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Spartan Development Environment Plan Addendum

PROJECT / FACILITY	Varanus Island Hub
REVIEW INTERVAL (MONTHS)	No Review Required
SAFETY CRITICAL DOCUMENT	NO

Rev	Owner	Reviewer/s *Managerial/Technical/Site*	Approver
	Manager - Integrated Projects	Environmental Approvals and Compliance Team Lead	Manager – Offshore Drilling and Completions
0	24/1/22		

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Rev	Rev Date	Author / Editor	Amendment
A	26/11/2021	CDM Smith	Draft for Santos review
B	10/01/2022	CDM Smith	Draft for Santos Review
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1.1 EP Addendum Summary

Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E)R 2009) Requirements
Regulation 11(3)
+ Within 10 days after receiving notice that the Regulator has accepted an Environment Plan (EP) (whether in full, in part or subject to limitations or conditions), the titleholder must submit a summary of the accepted plan to the Regulator for public disclosure.
Regulation 11(4)
+ The summary: (a) must include the following material from the environment plan: (i) the location of the activity; (ii) a description of the receiving environment; (iii) a description of the activity; (iv) details of environmental impacts and risks; (v) a summary of the control measures for the activity; (vi) a summary of the arrangements for ongoing monitoring of the titleholder's environmental performance; (vii) a summary of the response arrangements in the oil pollution emergency plan; (viii) details of consultation already undertaken, and plans for ongoing consultation; and (ix) details of the titleholder's nominated liaison person for the activity. (b) must be to the satisfaction of the Regulator.

This Spartan Development EP Addendum Summary has been prepared from material provided in the EP. The summary consists of the following as required by Regulation 11(4):

EP Summary Material Requirement	Relevant Section of EP containing EP Summary Material
The location of the activity	**Section 2.1**
A description of the receiving environment	**Section 3 and Appendix C**
A description of the activity	**Section 2**
Details of the environmental impacts and risks	**Sections 6 and 7**
The control measures for the activity	**Sections 6 and 7**
The arrangements for ongoing monitoring of the titleholder's environmental performance	**Section 8**
Response arrangements in the oil pollution emergency plan	**Sections 6.9, 7.5, 7.6 and 7.7** **See Oil Pollution Emergency Plan (OPEP)**
Consultation already undertaken and plans for ongoing consultation	**Section 4**
Details of the titleholders nominated liaison person for the activity	**Section 1.5.2**

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1.2 Activity Overview

Santos Ltd (Santos) proposes to develop the Spartan discovery, located in Commonwealth waters, approximately 125 km north-west of Karratha. The Spartan Development activities consist of drilling the Spartan Development well, installation of subsea equipment and pre-commissioning activities to connect the new well to the existing John Brookes Wellhead Platform (WHP) via a new flexible subsea flowline. Commissioning of the Spartan Development and ongoing operation of the well and flowline through the John Brookes WHP will be undertaken in accordance with the in-force Varanus Island Hub Operations Commonwealth Waters Environment Plan (EA-60-RI-10003) (VI Hub Operations EP).

1.3 Purpose of this Addendum to the Environment Plan

OPGGS(E)R 2009 Requirements
Regulation 17(5)
A titleholder must submit to the Regulator a proposed revision of the environment plan for an activity before the commencement of any significant modification or new stage of the activity that is not provided for in the environment plan as currently in force.

This addendum to the VI Hub Operations EP, together with the revision to the VI Hub Operations EP (EA-66-RI-10003.6), is made in accordance with Regulation 17 (5) of the OPGGS (E) Regulations (2009).

This Addendum to the VI Hub Operations EP details the environmental impacts and risks associated with the Spartan Development drilling, installation and pre-commissioning activities and demonstrates how these will be reduced to as low as reasonably practicable (ALARP) and to an acceptable level. This Addendum provides an implementation strategy that will be used to measure and report on environmental performance during planned activities and unplanned events to ensure impacts and risks are continuously reduced to ALARP and are at an acceptable level. The environmental management of the activity described in this Addendum complies with the Santos Environmental Management Policy and with all relevant legislation. This Addendum documents and considers all relevant stakeholder consultation performed during the planning of the activity.

1.4 Environment plan validity

This EP Addendum remains valid from NOPSEMA acceptance for a period of five years, or until NOPSEMA has accepted an end-of-activity notification under Regulation 25A, or until Santos revises this EP Addendum in the event a significant change to the activity or level of impact or risk occurs as required under Sub regulation 17(10), 17(5), 17(6) and 17(7). This period provides an appropriate window for safely and effectively executing the Spartan Development.

Santos may revise the EP Addendum, using the Management of Change (MoC) Process described in **Section 8.11**. Any changes made under this process will not affect the validity of this EP.

1.5 Titleholder

1.5.1 Details of Titleholder

OPGGS(E)R 2009 Requirements
Regulation 15. Details of titleholder and liaison person
15(1) The environment plan must include the following details for the titleholder: a) name b) business address c) telephone number (if any) d) fax number (if any) e) email address (if any) f) if the titleholder is a body corporate that has an ACN (within the meaning of the Corporations Act 2001)—ACN. 15(2) The environment plan must also include the following details for the titleholder's nominated liaison person: a) name b) business address c) telephone number (if any) d) fax number (if any) e) email address (if any).

Title holder details for the Spartan Development (WA-63-L, WA-11-PL, WA-214-P, WA-29-L and WA-30-L) are provided in **Table 1-1**.

