreck Creek / VIC	129	27	1
	Snowy River / VIC	22	3	-
	Sydenham Inlet / VIC	83	13	-
	Tamboon Inlet / VIC	45	13	-
	The Skerries / VIC	233	26	1
	Thurra River / VIC	125	21	2
	Tullaburga Island / VIC	222	28	2
	Wingan Inlet / VIC	220	24	1
	Wonboyn River / NSW	25	3	-
	Woodburn & Saltwater Creeks / NSW	118	3	1
	Yeerung River / VIC	28	5	-

**The release location resides within the receptor boundaries.

Table 8-25 Predicted probability and maximum entrained hydrocarbon exposure to individual receptors in the 0-10 m depth layer. Results are based on 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days, during winter (May to September) wind and current conditions.

Receptor		Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Probability of instantaneous exposure to entrained hydrocarbons (%)	
			Low	high
AMP	East Gippsland / CWTH	166	17	1
	Flinders / CWTH	33	2	-
	Jervis / CWTH	18	1	-
BIA	Antipodean Albatross - Foraging / CWTH **	22,587	98	89
	Black Petrel - Foraging / CWTH	69	9	-
	Black-browed Albatross - Foraging / VIC / TAS / CWTH **	22,587	98	89
	Bullers Albatross - Foraging / VIC / TAS / CWTH **	22,587	98	89

Receptor	Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Probability of instantaneous exposure to entrained hydrocarbons (%)	
		Low	high
Campbell Albatross - Foraging / VIC / TAS / CWTH **	22,587	98	89
Common Diving-petrel - Foraging / VIC / TAS / CWTH **	22,587	98	89
Crested Tern - Breeding / NSW / QLD / CWTH	55	3	-
Crested Tern - Foraging / NSW / QLD / CWTH	69	4	-
Flesh-footed Shearwater - Foraging / NSW / CWTH	69	9	-
Great-winged Petrel - Foraging / CWTH	51	9	-
Grey Nurse Shark - Foraging / NSW / QLD / CWTH	158	24	2
Grey Nurse Shark - Migration / NSW / QLD / CWTH	112	22	1
Humpback Whale - Foraging / NSW / CWTH	272	31	4
Indian Yellow-nosed Albatross - Foraging / VIC / TAS / CWTH **	22,587	98	89
Indo-Pacific/Spotted Bottlenose Dolphin - Breeding / NSW / QLD / CWTH	272	30	4
Little Penguin - Breeding / NSW / VIC / TAS / CWTH	311	27	3
Little Penguin - Foraging / VIC / TAS / CWTH	431	38	5
Northern Giant Petrel - Foraging / CWTH	51	9	-
Pygmy Blue Whale - Distribution / NSW / VIC / TAS / CWTH **	22,587	98	89
Pygmy Blue Whale - Foraging / NSW / VIC / TAS / CWTH **	22,587	98	89
Short-tailed Shearwater - Foraging / NSW / VIC / TAS / CWTH	525	24	4
Shy Albatross - Foraging / NSW / VIC / TAS / CWTH **	22,587	98	89
Sooty Shearwater - Foraging / NSW / TAS / CWTH	103	18	1
Southern Giant Petrel - Foraging / CWTH	51	9	-
Southern Right Whale - Migration / NSW / VIC / TAS / CWTH **	22,587	98	89
Wandering Albatross - Foraging / VIC / TAS / CWTH **	22,587	98	89
Wedge-tailed Shearwater - Foraging / NSW / VIC / QLD / TAS / CWTH	431	38	5
White Shark - Breeding / VIC / CWTH	67	1	-
White Shark - Distribution / NSW / VIC / QLD / TAS / CWTH **	22,587	98	89
White Shark - Foraging / VIC / TAS / CWTH	867	45	8
White-capped Albatross - Foraging / CWTH	51	9	-
White-faced Storm-petrel - Breeding / NSW / CWTH	311	27	3
White-faced Storm-petrel - Foraging / NSW / VIC / TAS / CWTH	3,522	60	37
Wilsons Storm Petrel - Migration / CWTH	51	9	-

Receptor		Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Probability of instantaneous exposure to entrained hydrocarbons (%)	
			Low	high
EEZ	Australian Exclusive Economic Zone **	22,587	98	89
IBRA	Bateman / NSW	42	2	-
	East Gippsland Lowlands / NSW / VIC	449	29	5
	Gippsland Plain / VIC	12	1	-
	Jervis / CWTH	20	2	-
	South East Coastal Ranges / NSW	12	1	-
IMCRA	Batemans Shelf / NSW / CWTH	69	6	-
	Flinders / CWTH	70	3	-
	Hawkesbury Shelf / NSW / CWTH	14	1	-
	Twofold Shelf / NSW / VIC / TAS / CWTH **	22,587	98	89
KEF	Big Horseshoe Canyon / CWTH	896	36	11
	Canyons on the eastern continental slope / CWTH	32	9	-
	Shelf rocky reefs / CWTH	68	3	-
	Tasman Front and eddy field / CWTH	14	1	-
	Upwelling East of Eden / NSW / VIC / CWTH **	22,587	98	89
MNP	Cape Howe / VIC	380	32	5
	Point Hicks / VIC	188	20	1
MP	Batemans / NSW	55	3	-
	Jervis Bay / NSW	14	2	-
MS	Beware Reef / VIC	53	1	-
RSB	Beware Reef / VIC	53	1	-
	New Zealand Star Bank / CWTH	335	42	6
LGA	Bega Valley / NSW / VIC	218	23	3
	East Gippsland / NSW / VIC	449	29	4
	Eurobodalla / NSW	19	2	-
	Gabo Island / VIC	408	29	5
	Montague Island / NSW	42	2	-
	Shoal Haven / NSW	20	2	-
Sub-LGA	Bega Valley / NSW / VIC	218	23	3
	Cape Conran / VIC	106	1	1
	Cape Howe / Mallacoota / NSW / VIC	449	29	5
	Croajingolong (East) / VIC	209	15	4
	Croajingolong (West) / VIC	116	16	1
	Eurobodalla / NSW	19	2	-
	Lake Tyers Beach / VIC	11	1	-
	Lakes Entrance / VIC	11	1	-
	Marlo / VIC	44	1	-
	Point Hicks / VIC	131	9	1
	Shoal Haven / NSW	20	2	-
	Sydenham Inlet / VIC	122	3	1

Receptor		Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Probability of instantaneous exposure to entrained hydrocarbons (%)	
			Low	high
State Waters	New South Wales	267	28	4
	Victoria State Waters	449	33	5
Estuaries	Bemm River / VIC	70	1	-
	Bendanore River / VIC	71	9	-
	Cann River / VIC	73	2	-
	Dowell Creek / VIC	27	6	-
	Mallacoota Inlet / VIC	126	12	1
	Seal Creek / VIC	131	12	3
	Teal Creek / VIC	19	3	-
	Wingan River / VIC	45	7	-
Other	Cape Conran / VIC	37	1	-
	Marlo Coastal Reserve / VIC	10	1	-
PP	Point Ricardo / VIC	11	1	-
	Salmon Beach / Rocks / VIC	38	1	-
TRP	Betka River / VIC	161	11	3
	Beware Reef / VIC	50	1	-
	Bittangabee Bay / NSW	22	3	-
	Davis Creek / VIC	138	11	3
	Easby Creek / VIC	61	8	-
	Gabo Island / VIC	339	27	3
	Lakes Entrance / VIC	11	1	-
	Mallacoota / VIC	119	11	2
	Mueller River / VIC	45	8	-
	Point Hicks / VIC	107	9	1
	Red River / VIC	73	10	-
	Shipwreck Creek / VIC	149	12	3
	Sydenham Inlet / VIC	90	2	-
	Tamboon Inlet / VIC	122	2	1
	The Skerries / VIC	78	10	-
	Thurra River / VIC	66	7	-
	Tullaburga Island / VIC	227	19	4
	Wingan Inlet / VIC	71	9	-
	Wonboyn River / NSW	33	2	-
	Yeerung River / VIC	31	1	-

**The release location resides within the receptor boundaries.

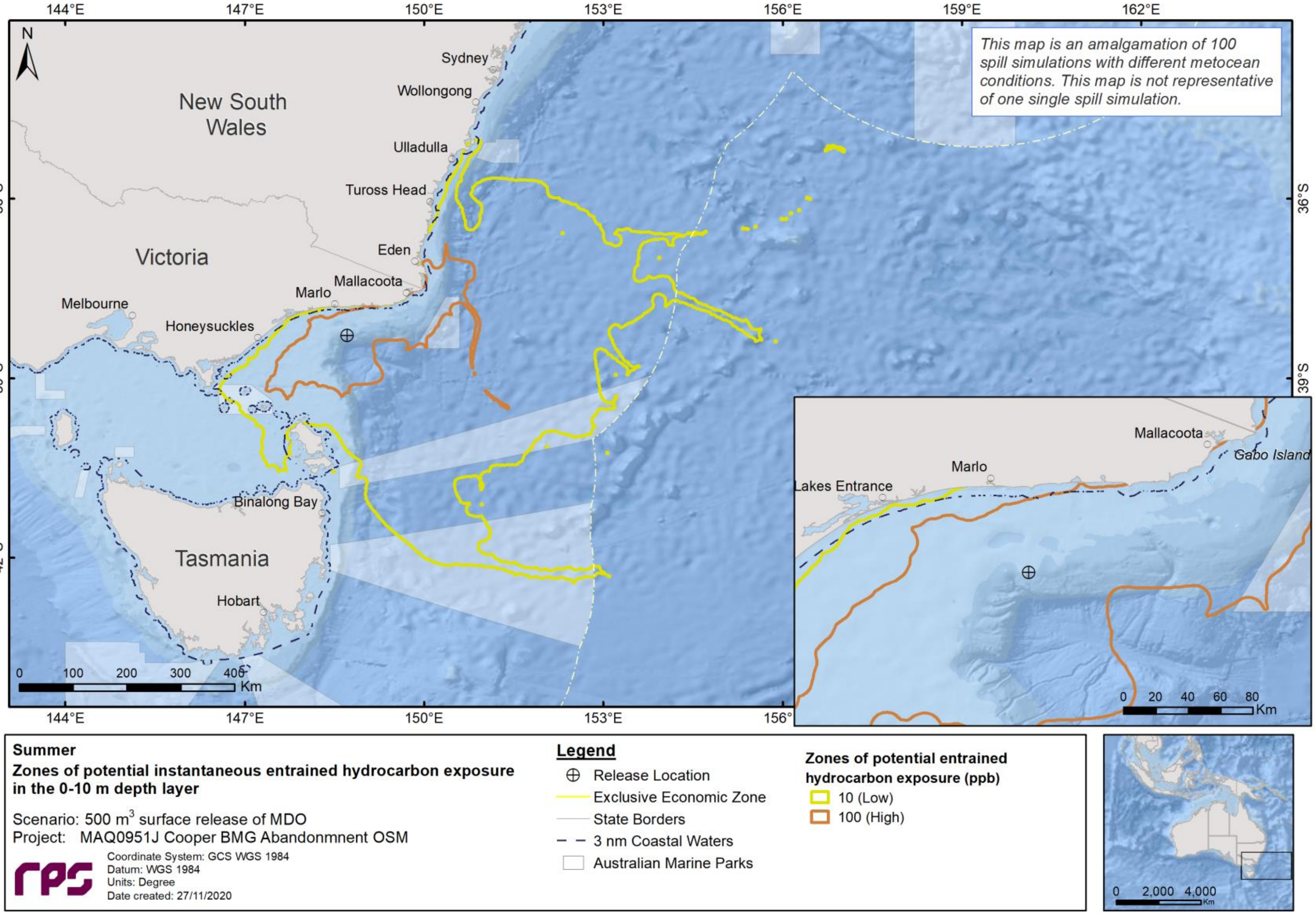


Figure 8-54 Zones of potential instantaneous entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days. The results were calculated from 100 spill trajectories simulated during summer (October to April) wind and current conditions.

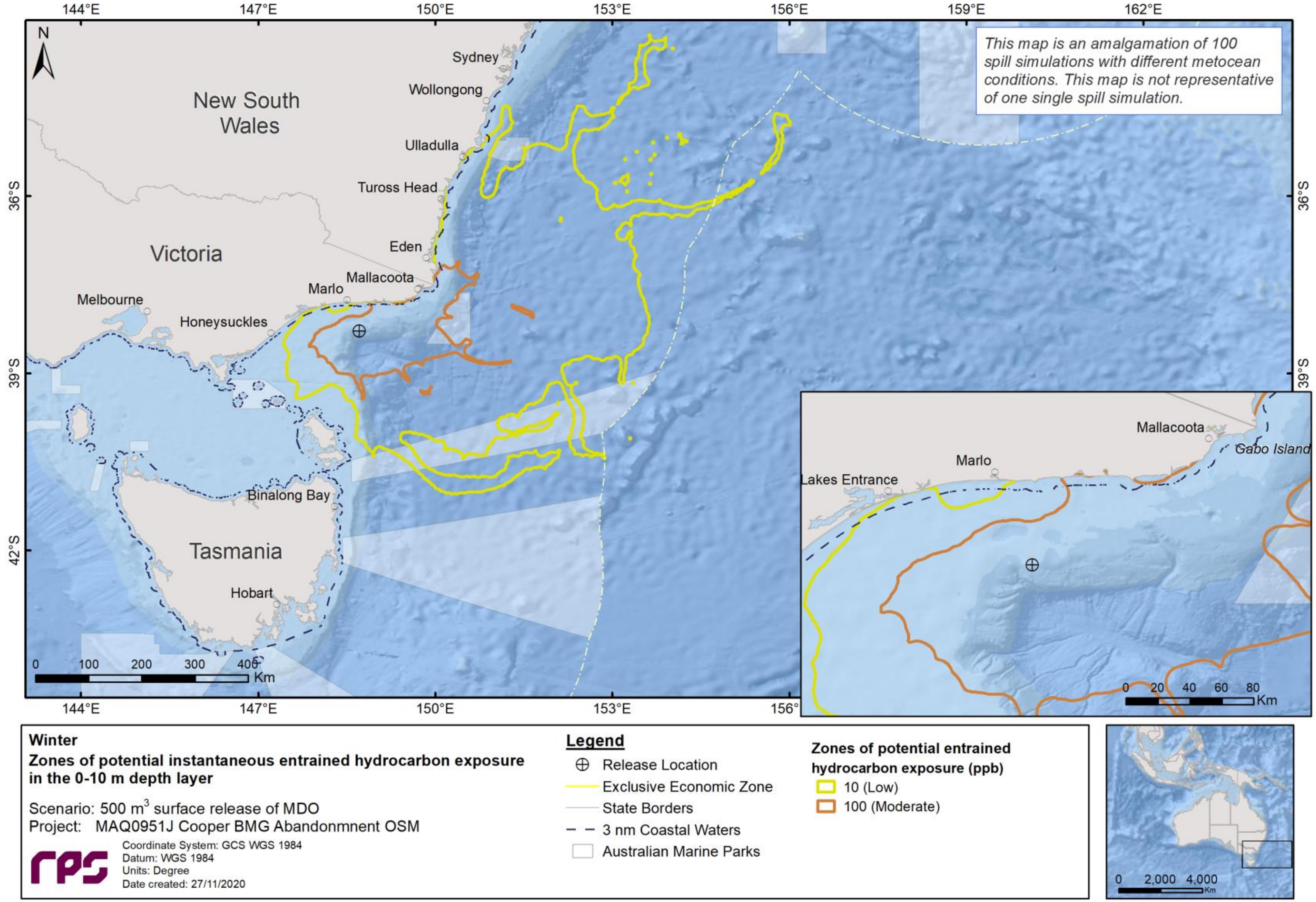


Figure 8-55 Zones of potential instantaneous entrained hydrocarbon exposure at 0-10 m below the sea surface in the event of a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days. The results were calculated from 100 spill trajectories simulated during winter (May to September) wind and current conditions.

9 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.

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 Maritime Safety Authority (AMSA) 2015a, Technical Guidelines for Preparing Contingency Plans for Marine and Coastal Facilities.

Australian Maritime Safety Authority (AMSA) 2015b, National Plan - Response, Assessment and Termination of Cleaning for Oil Contaminated Foreshores (NP-GUI-025)

Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) 2000, Australian and New Zealand Guidelines for Fresh and Marine Water, Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

Baines, PG & Fandry, CB 1983, 'Annual Cycle of the Density Field in Bass Strait', *Australian Journal of Marine and Freshwater Research* vol. 34, no. 1, pp 143–153.

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.

Bobra, MA 1991, 'Water-in-oil emulsification: A physicochemical study', in Proceedings of the 1991 International Oil Spill Conference, San Diego, CA, USA, pp. 483-488.

Bonn Agreement 2009, 'Bonn Agreement aerial operations handbook, 2009 - Publication of the Bonn Agreement', London, 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 2014. ISBN: 9788214057393.

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.

Cooper Energy (COE) 2020, BMG-EN-TFN-0003 BMG Well Abandonments: Spill Modelling Approach, 15th October 2020

Daling, PS & Brandvik, PJ 1991, 'Characterization and prediction of the weathering properties of oils at sea – a manual for the oils investigated in the DIWO project, IKU-R--02.0786.00/16/91', SINTEF, Trondheim, Norway, 140pp.

Daling, PS, Aamo, OM, Lewis, A & Strøm-Kristiansen, T 1997, 'SINTEF/IKU oil-weathering model: Predicting oils' properties at sea', in Proceedings of the 1997 International Oil Spill Conference, Fort Lauderdale, FL, USA, pp. 297-307.

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 1991, 'On scale modeling of oil droplet formation from spilled oil', in Proceedings of the 1991 International Oil Spill Conference, San Diego, CA, USA, pp. 501-506.

Delvigne, GAL & Sweeney, CE 1988, 'Natural dispersion of oil', *Oil and Chemical Pollution*, vol. 4, no. 4, pp. 281-310.

European Chemicals Agency 2008, 'Characterisation of dose [concentration] - response for environment' Chapter R.10 -in Guidance on information requirements and chemical safety assessment, European Chemicals Agency, Finland, pp. 26-29.

Fingas, M 1995, 'Water-in-oil emulsion formation: A review of physics and mathematical modelling', *Spill Science & Technology Bulletin*, vol. 2, no. 1, pp. 55-59.

Fingas, M 1997, 'The evaporation of oil spills: Prediction of equations using distillation data', in Proceedings of the 20th Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Vancouver, BC, Canada, pp. 1-20.

French, DP 1998, 'Modelling the impacts of the North Cape oil spill', in Proceedings of the 21st Arctic and Marine Oilspill Program (AMOP) Technical Seminar, Edmonton, AB, Canada, pp. 387-430.

French, D., Reed, M., Jayko, K., Feng, S., Rines, H., Pavignano, S.1996. The CERCLA Type A Natural Resource Damage Assessment Model for Coastal and Marine Environments (NRDAM/CME), Technical Documentation, Vol. I - Model Description, Final Report. Office of Environmental Policy and Compliance, U.S. Department of the Interior. Washington, D.C.: Contract No. 14-0001-91-C-11.

French, DP & Rines, HM 1997, 'Validation and use of spill impact modelling for impact assessment', in Proceedings of the 1997 International Oil Spill Conference, Fort Lauderdale, FL, USA, pp. 829-834.

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 Seminar, 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.

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.

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

Gundlach, ER & Boehm, PD 1981, 'Determine fates of several oil spills in coastal and offshore waters and calculate a mass balance denoting major pathways for dispersion of the spilled oil', RPI/R/81/12/31-30, National Oceanic and Atmospheric Administration, Seattle, WA, USA.

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.

King, BA & McAllister, FA 1998, 'Modelling the dispersion of produced water discharges', *The APPEA Journal*, vol. 38, no.1, pp.681–691.

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. <1, pp. WDS229–WDS234.

Li, Z., Spaulding, M. J., French McCay, D., Crowley, D., and Payne, J. R., 2017. Development of a unified droplet size distribution model with application to surface breaking waves and subsea blowout release considering dispersant effects. *Marine Pollution Bulletin*, vol. 114, no. 1, pp. 247-257.

Lin, Q & Mendelssohn, IA 1996, ‘A comparative investigation of the effects of south Louisiana crude oil on the vegetation of fresh, brackish and Salt Marshes’, *Marine Pollution Bulletin*, vol. 32, no. 2, pp. 202–209.

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

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.

Mackay D, Puig H & McCarty LS 1992, ‘An equation describing the time course and variability in uptake and toxicity of narcotic chemicals to fish’, *Environmental Toxicology and Chemistry: An International Journal*, vol. 11, no. 7, p.941–951.

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.

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 & 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.

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.

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. & Black, KP 1994. The low frequency circulation in and around Bass Strait: a numerical study. *Continental Shelf Research* 14, pp 1495–1521.

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, 'NOPSEMA Bulletin #1: Oil spill modelling', viewed April 2019, https://www.nopsema.gov.au/assets/Bulletins/A652993.pdf

National Research Council (NRC) 1985, 'Oil in the Sea: Inputs, Fates and Effects', National Academy Press, Washington, D.C., 601p.

National Research Council (NRC) 1989, 'Review of the State-of-Knowledge Regarding Dispersant Usage in Open-Ocean Spill Responses', NRC Marine Board, Washington, DC., 306p.

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 1998, '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.

Nordtug, T., Olsen, A.J., Altin, D., Overrein, I., Storøy, W., Hansen, B.H. and De Laender, F., 2011. Oil droplets do not affect assimilation and survival probability of first feeding larvae of North-East Arctic cod. *Science of the Total Environment*, 412, pp.148-153.

Oil Spill Solutions 2015, Evaluation - The Theory of Oil Slick Appearances, viewed 6 January 2015, http://www.oilspillsolutions.org/evaluation.htm

Okubo, A 1971,'Application of the telegraph equation to oceanic diffusion: Another mathematic model', Technical report 69 (N00014-67-A-0163-0006), Chesapeake Bay Institute The Johns Hopkins University, Maryland, USA.

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

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

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, ML., Kolluru, VS, Anderson, E & Howlett, E 1994, 'Application of three-dimensional oil spill model (WOSM/OILMAP) to hindcast the Braer Spill', Spill Science and Technology Bulletin, vol. 1, no. 1, pp. 23–35.

Spaulding, MS, Mendelsohn, D, Crowley, D, Li, Z, and Bird A, 2015. Technical Reports for Deepwater Horizon Water Column Injury Assessment- WC_TR.13: Application of OILMAP DEEP to the Deepwater Horizon Blowout. RPS APASA, 55 Village Square Drive, South Kingstown, RE 02879.

Suprayogi, B & Murray, F 1999, 'A field experiment of the physical and chemical effects of two oils on mangroves', *Environmental and Experimental Botany*, vol. 42, no. 3, pp. 221–229.

Swartz RC, Schults DW, Ozretich RJ, Lamberson JO, Cole FA, Ferraro SP, Dewitt TH & Redmond MS 1995, 'ΣPAH: A Model to predict the toxicity of polynuclear aromatic hydrocarbon mixtures in field-collected sediments', *Environmental Toxicology and Chemistry*, vol. 14, no. 11, pp. 1977–1187.

Verhaar HJM, Van Leeuwen CJ & Hermens JLM 1992, 'Classifying environmental pollutants', *Chemosphere*, vol. 24, no. 4, pp. 471–491.

Verhaar HJM, de Jongh J & Hermens JLM 1999, 'Modelling the bioconcentration of organic compounds by fish: A novel approach', *Environmental Science & Technology*, vol. 33, no. 22, pp. 4069–4072.

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 A

Loss of Well Control – 77,338 m3 subsea release of Basker 6ST1 Crude over 120 days

In-water stochastic results were assessed up to a depth of 100 m using the following intervals 0-10 m, 10-20 m, 20-30 m, 30-40 m, 40-60 m, 60-80 m and 80-100 m. Stochastic results for the 0-10 m and 10-20 m depth layers are presented in Section 8.1.2.3 while all other depth layers are presented in this section.

A.1.1 Water Column Exposure

A.1.1.1 Dissolved Hydrocarbons

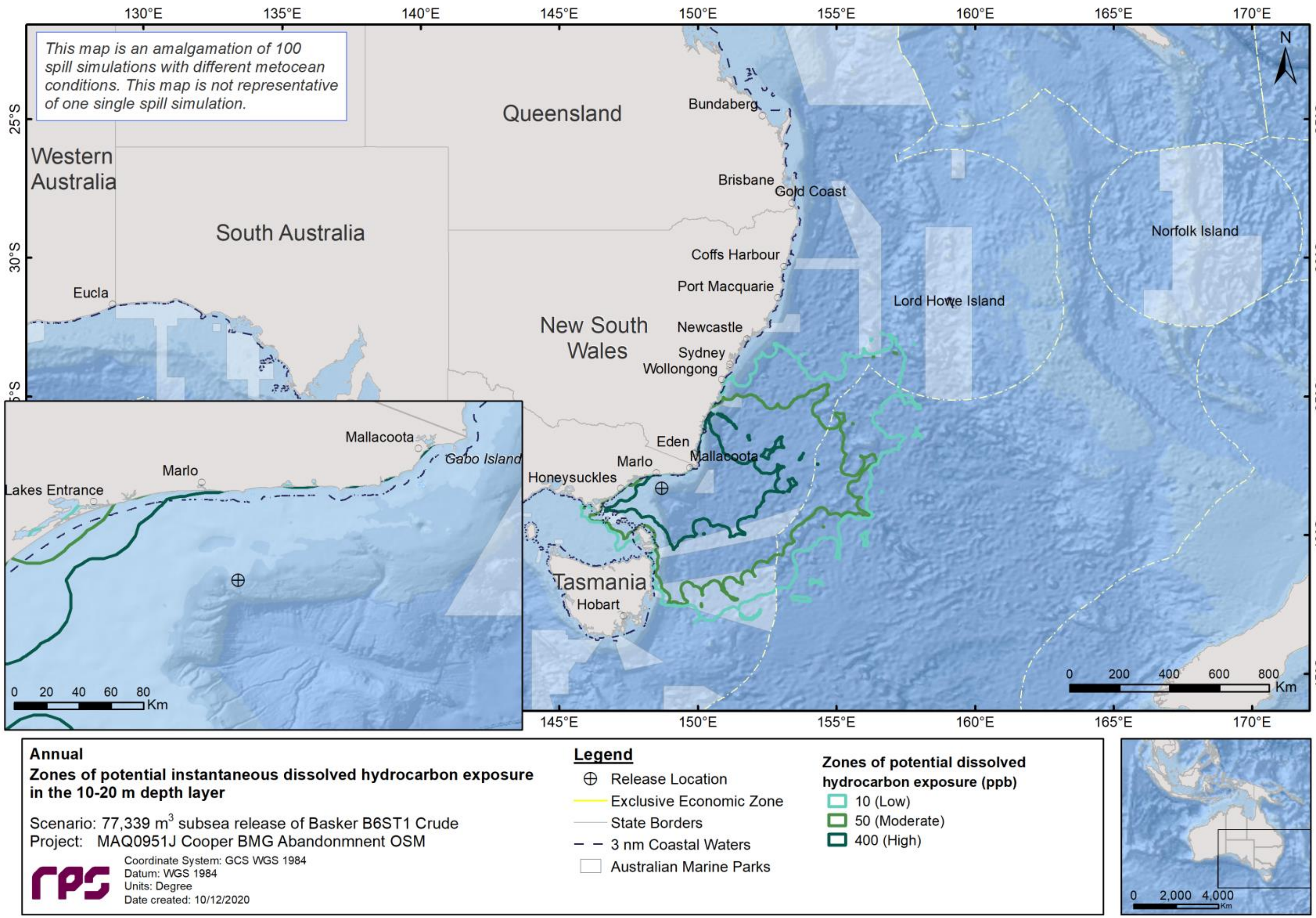


Figure 9-1 Zones of potential instantaneous dissolved hydrocarbon exposure at 10-20 m below the sea surface in the event of a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days. The results were calculated from 100 spill trajectories simulated during annual conditions.