Table 1-1: Titleholder Details for All Titles Under this EP Addendum

Title	Pipeline Licence	Titleholder (Operators in bold)	ACN	Interest (%)	Address
WA-29-L	WA-11-PL	**Santos WA Northwest Pty Ltd**	009 140 854	55	Business Address: Level 7, 100 St Georges Terrace, Perth, Western Australia, 6000 Telephone number: (08) 6218 7100 Fax number: (08) 6218 7200 Email address: offshore.environment.admin@santos.com
		Santos (BOL) Pty Ltd	000 670 575	45	Business Address: Level 7, 100 St Georges Terrace, Perth, Western Australia, 6000 Telephone number: (08) 6218 7100 Fax number: (08) 6218 7200 Email address: want@santos.com

WA-63-L	WA-30-PL	**Santos WA Southwest Pty Ltd**	050 611 688	55	Business Address: Level 7, 100 St Georges Terrace, Perth, Western Australia, 6000 Telephone number: (08) 6218 7100 Fax number: (08) 6218 7200 Email address: offshore.environment.admin@santos.com
		Santos (BOL) Pty Ltd	000 670 575	45	Business Address: Level 7, 100 St Georges Terrace, Perth, Western Australia, 6000 Telephone number: (08) 6218 7100 Fax number: (08) 6218 7200 Email address: want@santos.com
WA-214-P		**Santos WA Northwest Pty Ltd**	009 140 854	55	Business Address: Level 7, 100 St Georges Terrace, Perth, Western Australia, 6000 Telephone number: (08) 6218 7100 Fax number: (08) 6218 7200 Email address: offshore.environment.admin@santos.com
		Santos (BOL) Pty Ltd	000 670 575	45	Business Address: Level 7, 100 St Georges Terrace, Perth, Western Australia, 6000 Telephone number: (08) 6218 7100 Fax number: (08) 6218 7200 Email address: want@santos.com

1.5.2 Details of Nominated Liaison Person

Details for Santos' nominated liaison person for the activities covered by this Addendum are as follows:

Name: Dawn MacInnes (Environmental Approvals and Compliance Team Lead)

Business address: Level 7, 100 St Georges Terrace, Perth, WA 6000

Telephone number: (08) 6218 7100

Email address: offshore.environment.admin@santos.com

1.6 Environmental Management Framework

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment
Description of the activity 13(4) The environment plan must: (a) describe the requirements, including legislative requirements, that apply to the activity and are relevant to the environmental management of the activity; and (b) demonstrate how those requirements will be met.
Regulation 16(a). Other information in the environment plan
The environment plan must contain the following: (a) a statement of the titleholder's corporate environmental policy;

1.6.1 Santos Environment, Health and Safety Policy

The activity will be conducted in accordance with the Santos Environment, Health and Safety Policy presented in **Appendix A** and relevant legislative requirements presented in **Appendix B**, inclusive of the relevant EP Addendum sections where the legislation may prescribe or control how an activity is undertaken.

Sections 6, 7 and 8 reflect Santos' Environment, Health and Safety Policy, detailing and evaluating impacts and risks from planned and unplanned events and providing control measures with set performance outcomes, standards, and measurement criteria to ensure environmental performance is achieved.

1.6.2 Relevant Environmental Legislation

Australia is a signatory to numerous international conventions and agreements that obligate the Commonwealth government to prevent pollution and protect specified habitats, flora and fauna. Those that are relevant to the activities are detailed in **Appendix B**.

2 Activity Description

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment.
Description of the Activity: 13 (1) The environment plan must contain a comprehensive description of the Activity including the following: a) the location or locations of the Activity; b) general details of the construction and layout of any facility; c) an outline of the operational details of the Activity (for example, seismic surveys, exploration drilling or production) and proposed timetables; and d) any additional information relevant to consideration of environmental impacts and risks of the Activity. Note: An environment plan will not be capable of being accepted by the Regulator if an Activity or part of the Activity, other than arrangements for environmental monitoring or for responding to an emergency, will be undertaken in any part of a declared World Heritage property – see regulation 10A.

2.1 Activity Location

2.1.1 Well location

The Spartan Development activities are located within production licences WA-63-L, WA-29-L, permit area WA-214-P and pipeline licences WA-11-PL and WA-30-PL, within Commonwealth waters, 125 km north-west of Karratha. Water depths in the operational areas ranges from approximately 48 m to 60 m.

The Spartan Development well will be drilled in production licence WA-63-L, with a Petroleum Safety Zone (PSZ) of 500 m radius established around the well location. The coordinates of the Spartan well are shown in **Table 2-1**. Subsea installation activities will take place in production licences WA-63-L, WA-29-L, permit area WA-214-P and pipeline licences WA-11-PL and WA-30-PL. Project activity locations are shown in **Figure 2-1** .

Table 2-1: Spartan Development Location

Well name	Spartan	
Location	North West Shelf, WA, Australia	
Permit	WA-63-L (Commonwealth waters)	
Planned Well Location (Datum: GDA 94 Zone 50)	Lat: 20° 32' 4.47" S Long: 115° 14' 52.90" E	
Operational area (Datum: GDA 94 Zone 50)	Point 1	Lat: 20° 55' 26.40" S Long: 115° 22' 88.41" E
	Point 2	Lat: 20° 51' 65.10" S Long: 115° 22' 88.41" E

	Point 3	Lat: 20° 51' 65.10" S Long: 115° 26' 72.14" E
	Point 4	Lat: 20° 55' 26.40" S Long: 115° 26' 72.14" E
	John Brookes Wellhead Platform (WHP)	Lat: 20° 26' 50" S Long: 115° 07' 13" E 500 m buffer around WHP
	Spartan flexible flowline route	Linear from Spartan well location to JB WHP, within 250 m corridor.