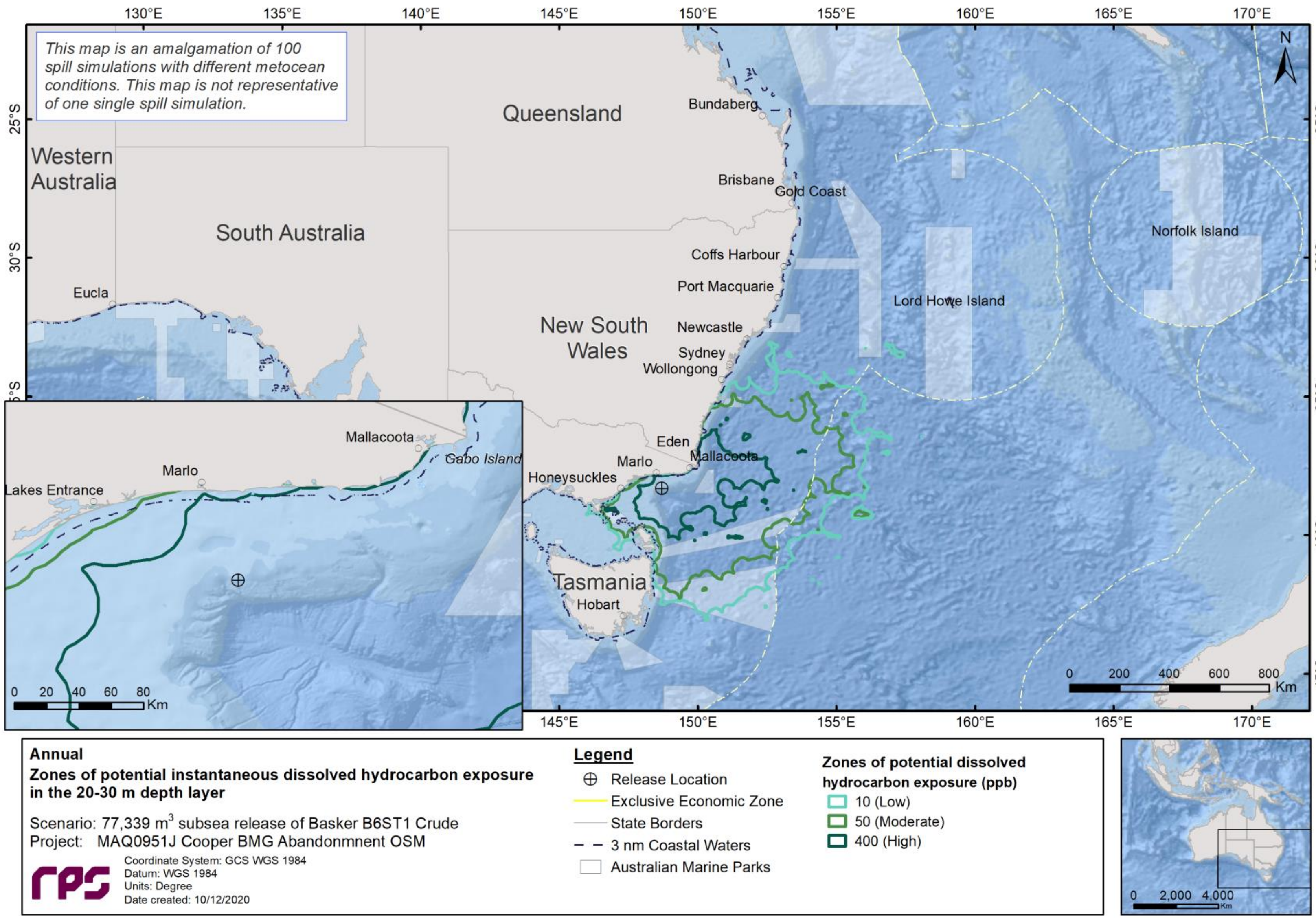


Figure 9-2 Zones of potential instantaneous dissolved hydrocarbon exposure at 20-30 m below the sea surface in the event of a 77,338 m³ subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days. The results were calculated from 100 spill trajectories simulated during annual conditions.

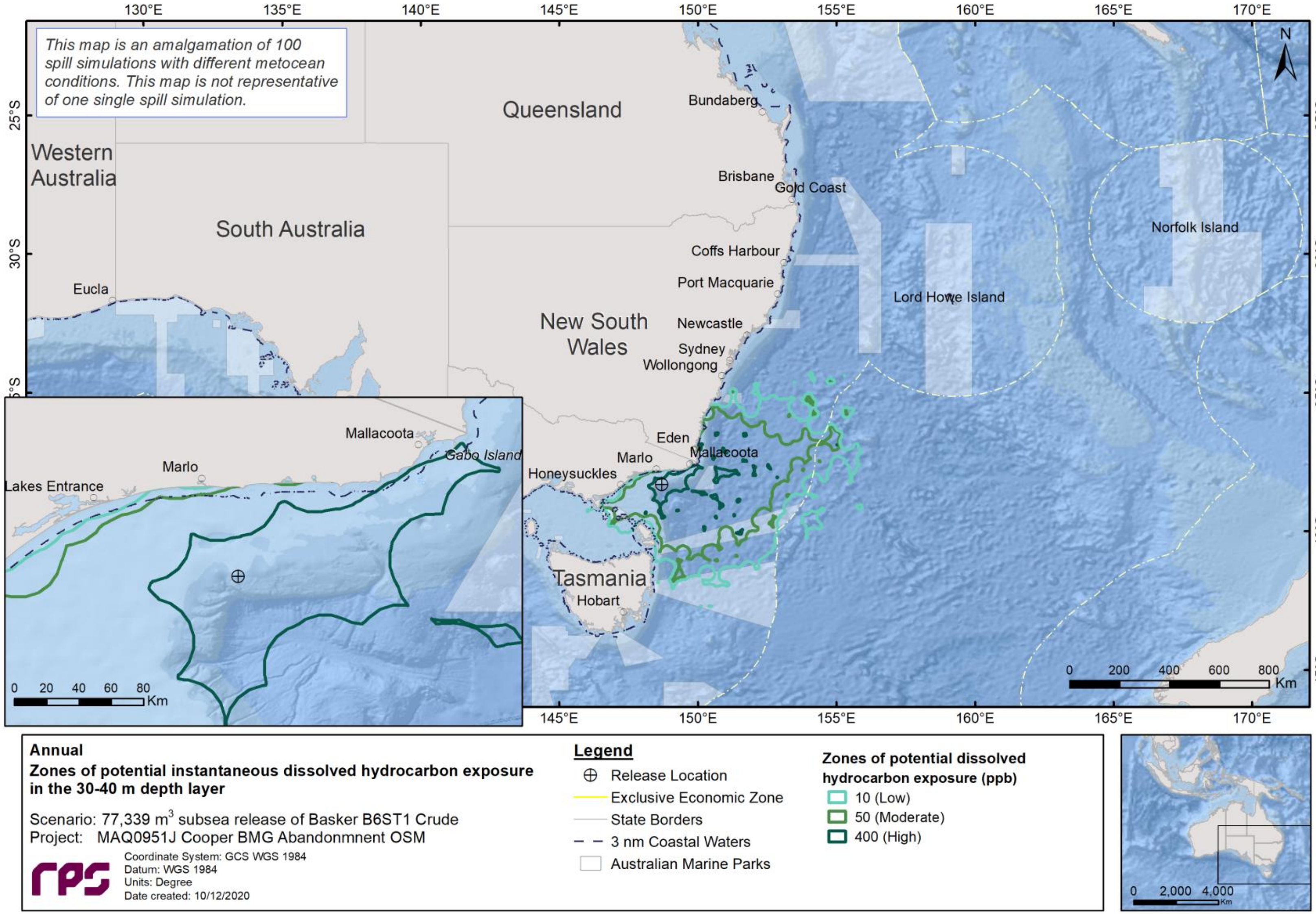


Figure 9-3 Zones of potential instantaneous dissolved hydrocarbon exposure at 30-40 m below the sea surface in the event of a 77,338 m³ subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days. The results were calculated from 100 spill trajectories simulated during annual conditions.

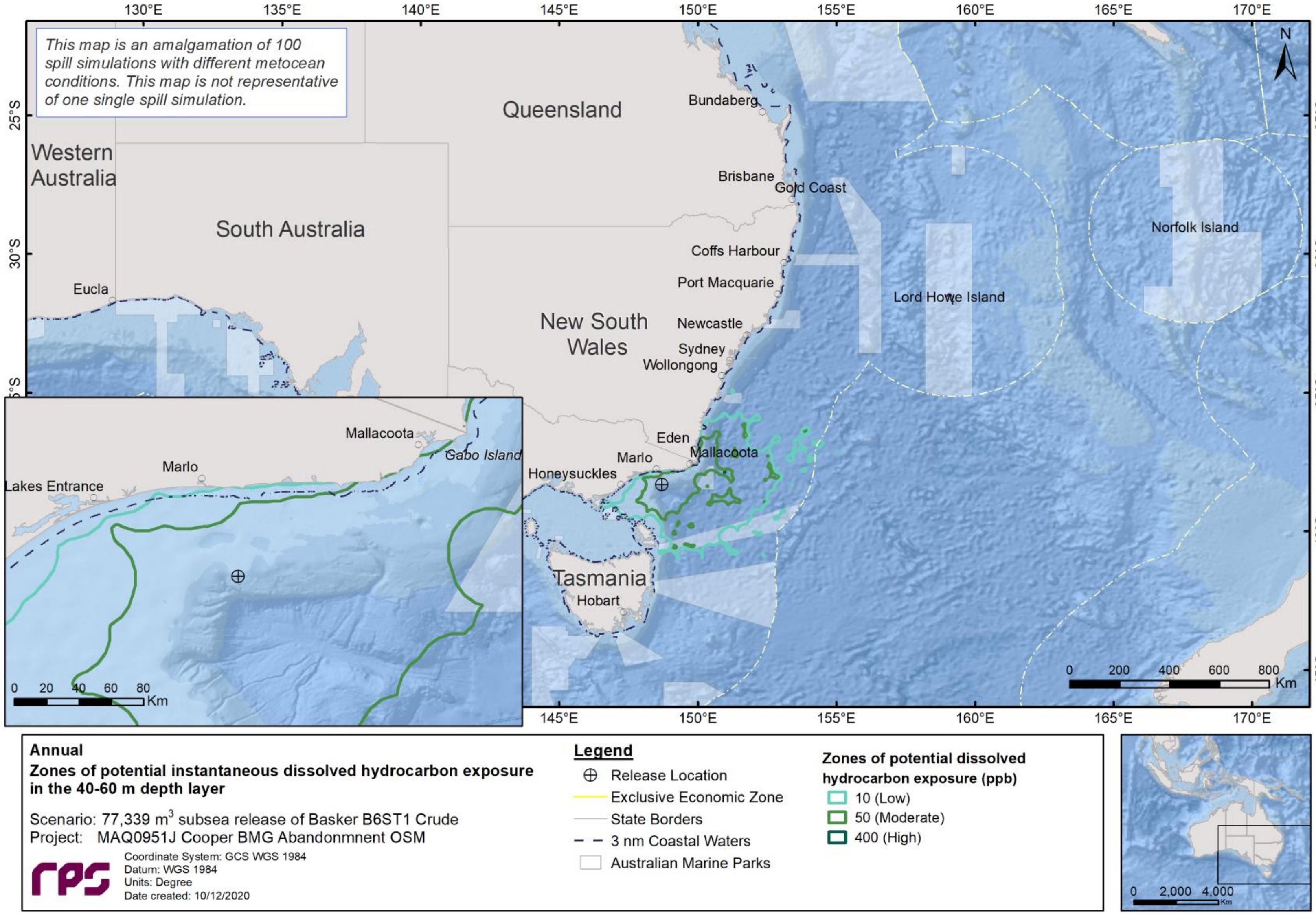


Figure 9-4 Zones of potential instantaneous dissolved hydrocarbon exposure at 40-60 m below the sea surface in the event of a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days. The results were calculated from 100 spill trajectories simulated during annual conditions.

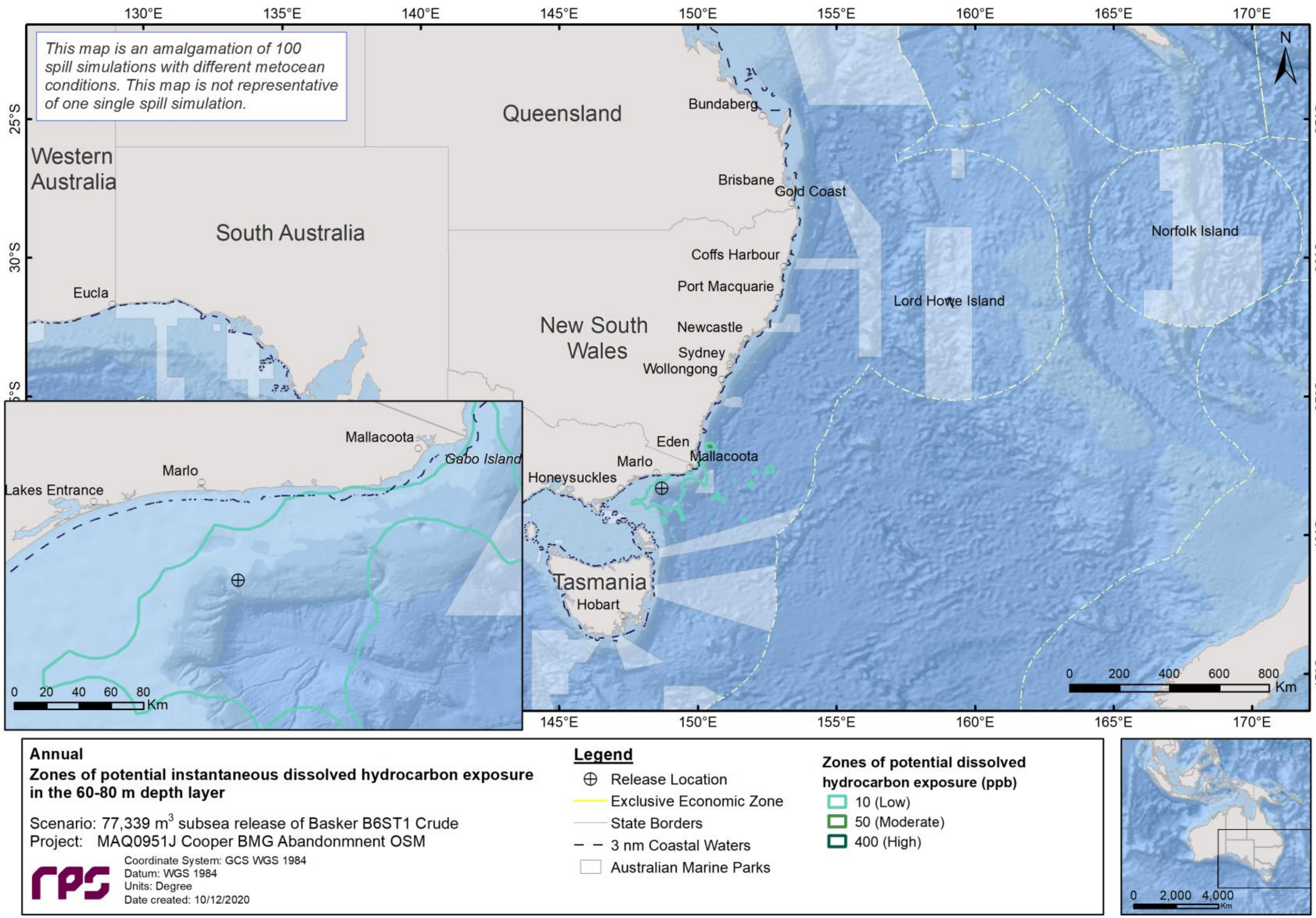


Figure 9-5 Zones of potential instantaneous dissolved hydrocarbon exposure at 60-80 m below the sea surface in the event of a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days. The results were calculated from 100 spill trajectories simulated during annual conditions.

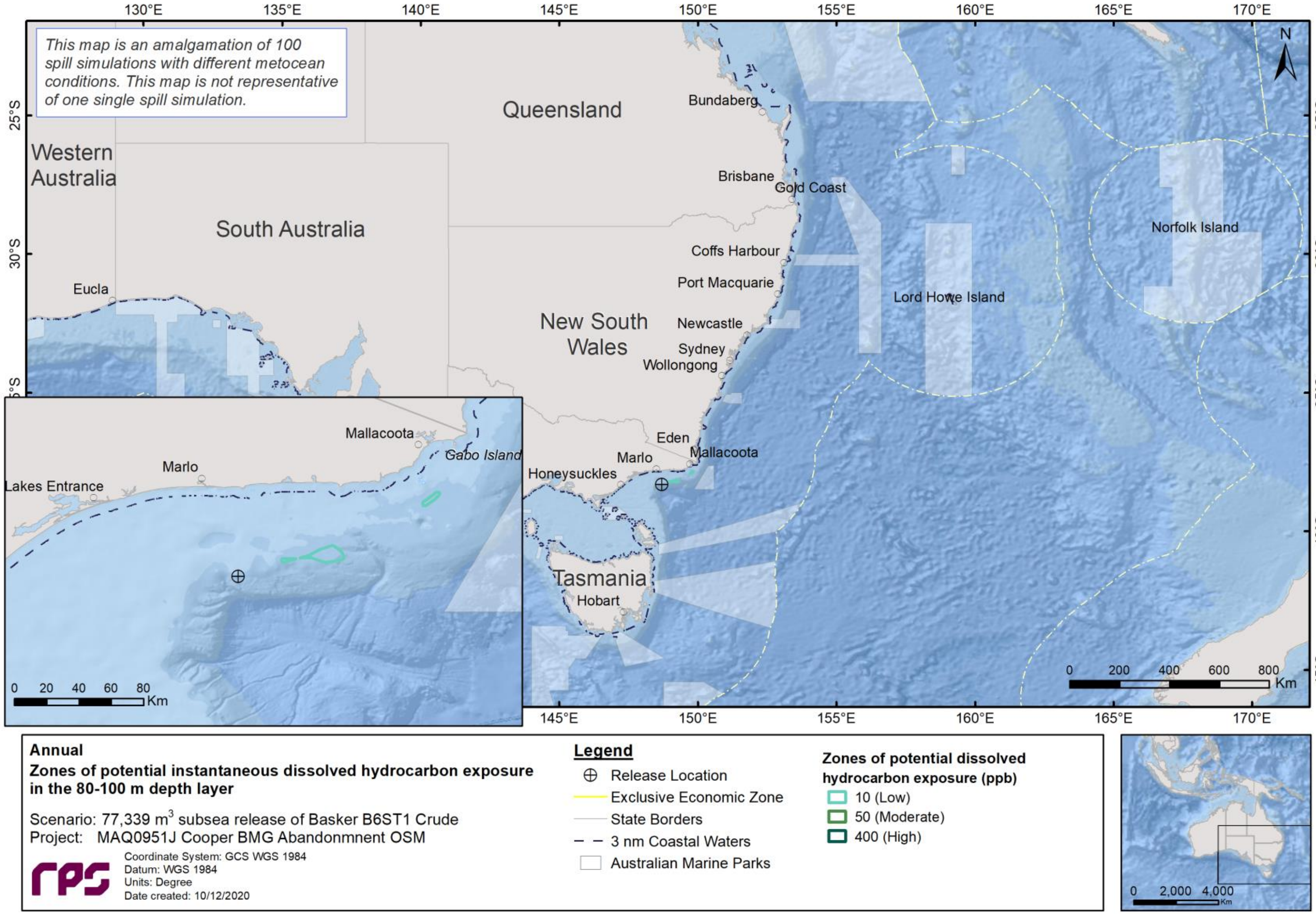


Figure 9-6 Zones of potential instantaneous dissolved hydrocarbon exposure at 80-100 m below the sea surface in the event of a 77,338 m3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days. The results were calculated from 100 spill trajectories simulated during annual conditions.

A.1.1.2 Entrained Hydrocarbons

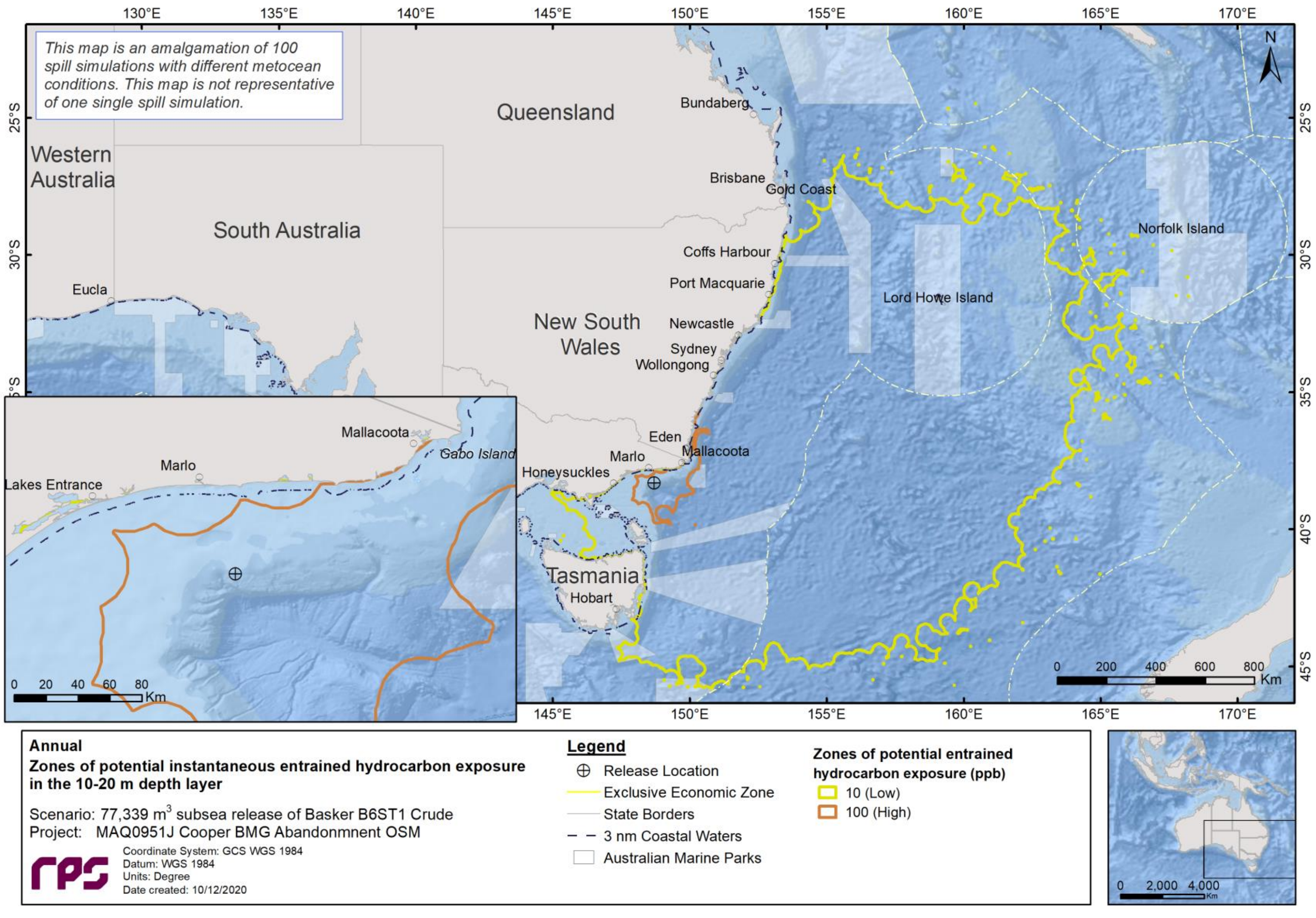


Figure 9-7 Zones of potential instantaneous entrained hydrocarbon exposure at 10-20 m below the sea surface in the event of a 77,338 m³ subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days. The results were calculated from 100 spill trajectories simulated during annual conditions.