2.1.2 Operational Area

The operational area is the area within which all planned activities will occur. The operational area for this EP Addendum is:

+ A 2 km x 2 km square around the planned well location to allow for respudding contingency;
+ a 250 m corridor around the Spartan flexible flowline lay route; and
+ 500 m radius around the John Brookes (JB) Wellhead Platform (WHP).

The operational area is shown in **Figure 2-1**.

2.2 Activity Duration and Timings

The Spartan Development activities are planned to commence in Q3 2022. Drilling activities are expected to take approximately 42 days and subsea installation and pre-commissioning activities approximately 25 days (**Table 2-2**). Timing and duration of activities are subject to change due to project requirements, MODU/vessel availability, unforeseen circumstances and weather. The EP Addendum has risk-assessed all activities throughout the year (i.e. all seasons) to provide operational flexibility.

Table 2-2: Activity timings

Activity	Approximate Timing
Drilling and completion	Commence Q3 2022, 42 days duration
Subsea installation and pre-commissioning	Commence Q3/Q4 2022, 25 days duration
Topsides activities and commissioning (To be undertaken under the VI Hub Operations EP)	Commence Q4 2021

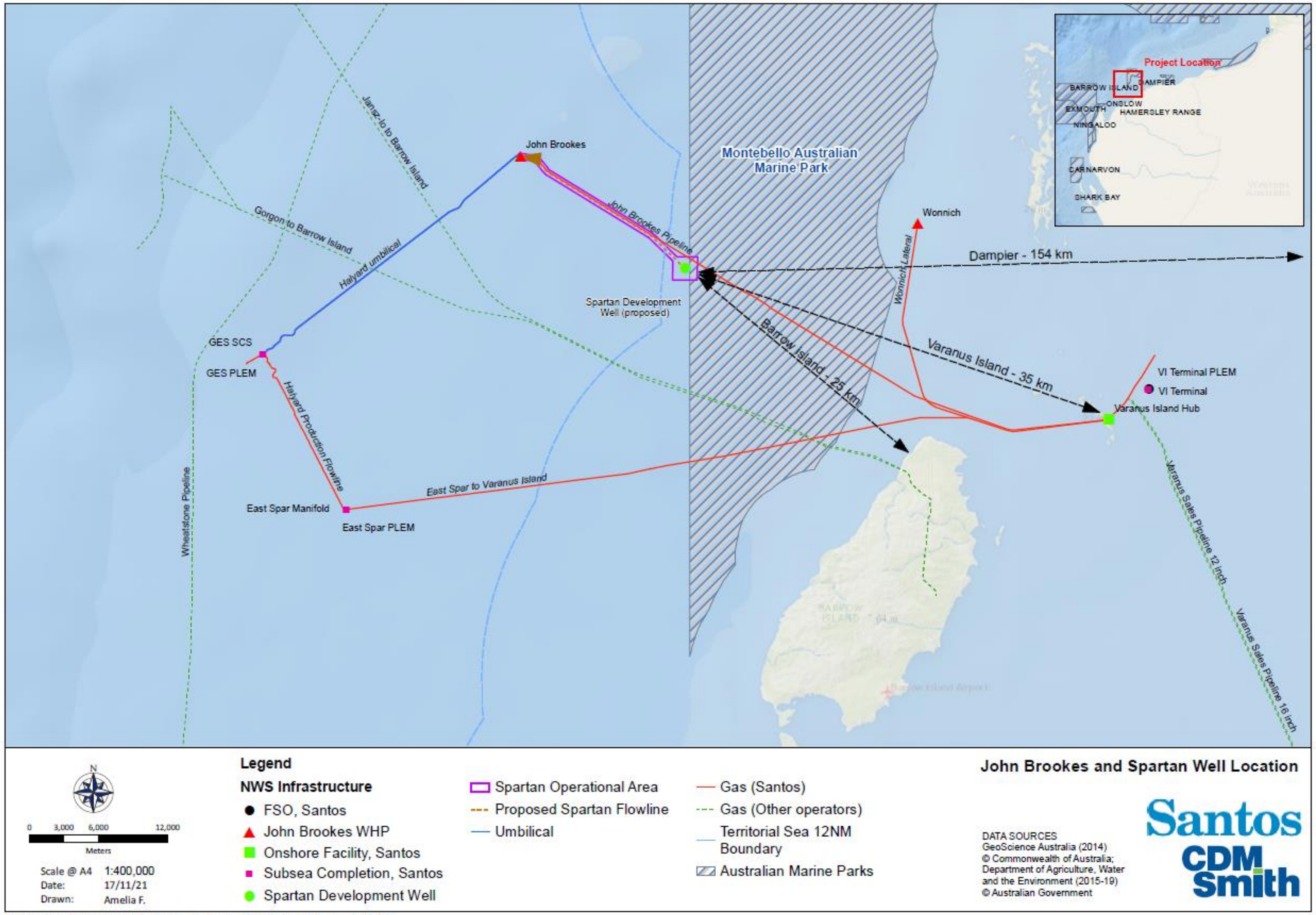

Figure 2-1: Location of Spartan Development operational area

2.3 Project Vessels

Several vessel types will be required to complete the Spartan Development activities and may include:

- Jack-up MODU;
- Installation Support Vessel;
- Support vessels including but not limited to:
  - Activity support vessels for transportation of hardware and infrastructure from port to the MODU and installation vessels, and for general re-supply and support for the MODU and installation vessels.