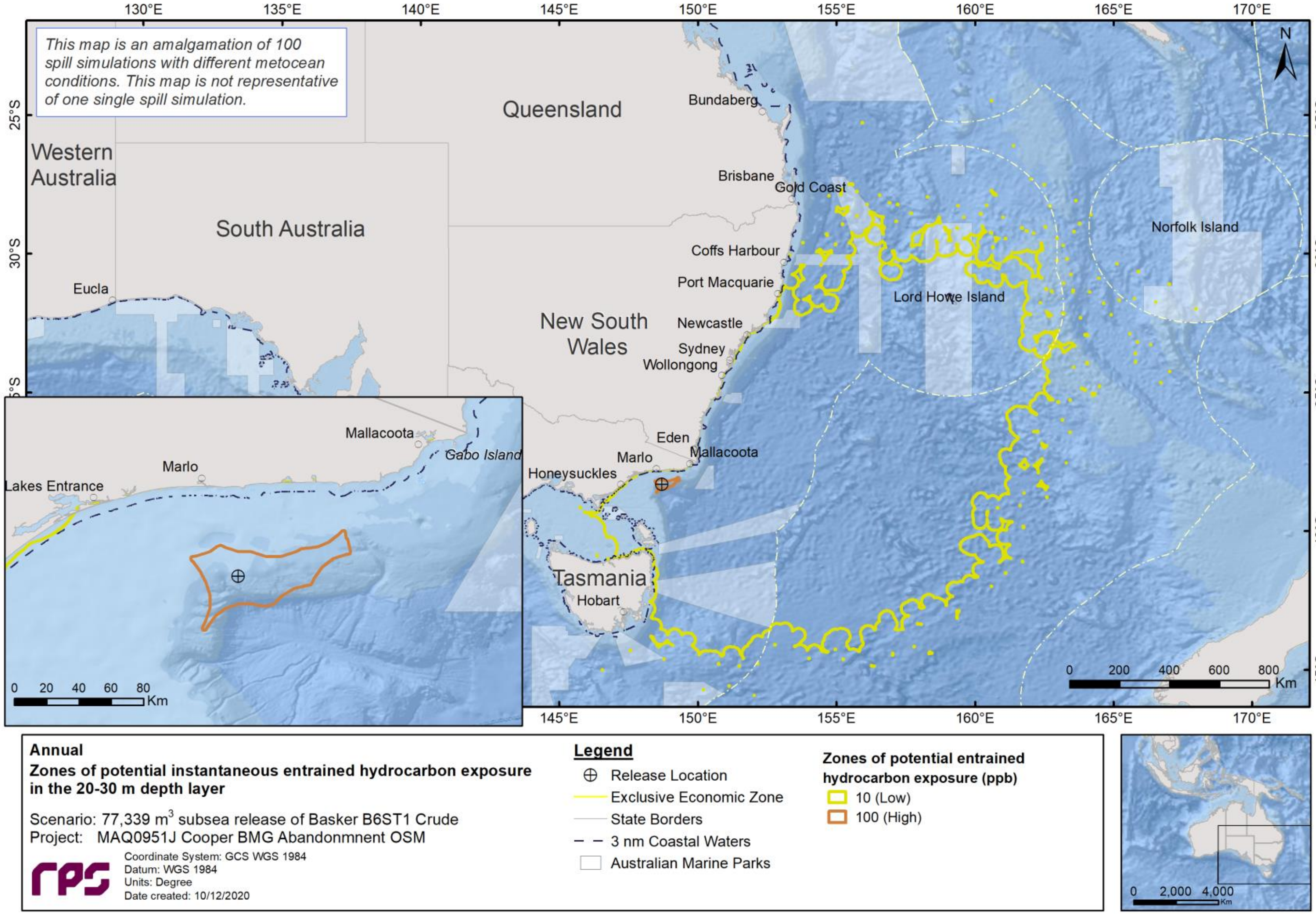


Figure 9-8 Zones of potential instantaneous entrained hydrocarbon exposure at 20-30 m below the sea surface in the event of a 77,338 m³ subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days. The results were calculated from 100 spill trajectories simulated during annual conditions.

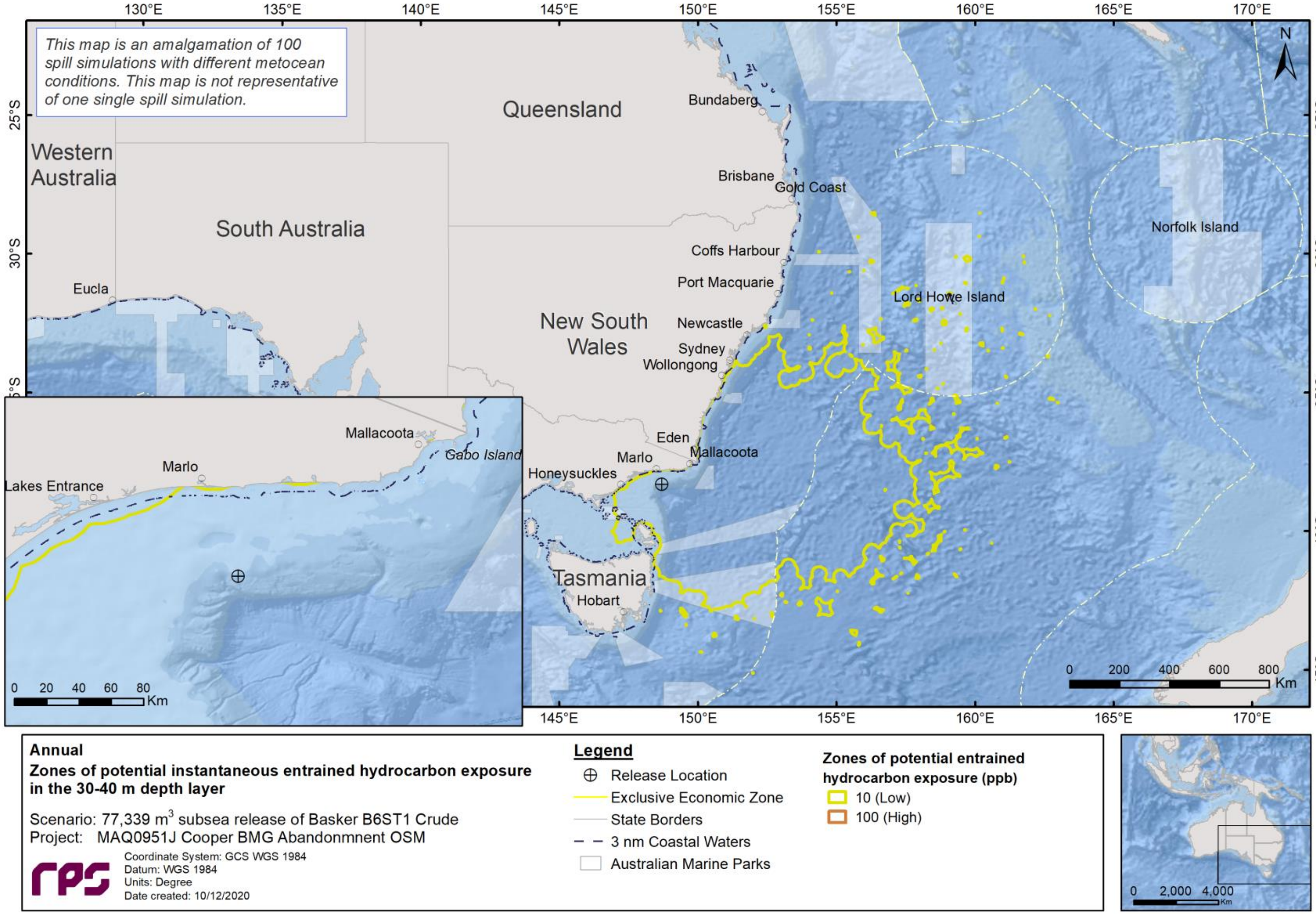


Figure 9-9 Zones of potential instantaneous entrained hydrocarbon exposure at 30-40 m below the sea surface in the event of a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days. The results were calculated from 100 spill trajectories simulated during annual conditions.

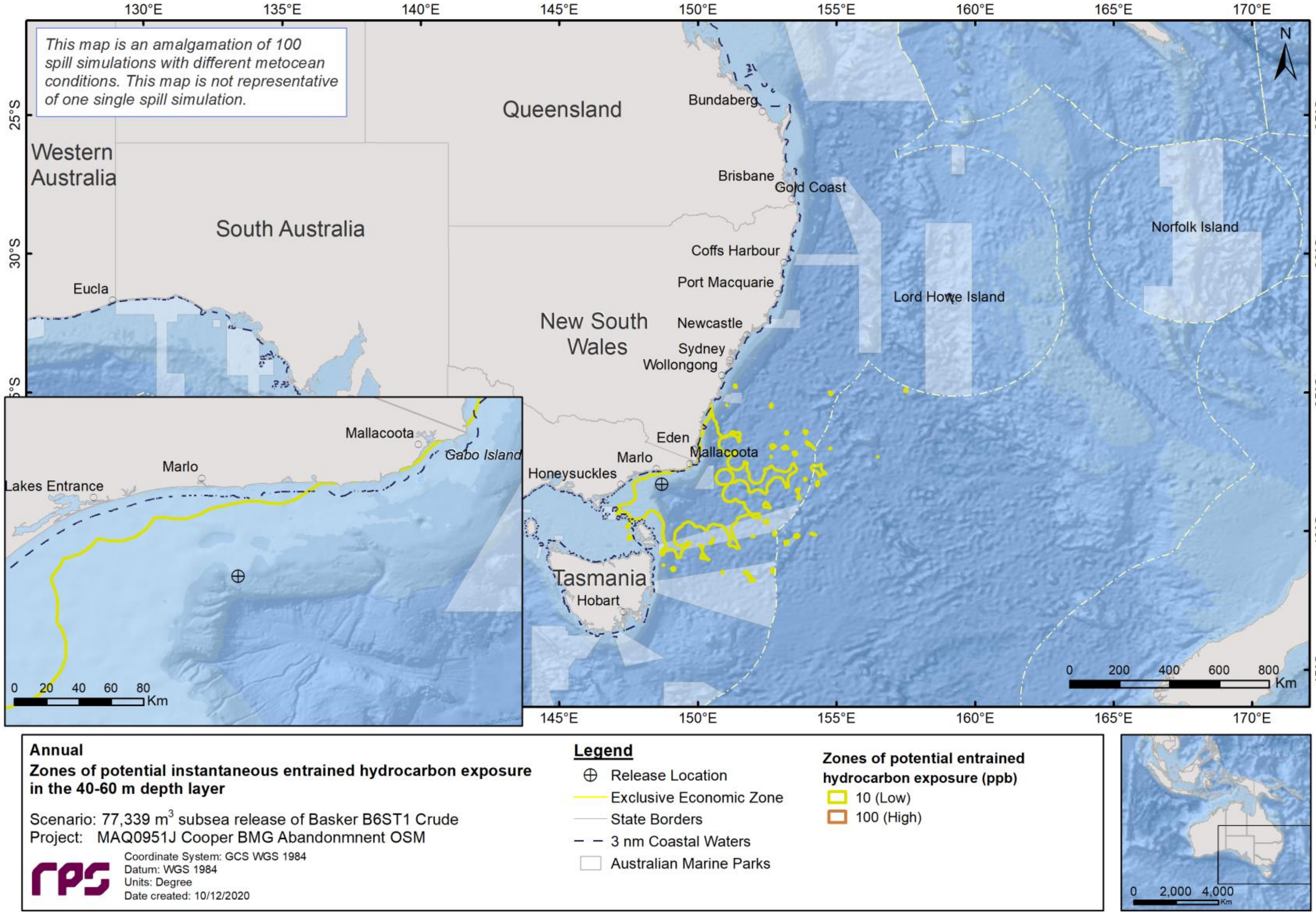


Figure 9-10 Zones of potential instantaneous entrained hydrocarbon exposure at 40-60 m below the sea surface in the event of a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days. The results were calculated from 100 spill trajectories simulated during annual conditions.

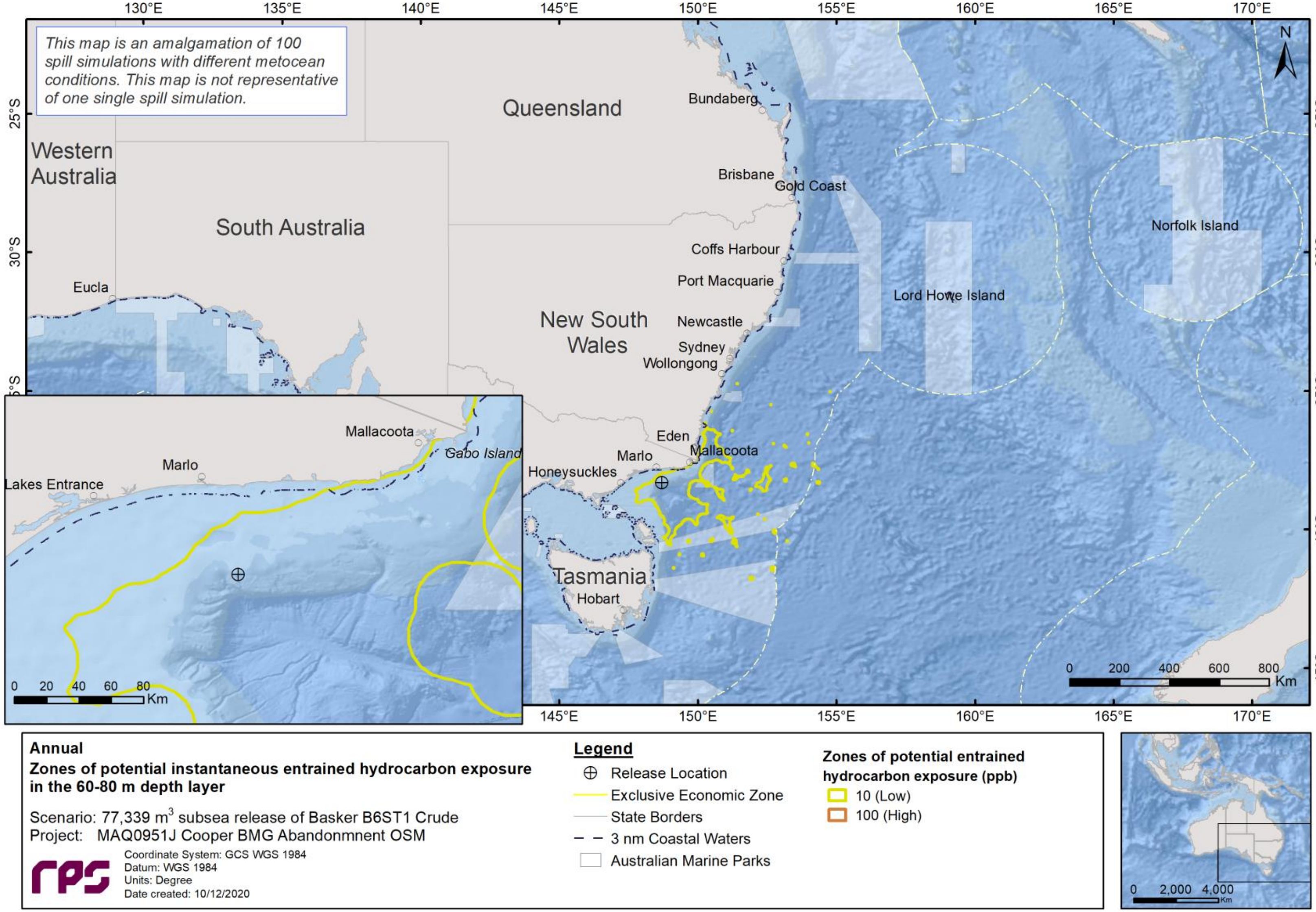


Figure 9-11 Zones of potential instantaneous entrained hydrocarbon exposure at 60-80 m below the sea surface in the event of a 77,338 m³ subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days. The results were calculated from 100 spill trajectories simulated during annual conditions.

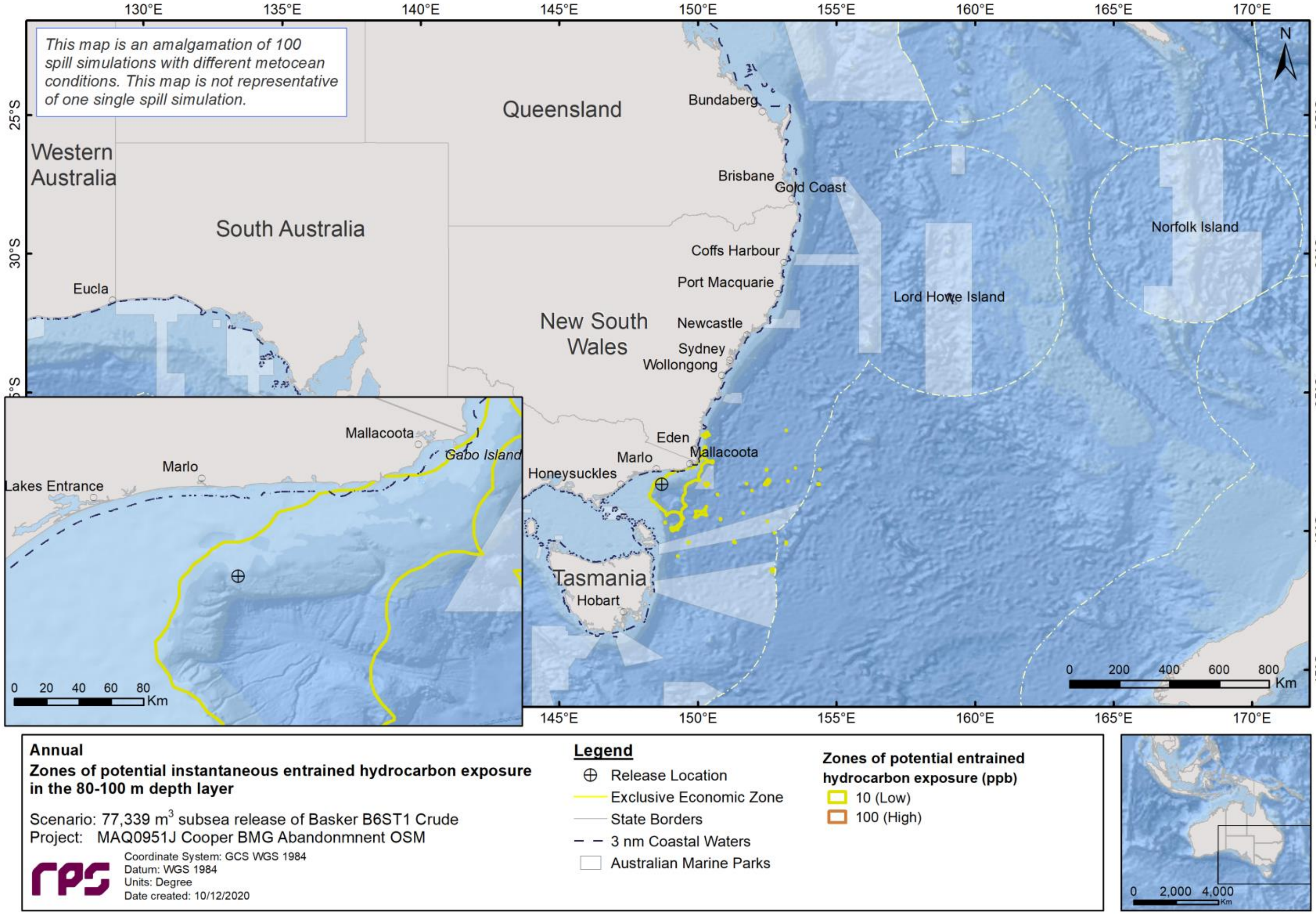


Figure 9-12 Zones of potential instantaneous entrained hydrocarbon exposure at 80-100 m below the sea surface in the event of a 77,338 m^3 subsea release of Basker 6ST1 crude at the B2 well location over 120 days, tracked for 180 days. The results were calculated from 100 spill trajectories simulated during annual conditions.

Appendix B

Vessel collision – 500 m^3 surface release of MDO over 5 hours

In-water stochastic results were assessed up to a depth of 30 m using the following intervals 0-10 m, 10-20 m and 20-30 m. Stochastic results for the 0-10 m depth layer are presented in Section 8.2.2.3 while all other depth layers are presented in this section.

B.1.1 Water Column Exposure

B.1.1.1 Dissolved Hydrocarbons

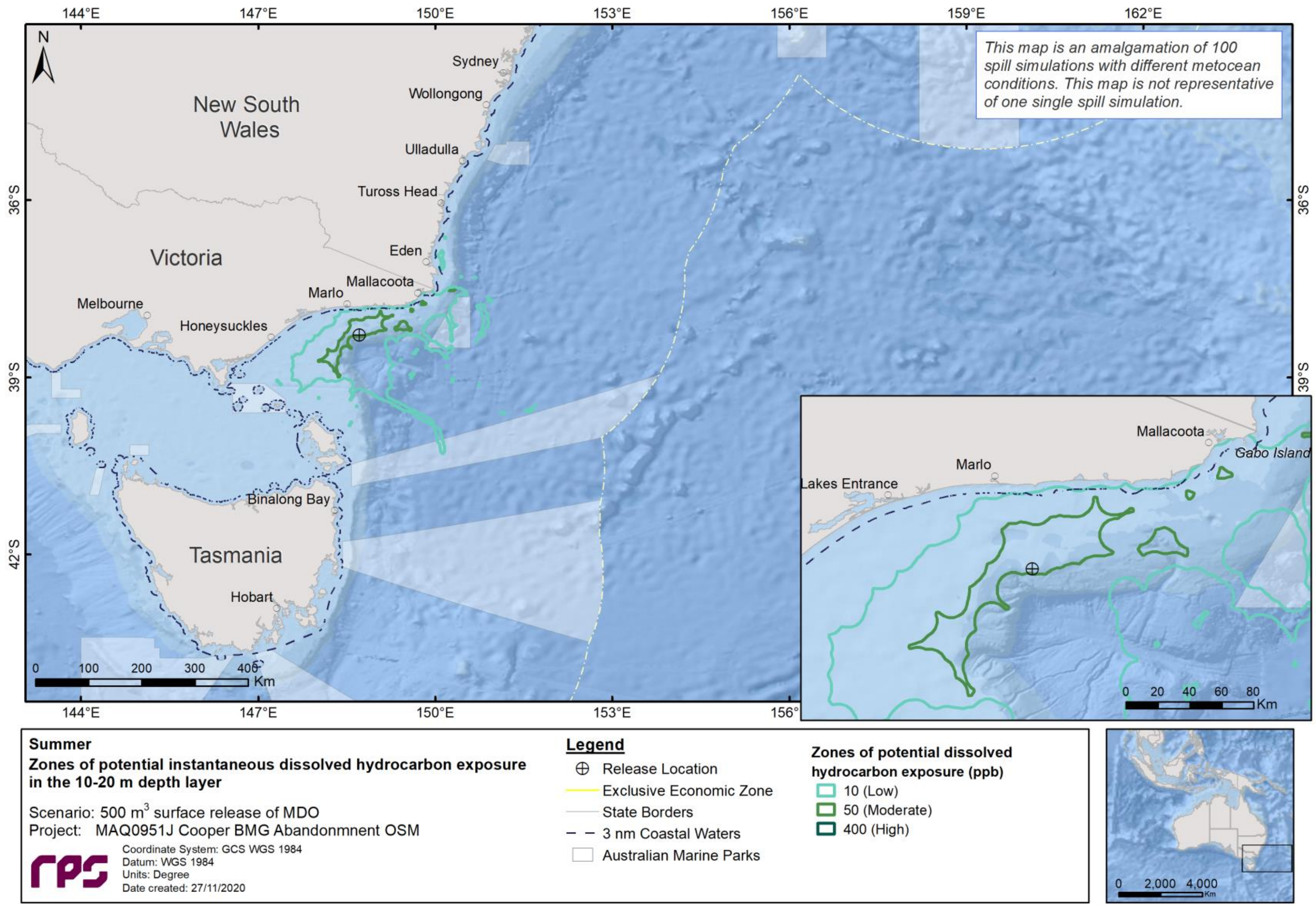


Figure 9-13 Zones of potential instantaneous dissolved hydrocarbon exposure at 10-20 m below the sea surface in the event of a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days. The results were calculated from 100 spill trajectories simulated during summer (October to April) wind and current conditions.

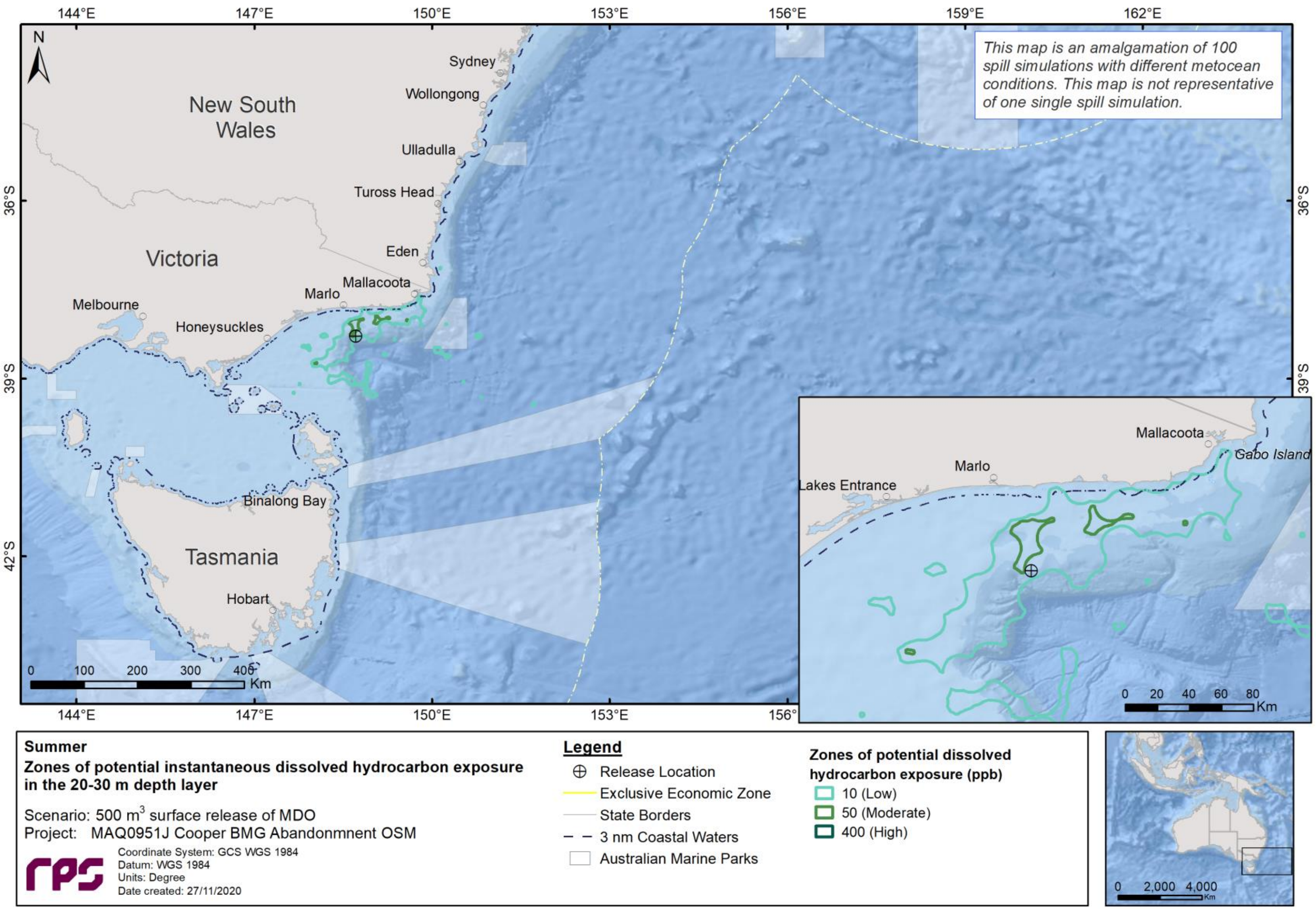


Figure 9-14 Zones of potential instantaneous dissolved hydrocarbon exposure at 20-30 m below the sea surface in the event of a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days. The results were calculated from 100 spill trajectories simulated during summer (October to April) wind and current conditions.