All project vessels will use diesel fuel for power generation. Project vessels are discussed in further detail below. The assessment of project vessel environmental impacts and risks for the activities associated with the Spartan Development activities are provided in Section **6** and Section **7**.

2.3.1 Mobile Offshore Drilling Unit (MODU)

The Spartan well will be drilled with a jack-up MODU. The MODU will be towed into position at the well location by one or more support vessels.

A MODU is a vessel capable of engaging in drilling or well intervention operations.

The MODU is fitted with various equipment to support operations including:

- power generation systems;
- fuel oil storage;
- cooling water and freshwater systems;
- drainage, effluent and waste systems; and
- solids control equipment used in drilling to separate the solids and drilling fluids (this may include shale shakers, centrifuging systems and cuttings driers).

MODU refuelling in the operational area may occur during the activity.

Whilst on position, a 500 m PSZ will be maintained around the MODU at all times, as required under the OPGGS Act.

2.3.2 Installation Support Vessel (ISV)

The Spartan subsea installation activities will be carried out by a manned ISV. The ISV will be a dynamic positioning (DP) Class 2 or 3 vessel with a built-in crane. The specification for the ISV (Sapura Constructor) is provided in **Table 2-3**.

The ISV will be fitted with various system to support operations including:

- power generation systems;
- fuel oil storage;
- cooling water and freshwater systems; and
- drainage, effluent and waste systems.

Whilst undertaking the activity, 500 m safety zone will be established around the ISV.

No anchoring will be required during the activity. ISV refuelling at sea may occur during the activity.

Table 2-3: ISV specifications

Component	Specification
Vessel type	Subsea Operational Support Vessel
Overall length	117.35 m
Maximum draught	7.15 m
Deadweight	6,400 tonnes
Crane capacity	Main crane: 250 Te
ROVs	2 x work class ROVs
Deck space	1, 300 m^2
Accommodation	120 POB
Fuel oil	1,006 m^3
Potable water	1,253 m^3

2.3.3 Support Vessels

Typically, two support vessels will be required to assist the MODU, however this EP Addendum accounts for up to four (used for towing, equipment and material transfers, standby operations etc.). The support vessels are yet to be confirmed but are usually offshore multi-purpose or anchor handling vessels. These support vessels may conduct the following activities:

+ Towing the MODU;
+ Holding MODU position temporarily over the drilling location while pinning rig;
+ Running and recovering vessel standby moorings, consisting of an anchor and mooring chain; however, no anchoring will occur in the operational area during the activity;
+ Standing-by at close proximity to the MODU during critical operations;
+ Standing-by outside the 500m exclusion zone from the MODU;
+ Delivering food, potable water, drill water, fuel, dry bulk, drilling fluids, chemicals, equipment and other supplies to the MODU from shore; and
+ Delivering dry bulk, chemicals, equipment and waste from the MODU to shore.

Equipment and material transfers may include, but are not limited to, crew supplies, hydrocarbons (diesel, engine oil, hydraulic fluids, grease etc.), bulk drilling products, MODU and drilling equipment/parts and waste. MODU cranes will be used for transfers between the MODU and support vessels.

Bulk products will also be transferred via hose from the support vessels and MODU. Such products include drilling fluids and solids, completion fluids, brine, drilling water, cement and fuel oil (diesel).

At least one support vessel will remain on standby to the MODU within the distance defined in the Safety Case (nominally 3 nautical miles).

For the subsea installation and pre-commissioning activities, the ISV may be supported by support vessels used to transport and transfer equipment and infrastructure to the ISV, as well as general support vessels for re-supply.

Support vessels will not refuel or anchor within the Operational Area.

2.4 Other Support

2.4.1 Remotely Operated Vehicles

The MODU, ISV or support vessels may be equipped with a work class remotely operated vehicle (ROV). A ROV is a tethered underwater vehicle deployed from a vessel or from the MODU. ROVs are unoccupied, highly manoeuvrable and operated by a crew aboard a vessel or MODU to undertake activities required throughout drilling and installation activities. ROVs may be fitted with hydraulically actuated tooling to complete planned activities.

2.4.2 Helicopters

Helicopters will be used primarily for crew change, medi-vac and occasionally equipment and material transfers. Helicopter flights will occur several times a week dependent on the progress of the planned activities and logistical constraints.

2.5 Drilling Activities

2.5.1 Drilling and Completion Phases

The following high-level phases describe the planned drilling activity:

+ Move MODU to location, position and pin MODU, pre-load and jack-up to operational elevation;
+ Drill top hole section riserless;
+ Run and cement conductor casing;
+ Drill surface hole section riserless;
+ Run and cement surface casing;
+ Install high-pressure (HP) riser and blowout preventer (BOP);
+ Drill intermediate hole section;
+ Run and cement production casing;
+ Drill reservoir hole section;
+ Run and cement production liner;
+ Perform wellbore clean-out and displace well to completion fluid;
+ Run cased hole wireline evaluation program;
+ Run upper completion;
+ Install the Xmas Tree;
+ Perforate the well and perform the clean-up flow; and
+ Suspend the well ready for commissioning activities.

2.5.2 Pre-MODU Positioning ROV Survey

Prior to positioning the MODU legs (spud-cans) on the seabed at the well location, a survey may be undertaken using an ROV (ROV and/or side-scan sonar) to understand the seabed conditions and minimise any potential risks caused by subsea hazards (e.g. seabed structures). This may be undertaken by a vessel in advance of the MODU arriving.

2.5.3 Move In and Rig Up

The MODU will be moved into position using one or more support vessels. The legs are jacked up during rig positioning to avoid contact with the seabed. Once at the desired location and with the MODU stationary, the legs are lowered to be fully in contact with the seabed and the MODU raises itself approximately 20m above the sea surface and the cantilever will be skidded out.

2.5.4 Well Design

The well design includes drilling top hole and surface hole sections riserless to set the conductor and surface casing respectively. The HP riser and BOP will then be installed and tested before any subsequent drilling is undertaken.

The intermediate hole section is then drilled to accommodate the production casing. Following this is the reservoir hole section, which will be drilled to a total depth (TD) of approximately 2,640 m MDRT (measured depth from rotary table), and which accommodates the production liner.

The upper completion is set inside the production casing with perforating guns set adjacent to the reservoir target inside the production liner.

2.5.5 Drilling and Completion Fluids

Only water-based drilling fluids will be used for the well.

The top hole section will be drilled using seawater with pre-hydrated gel (PHG) sweeps to clean the hole. This fluid will exit the well at the seabed and be discharged to the sea.

The surface hole section will also be drilled using seawater with PHG sweeps to clean the hole. This fluid will exit the well at the top of the conductor and be discharged to the sea.

Once surface casing, wellhead, HP riser and BOP are installed, a closed circulating system will be established. This facilitates the use of a weighted brine/shale-inhibitive (e.g. KCL/Kla-Stop) water-based mud (WBM) during the intermediate hole section, and a weighted and reservoir optimised WBM (e.g. RDIF/Flo-Pro) for the reservoir hole section. The WBM will be discharged from the MODU at sea surface, either on cuttings or from surface storage tanks/mud pits when no longer required (**Section 6.7**).

After the production liner is set, and prior to running the upper completion, the well will be fully displaced to a weighted brine completion fluid. Then, after the upper completion is run to depth, but before the production packer is set, a hydrocarbon-based underbalance fluid (e.g. Saraline base oil) will be circulated into the well. The underbalance fluid is flowed back to surface during the clean-up flow and is subsequently burned. The brine will be discharged from the MODU at sea surface from surface storage tanks/mud pits when no longer required.

Aqueous-based lost circulation material (LCM) will be available to pump should downhole losses occur.

Estimated volumes of drillings and completions fluids discharged to the marine environment are provided in **Table 2-4**.

2.5.6 Drill Cuttings

Similar to drilling fluids, cuttings for the top hole section will exit the wellbore at the seabed.

Cuttings from the surface hole section will exit the well at the top of the conductor and be discharged to the sea.

Cuttings for the remaining hole sections to TD will be discharged at sea level after being removed from the WBM system through the MODU's solids control equipment. The solids control system comprises shale shakers and, if required to remove ultra-fine solids in the WBM, centrifuges. Estimated cuttings volumes are provided in **Table 2-4**.

Table 2-4: Estimated discharges of drilling fluids and drill cuttings

Parameter	Estimated Discharge Volume	Notes
Planned WBM drilling		
Cuttings discharge		
Volume of cuttings discharged to seabed (riserless tophole sections)	300 - 350 m^3	Estimate based on riserless 36" and 17.5" tophole sections and 1.50x washout factor.
Volume of cuttings returned via riser and discharged at sea surface	100 - 150 m^3	Estimate range based on 12.25" and 8.5" sections with 1.25x washout factor.
Drilling fluid discharges		
Volume of seawater/gel sweeps/PAD mud discharged at seabed (riserless tophole sections)	2500 - 3000 m^3	Estimate based on drilling riserless 36" and 17.5" tophole sections.
Volume of WBM returned via riser and discharged at sea surface	1250 - 1500 m^3	Estimate range based on drilling 12.25" and 8.5" sections.
Volume of completions brine discharged (saturated NaCl)	250 - 300 m^3	Estimate includes 2 x well volume.

2.5.7 Cement Operations

Primary casing cement jobs are planned for the conductor, surface casing, production casing and production liner strings. These cement jobs will provide a structural base for the well and are critical to well integrity.

Any cement returns during the conductor cement job would be to seabed. No cement returns to surface are planned for subsequent casing cement jobs; however, cement may be circulated to surface during drilling operations, and this will be discharged to the sea at the sea surface.

During cementing operations, surface cementing equipment and lines will need to be flushed, washed and cleaned with water to prevent hard setting. The residual cement and wash water will be discharged to sea at the sea surface after each cement job.

Cement spacer in well returns and residual surface tank volumes will also be discharged to sea at the sea surface during cementing operations.

Estimated volumes of cement discharges, including contingencies for failed cement jobs, are provided in **Table 2-5**.

Table 2-5: Estimated discharge volumes of cement during drilling

Parameter	Estimated Discharge Volume	Notes
Cement discharges		
Volume of cement (wet) discharged to seabed	Minor planned discharges. Up to 260 m^3 contingency	There will be planned cement discharges at seabed during cementing of the conductor and surface casings of approximately 30 m^3. However, contingency discharges may be required in the event that a cement job does not meet technical and safety standards. Recirculated volumes of up to 260 m^3 discharged as cement slurry at seabed (based on a recirculated 13 3/8" cement job) or volumes up to 150 m^3 at sea surface (based on recirculated 9 5/8" cement job).