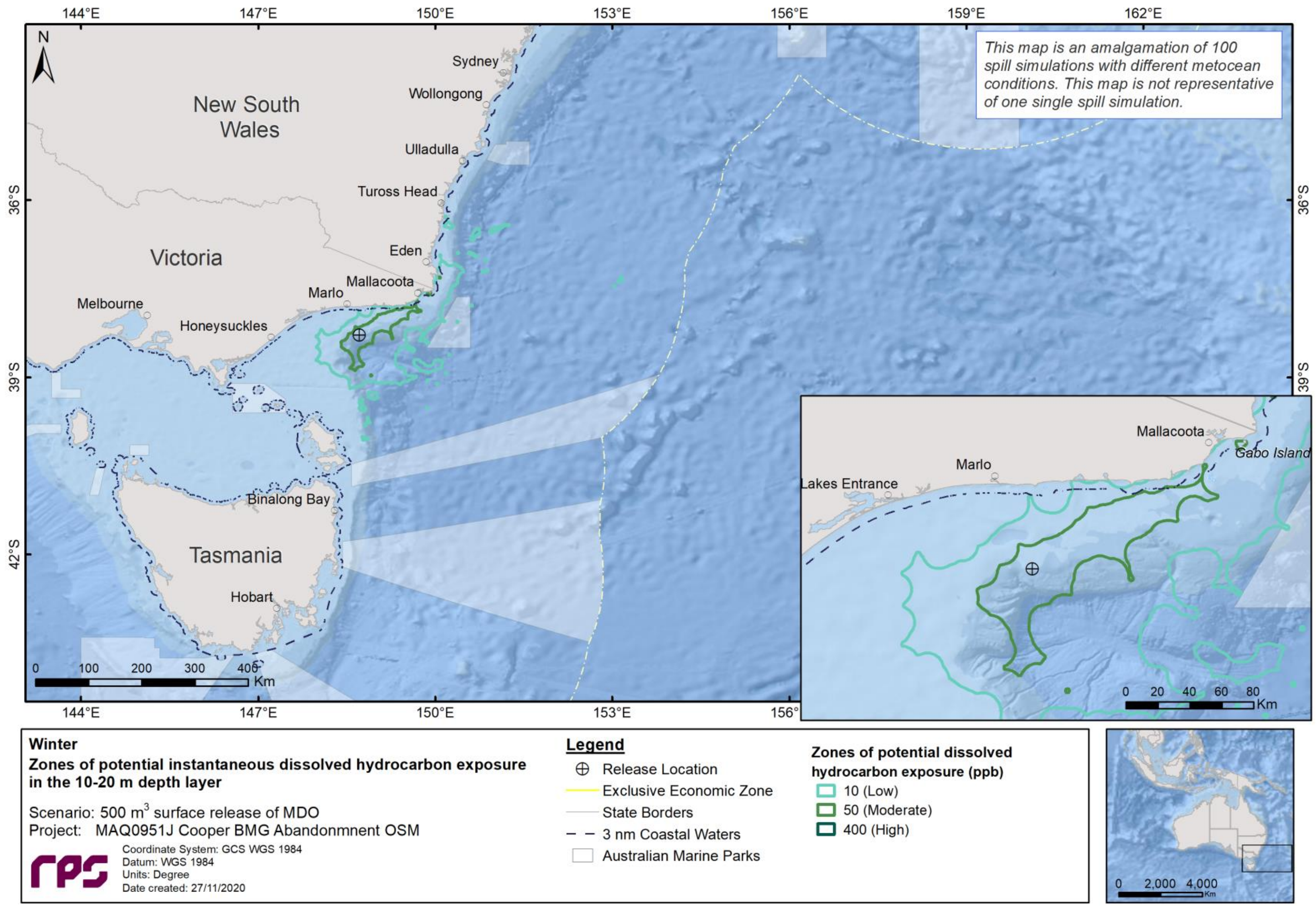


Figure 9-15 Zones of potential instantaneous dissolved hydrocarbon exposure at 10-20 m below the sea surface in the event of a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days. The results were calculated from 100 spill trajectories simulated during winter (May to September) wind and current conditions.

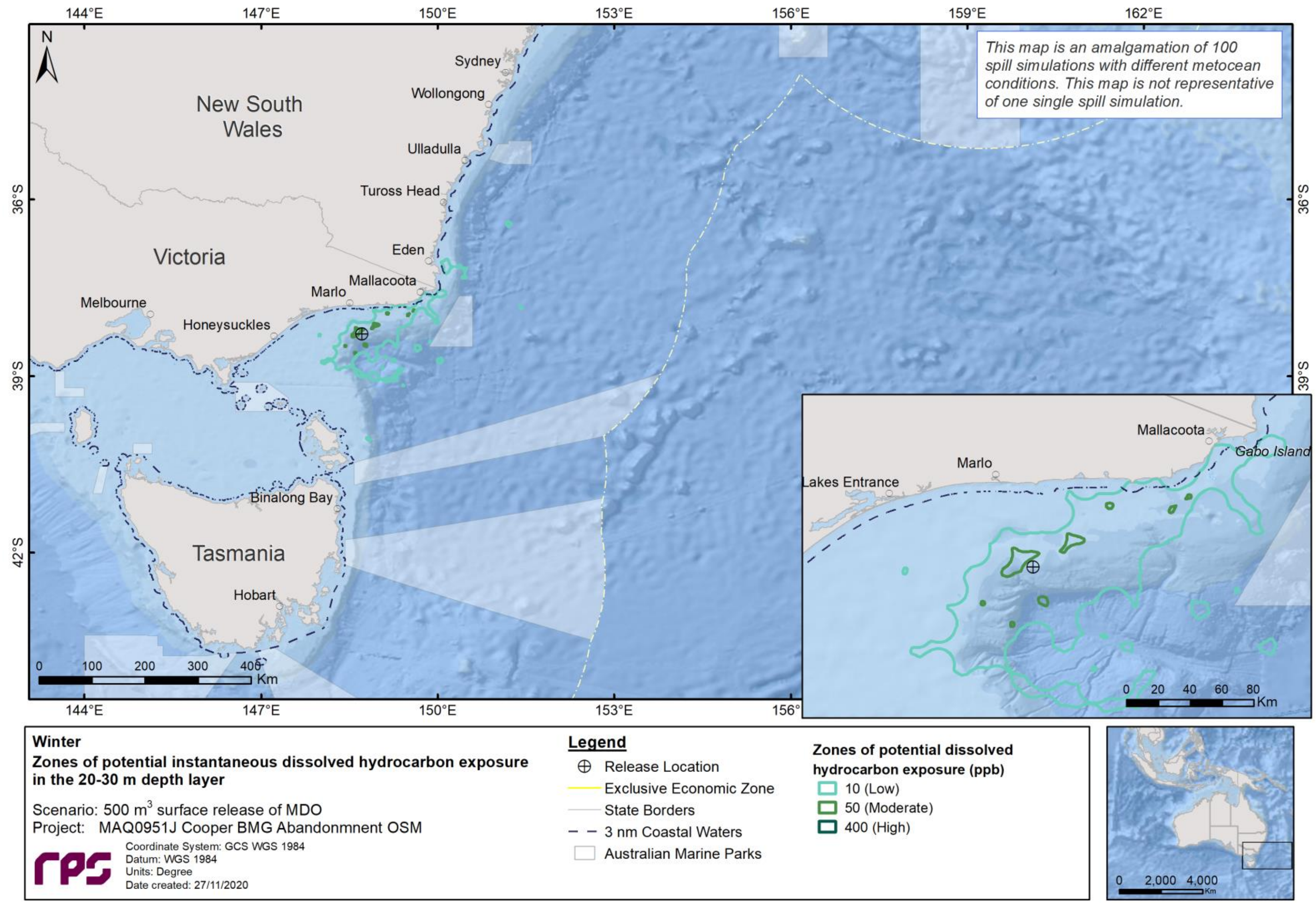


Figure 9-16 Zones of potential instantaneous dissolved hydrocarbon exposure at 20-30 m below the sea surface in the event of a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days. The results were calculated from 100 spill trajectories simulated during winter (May to September) wind and current conditions.

B.1.1.2 Entrained Hydrocarbons

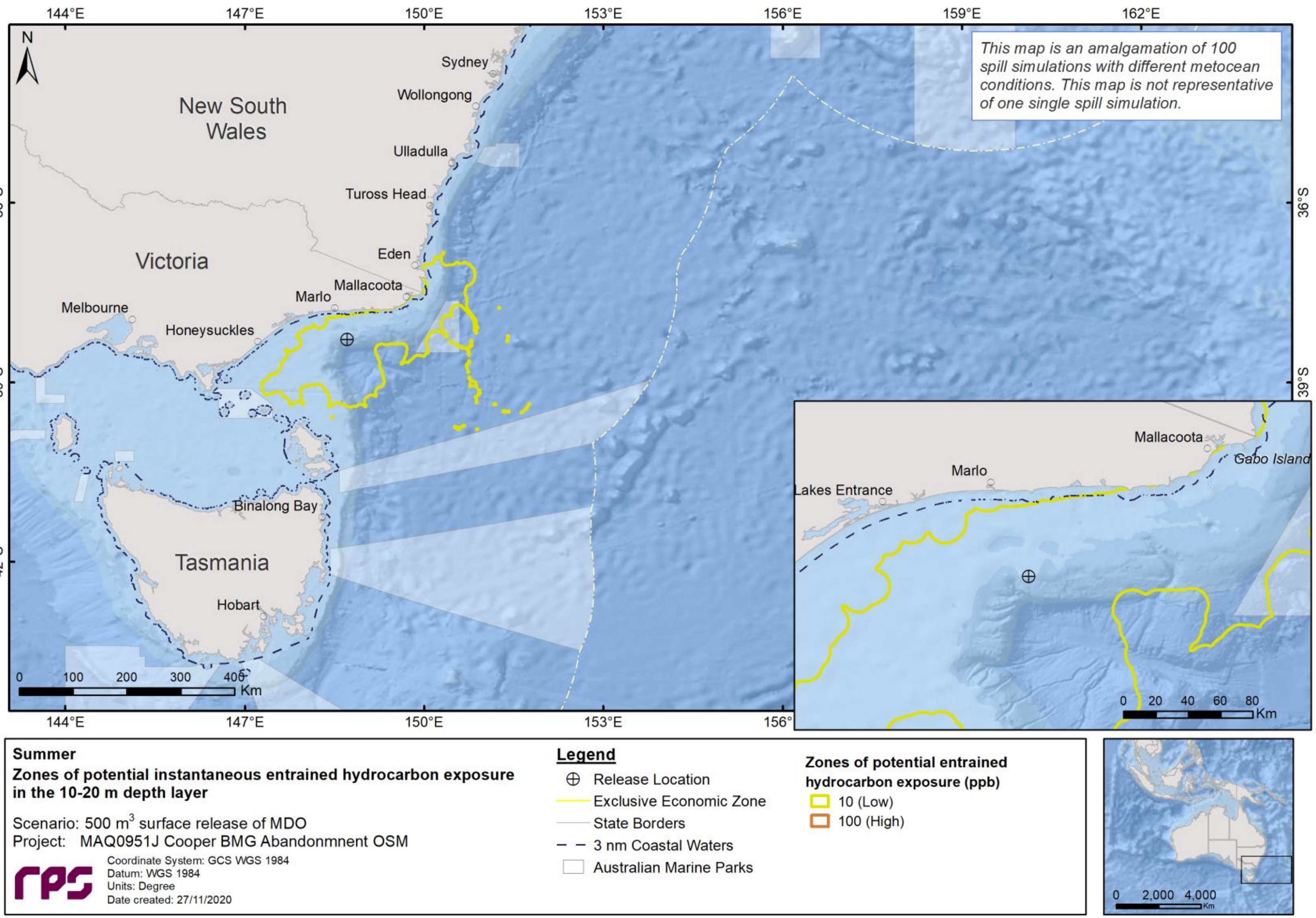


Figure 9-17 Zones of potential instantaneous entrained hydrocarbon exposure at 10-20 m below the sea surface in the event of a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days. The results were calculated from 100 spill trajectories simulated during summer (October to April) wind and current conditions.

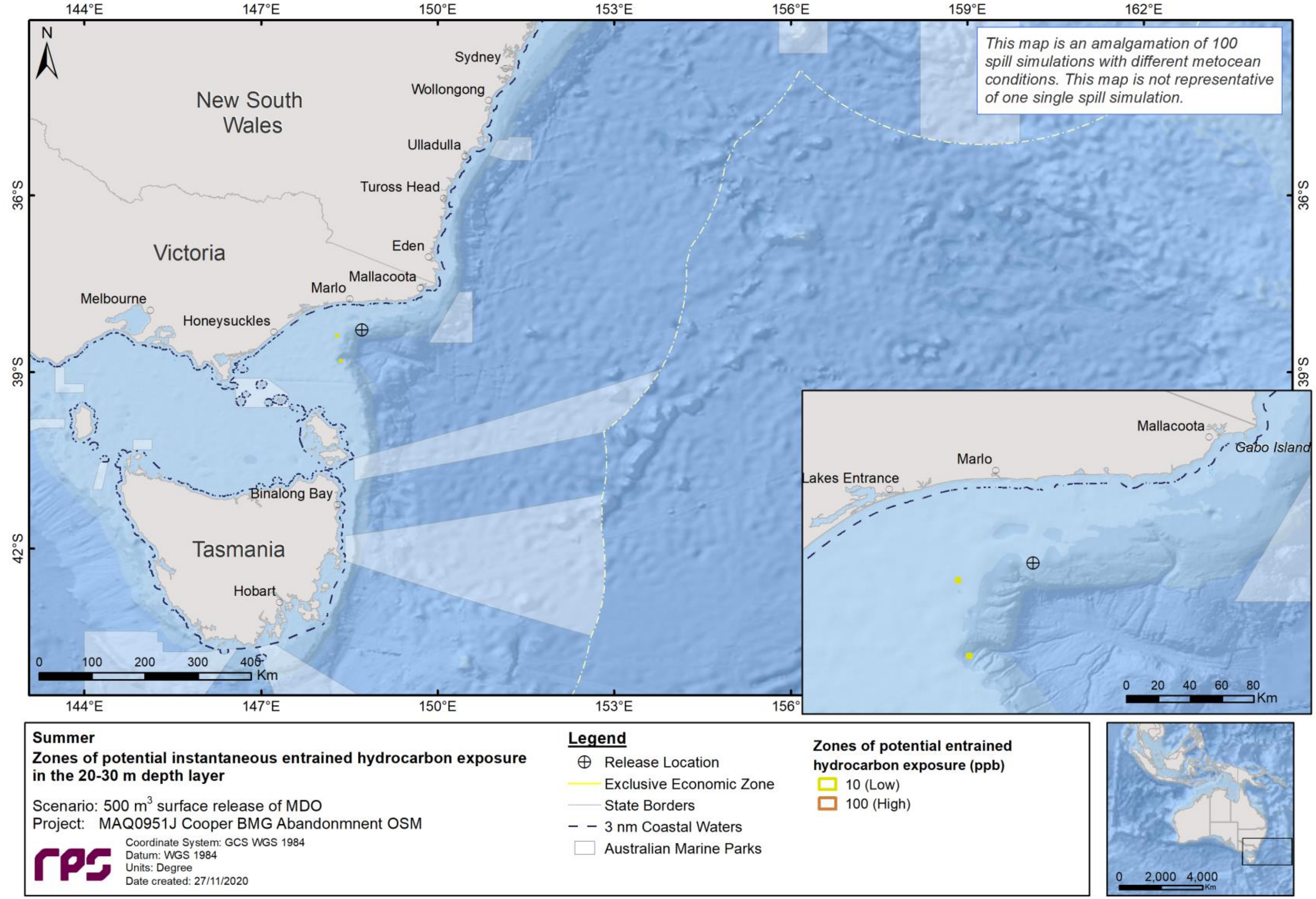


Figure 9-18 Zones of potential instantaneous entrained hydrocarbon exposure at 20-30 m below the sea surface in the event of a 500 m³ surface release of MDO at the M2A well location over 5 hours, tracked for 30 days. The results were calculated from 100 spill trajectories simulated during summer (October to April) wind and current conditions.

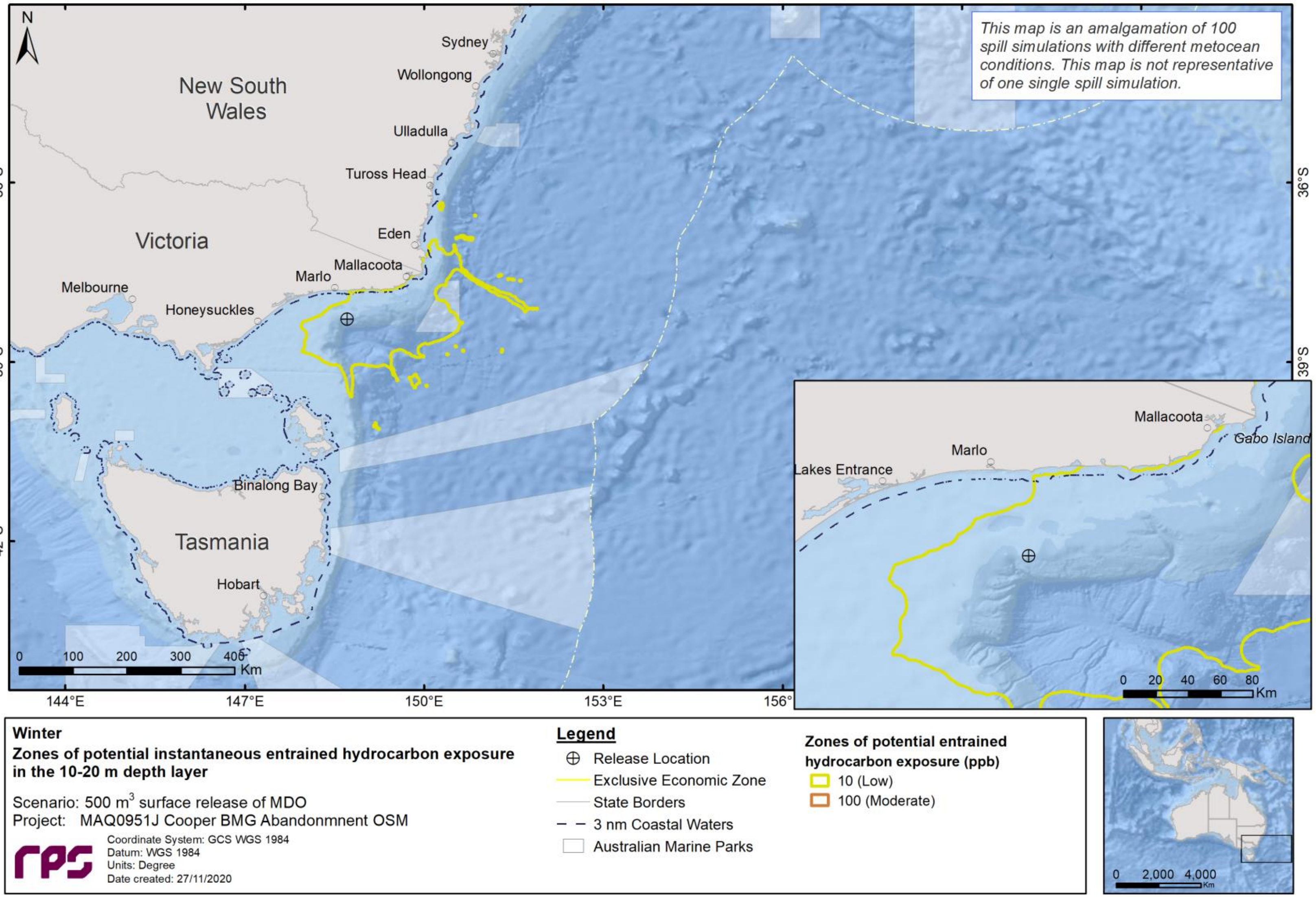


Figure 9-19 Zones of potential instantaneous entrained hydrocarbon exposure at 10-20 m below the sea surface in the event of a 500 m³ surface release of MDO at the M2A well location over 5 hours, tracked for 30 days. The results were calculated from 100 spill trajectories simulated during winter (May to September) wind and current conditions.

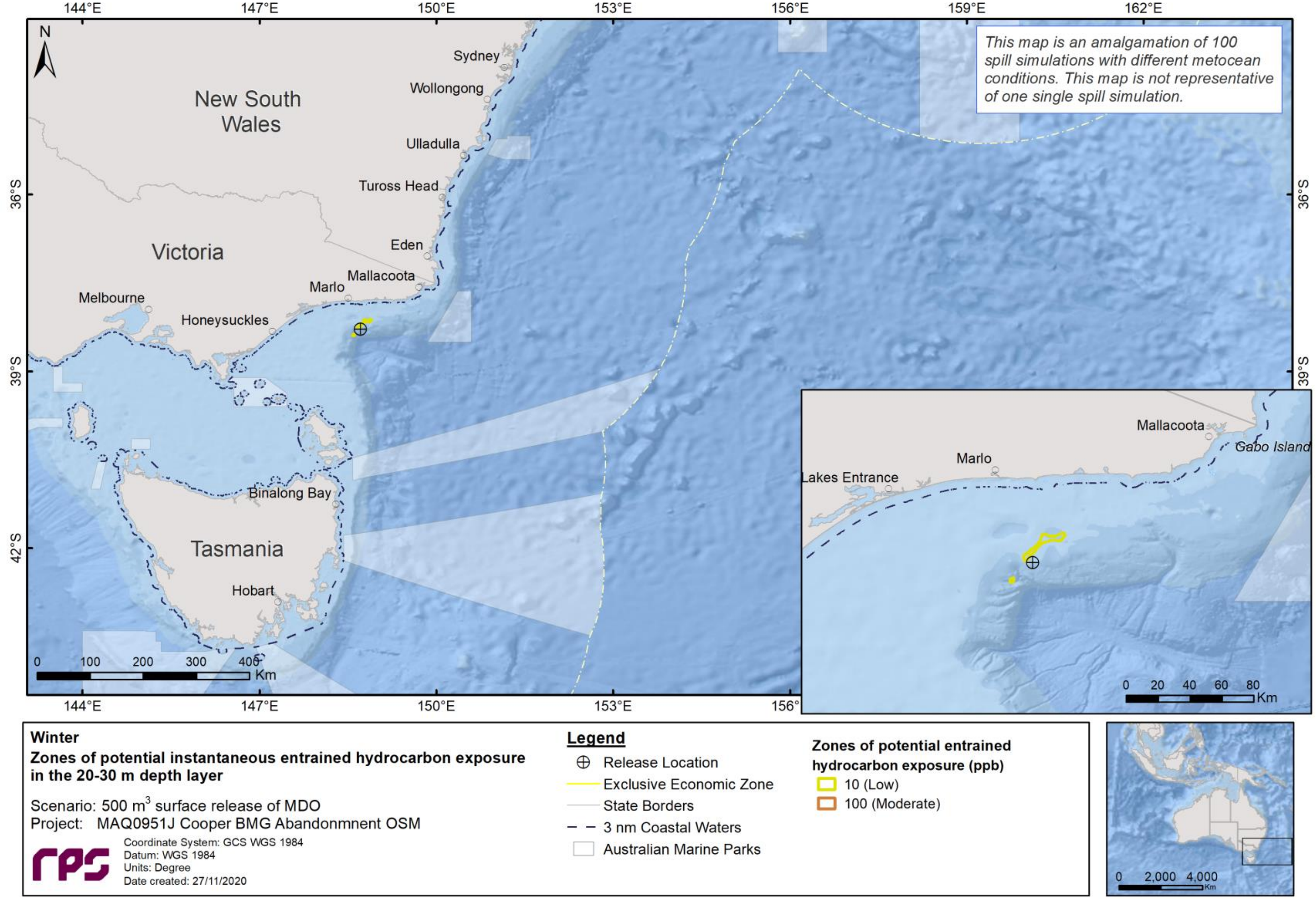


Figure 9-20 Zones of potential instantaneous entrained hydrocarbon exposure at 20-30 m below the sea surface in the event of a 500 m^3 surface release of MDO at the M2A well location over 5 hours, tracked for 30 days. The results were calculated from 100 spill trajectories simulated during winter (May to September) wind and current conditions.