2.5.8 Well Evaluation

Downhole formation evaluation will be performed via logging while drilling and wireline logging equipment. Radioactive sources used in downhole tools for logging purposes will be managed in accordance with the MODU Safety Case so that occupational health and safety risks to people are managed to an acceptable and ALARP level.

2.5.9 Xmas Tree installation

The Xmas Tree will be installed on top of the subsea wellhead, which requires the removal of the HP riser and BOP. Prior to removing the HP riser and BOP, temporary barriers will be installed in the well. After the Xmas Tree is installed and tested, the temporary barriers can be removed.

2.5.10 Well Clean-up

After the upper completion is set and well integrity confirmed, a clean-up flow will be performed. This consists of perforating the reservoir target and flowing the well back to a temporary well test package on the MODU, which includes flare booms designed for cleanly burning oil and gas. All the fluids recovered from the well will be either burned or, if not possible to burn (e.g. large volumes of completion fluid and/or formation water), discharged overboard the MODU after being cleaned by water treatment equipment.

2.5.11 Well Suspension

Upon completion of drilling, completion and clean-up flow activities, the well will be suspended at the Xmas Tree.

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2.5.12 Contingency Activities

2.5.12.1 Well re-Spud and Side-track

Should drilling difficulties be experienced and the well cannot progress, contingency options exist to recover and progress drilling operations. This includes, but is not limited to:

+ Cementing up the existing hole above the trouble zone and side-tracking the well around the problem; and
+ Plugging and abandoning the existing wellbore and re-drilling the well from surface (re-spud).

These activities would require additional time on location, an increase in the excavated rock volume (i.e. cuttings) and an increase in the drilling fluids and cement consumed compared to the planned activity. These contingency operations would only be exercised should drilling difficulties be experienced.

Any re-spud and/or side-track are not considered new stages of the petroleum activity. If required, a re-spud would be conducted within the 1km x 1km geophysical site survey area.

2.5.12.2 Cyclone Response

Standard well suspension equipment will be available offshore to safely install temporary barriers should the MODU require evacuation for any reason (e.g. due to a cyclone).

2.5.13 End of Activity

The drilling activity ends once the well has been suspended and the MODU and all support vessels have departed the operational area. The subsea wellhead will remain at the well location, with the Xmas Tree installed thereon.

2.6 Subsea Installation and Pre-commissioning Activities

The subsea installation and pre-commissioning activities will include the installation and pre-commissioning of the subsea infrastructure listed in **Table 2-6**.

Table 2-6: Spartan subsea installation infrastructure

Infrastructure	Description	Approximate Dimensions
Production Flexible flowline	8" ID production gas flowline between the Spartan XT and JB WHP filled with treated seawater.	17 km in length
Umbilical	Transqaua HT2, and MEG/water (80/20) filled umbilical between Spartan XT and JB WHP	17 km
Electrical flying leads (EFLs)	2 x EFLs installed at the Spartan Drill Centre to connect the cobra head to the XT.	7.7m
Mattresses	Approximate numbers only: + 3 x Umbilical pre-lay mattresses	Each mattress is 6 m (L) x 3 m (W) and weighs approximately 7.5 te.

Infrastructure	Description	Approximate Dimensions
	+ 2 x GEP crossing stabilisation mattresses + 42 x umbilical stabilisation mattresses + 84 x Post-lay flowline stabilisation mattresses + 16 x dropped object protection mattresses	
Grout bags	Contingency of 20 x bulka bags.	1 m^3 each

2.7 Site Surveys

A pre-lay seabed survey will be executed along both the production flexible flowline route and the umbilical route to:

+ Ensure the seabed is suitable for installation
+ Survey existing export pipeline for umbilical crossing (umbilical route only)
+ Check for debris and natural features (i.e. rocks or spans) and confirm clearance from existing infrastructure.

If required, the Work Class Remote Operated Vehicle (ROV) may use water jetting to remove marine growth and/or cuttings on the existing subsea infrastructure, or a ROV dredge to uncover buried equipment on the seabed.

Ultra-short baseline (USBL) transponders will be used for crane and ROV positioning.

On completion of the installation and pre-commissioning activities, an as-built survey will be conducted using a WROV.

2.8 Installation of Umbilical Pre-lay Mattresses

The Spartan umbilical will make one crossing of the existing JB WHP to VI export pipeline. Prior to umbilical installation, concrete mattresses will be installed either side and over the existing export pipeline. Mattresses will be installed using the ISV’s onboard crane and an installation frame. An ROV will be used to guide the final position and orientation of the mattresses and release the mattresses from the installation frame. Up to three pre-lay mattresses are expected to be installed. Mattress dimensions are provided in **Table 2-6**.

2.9 J-tube Pull-in

The Spartan flexible production flowline and umbilical will both be pulled through and hung-off through existing j-tubes at the JB WHP. Localised cleaning of the j-tubes using water jetting or mechanical tools may be required. During the flowline and umbilical installation, a j-tube seal is inserted onto the product at the required location and pulled into the base of each j-tube. The seawater in each j-tubes may then be dosed with a chemical inhibitor to prevent corrosion.

2.10 Umbilical and Electrical Flying Leads Installation

The Spartan umbilical will be installed using a horizontal lay system (HLS) on the ISV, with the umbilical reel powered by a reel drive system, and assisted by the vessel's auxiliary/main cranes. The umbilical will first be pulled in through an existing j-tube slot at the JB WHP and hung-off (Section 1.9). The umbilical is then laid on the seafloor by the ISV in one length to the Spartan Drill Centre. Once at the Spartan Drill Centre, using an ROV, the umbilical is connected to the Spartan XT by a cobrahead complete with Multi Quick Connect system.

The umbilical cores will be pressurised with 80/20 MEG/Water and hydraulic fluid (Transaqua HT2 or SP) prior to loadout and installation, with the pressure monitored throughout installation. During disconnection of the MQC cover subsea and connection of the umbilical cobra-head to the XT, a small amount of hydraulic fluid (Transaqua HT2) and MEG/water may be released to the environment (< 10 L).

Electrical Flying Leads (EFLs) will be installed at the Spartan Drill Centre location, to connect the cobra-head to the XT. EFL's will be installed from the ISV using the vessel's auxiliary/main cranes and an installation frame. An ROV will install the EFL's into position, release the EFLs from the installation frame and preform the connections.

Subsea ROV baskets shall be used as required to assist with handling of equipment from the ISV deck to subsea as required. A typical subsea basket has a footprint of 3m x 3m approximately.

2.11 Installation of Flexible Production Flowline

The 8 inch internal diameter (ID) Spartan flexible production flowline will be installed using a horizontal lay system (HLS) on the ISV, with reels powered by a reel drive system. To initiate installation of the flexible flowline, the flowline will first be pulled in through an existing j-tube slot at the JB WHP and hung-off (**Section 2.9**). The flexible flowline will then be installed in six lengths from the JB WHP platform to the Spartan Drill Centre where it will be connected to the XT by ROV, using a hydraulically actuated connector. Flowline lengths for each segment are approximately 2.8 km long per reel.

The flexible flowline sections will be installed filled with treated seawater (Hydrosure 0-3670R @ 500 ppm and Fluorscent Dye) on the deck of the ISV. Midline connections at flowline reel change-over will be performed on the hang-off platform over the side of the ISV. During the removal of pull-heads on the end of each flowline section, a release of approximately 0.5 m^3 of treated seawater will be released for each section (total of approximately 3 m^3 for the entire flowline). Applicable subsea components such as anodes and bend restrictors will be installed on the ISV prior to installation. When the flowline end is laid down from the ISV at the Xmas tree, assuming sealed topsides, there will be a small release of treated seawater of approximately 0.5 m^3. However, if the topside vent is open, approximately 2 m^3 of treated seawater could be released.

In order to tie in the flowline to the XT, the production system pressure cap shall be removed from the XT by ROV. Once removed the preservation fluid (D&C to confirm) in the XT between the cap and the Production Isolation Valve shall co-mingle with seawater. Approximately 10 L of the preservation fluid could be release subsea prior to installing the diverless connector onto the XT. Prior to landing the hydraulically actuated connector, a preservation chemical stick shall be inserted by ROV into the XT consisting of biocide, oxygen scavenger and dye.

2.12 Installation of Post-Lay Stabilisation and Protection

Stabilisation will be required to ensure that the flexible flowline, umbilical and EFLs remain at their installed locations. Dropped object protection is also required for the flexible flowline and umbilical within the vicinity of the JB WHP. Mattresses will be installed using the ISV's onboard crane and an installation frame. An ROV will be used to guide the final position and orientation of the mattresses and release the mattresses from the installation frame. **Table 2-6** provides the estimated number of mattresses required for each activity, and the estimated seabed footprint.

Grout bags and/or cement bags may also be required for stabilising EFLs and for correcting unacceptable freespans on the EHU and flexible flowline. All the grout bags or cement bags will be lowered to the seabed from the ISV in a steel work basket (approx. 2m x 2m), positioned temporarily on the seabed, and the ROV will fly each bag from the basket onto the target. The basket will be recovered after installation. **Table 2-6** provides the estimated number of bags required for each activity, and the estimated seabed footprint.

2.13 Pre-commissioning

Production system leak testing/pressure testing of the flexible production flowline will be completed between the production wing valve (PWV) on the Spartan XT and the blind flange at the end of the flexible riser (top of the production j-tube on the JB WHP).

The excess fluid used to pressurize the flexible flowline for the leak test shall be released to the environment following the leak test. Approximately 20 m^3 of treated seawater (Hydrosure 0-3670R @ 500 ppm and Fluorscent Dye) may be released if first test is unsuccessful. Approximately 100 L of treated seawater may be release during deployment, disconnection and recovery of the hot stab and downline assembly used for the leak test.

The Spartan umbilical will be installed with a nominal retained pressure in the individual lines between the umbilical termination head (UTH) and the umbilical pull-head at the top of the j-tube on the JB WHP. During connection, negligible amounts (approximately 1 L) of hydraulic fluid and MEG may be released subsea. Once connected, there are no expected leaks from the umbilical during pre-commissioning.

2.13.1 Cold-commissioning

Prior to introduction of hydrocarbons into the system, the controls system shall be tested to ensure it has been correctly installed. Once the subsea system is fully installed and leak tested, the valves on the XT shall be functioned in a pre-determined sequence to demonstrate operability. During the valve operations (closing) hydraulic fluid shall be released from the SCM vent line due to the open loop system design. Approximately 2-5 L of hydraulic fluid is released per valve, resulting in a total of 25 L of hydraulic fluid released during cold commissioning.

2.14 John Brookes WHP Topsides Activities

John Brookes brownfields activities will be performed consistent with the existing operational and maintenance processes and procedures (refer to Sections 2.6 and 2.7 of the VI Hub Operations EP for Commonwealth Waters (EA-60-RI-10003)). Installation and testing of the associated equipment will occur throughout 2022, planned over several one-to-two-week campaigns given that the facility operates in an unmanned manner. Maximum facility POB is 16.

Mobilisation of plant and people will occur using the routine helicopter and supply vessel logistics.

Temporary lighting will be installed on the JB WHP, consistent with Section 6.2 of the VI Hub Operations EP (EA-60-RI-10003).

2.15 Dewatering

The Spartan flexible flowline will be installed filled with chemically treated seawater (refer **Section 2.11**). After installation, leak testing and pressure testing, the flexible flowline will be dewatered using JB production gas, back to the VI facility (volume of approximately 550 m^3). No discharges to the marine environment are expected as a result of flexible flowline dewatering. The treatment and disposal of the treated seawater is covered by the existing in-force VI HUB Operations EP (State)(EA-60-RI-00186) and is therefore, outside the scope of this EP.

2.16 Chemical Assessment

A risk-based approach to select chemical products ranked under the Offshore Chemical Notification Scheme (OCNS) is applied for those chemicals used and discharged to the marine environment. This scheme lists and ranks all chemicals used in the exploration, exploitation, and associated offshore processing of petroleum on the UK Continental Shelf.

Chemicals are ranked according to their calculated Hazard Quotients (HQ) by the CHARM (Chemical Hazard Assessment and Risk Management) mathematical model, which uses aquatic toxicity, biodegradation and bioaccumulation data. The HQ is converted to a colour banding with Gold and Silver colour bands representing the least environmentally hazardous chemicals. Chemicals not amenable to the CHARM model (i.e. inorganic substances, hydraulic fluids or chemicals used only in pipelines) are assigned an OCNS grouping based on the worst-case ecotoxicity data with Group E and D representing the least hazard potential.

The Santos Operations Chemical Selection, Evaluation and Approval Procedure (EA-91-II-10001) and Santos Drilling Fluid and Chemical Selection in Drilling Activities Procedure (EA-91-II-00007) accept CHARM ranked Gold/Silver, or non-CHARM ranked E/D chemicals for use and discharge without a detailed environmental risk assessment. The same applies to chemicals that are OSPAR Pose Little or No Risk to the Environment (PLONOR) List. The PLONOR Listed, agreed upon by the OSPAR Convention (Convention for the Protection of the Marine Environment of the North-East Atlantic), contains a list of substances that will pose little or no risk to the environment in offshore waters. If chemicals are ranked lower than Gold, Silver, E or D (i.e. CHARM ranked purple, orange, blue or white, or non-CHARM A, B or C ranked chemicals) and no alternatives are available, a risk assessment is conducted providing technical justification for their use, and showing that their use and associated risk is acceptable and ALARP.

As described above, investigation of potential alternative chemicals are completed when chemicals are ranked lower than CHARM Gold, Silver, E or D (i.e. CHARM ranked purple, orange, blue or white, or non-CHARM A, B or C ranked chemicals). There is a preference for chemical options that are CHARM ranked Gold/Silver, or non-CHARM ranked E/D chemicals and / or chemical that have a low aquatic toxicity, are readily biodegradable and do not bioaccumulate (discussed below).

Any chemicals that may be discharged to the marine environment and not OCNS CHARM or non-CHARM ranked are risk assessed using the OCNS CHARM or non-CHARM models. The chemical is assigned a pseudo-ranking based on the available aquatic toxicity, biodegradation and bioaccumulation data (discussed below) and assessed for environmental acceptability for discharge to the marine environment.

2.16.1 Ecotoxicity Assessment

Table 2-7 and Table 2-8 act as guidance in assessing the ecotoxicity of chemicals during the investigation of potential alternatives. Table 2-7 is used by Cefas to group a chemical based on ecotoxicity results, 'A' representing highest toxicity/risk to environment and 'E' lowest. Table 2-8 shows classifications/categories of toxicity against aquatic toxicity results.

Table 2-7: Initial OCNS grouping

Initial grouping	A	B	C	D	E
Result for aquatic-toxicity data (ppm)	<1	≥1-10	>10-100	>100-1,000	>1,000
Result for sediment-toxicity data (ppm)	<10	≥10-100	>100-1,000	>1,000-10,000	>10,000

Note: Aquatic toxicity refers to the *Skeletonema costatum* EC50, *Acartia tonsa* LC50, and *Scophthalmus maximus* (juvenile turbot) LC50 toxicity tests. Sediment toxicity refers to the *Corophium volutator* LC50 test.

Source: Cefas Standard Procedure 2019, OCNS 011 NL Protocol PART 1: Core Elements

Table 2-8: Aquatic Species Toxicity Grouping

Category	Species	LC_{50} and EC_{50} criteria
Category Acute 1 Hazard statement - Very toxic to aquatic life	Fish	LC_{50} (96hr) of ≤1 mg/L
	Crustacea	EC_{50} (48hr) of ≤1 mg/L
	Algae / other aquatic plant species	ErC_{50} (72 or 96hr) of ≤1 mg/L
Category Acute 2 – Hazard statement – Toxic to aquatic life	Fish	LC_{50} (96hr) of >1 mg/L to ≤10 mg/L
	Crustacea	EC_{50} (48hr) of >1 mg/L to ≤10 mg/L
	Algae / other aquatic plant species	ErC_{50} (72 or 96hr) of >1 mg/L to ≤10 mg/L
Category Acute 3 – Hazard statement – Harmful to aquatic life	Fish	LC_{50} (96hr) of >10 mg/L to ≤100 mg/L
	Crustacea	EC_{50} (48hr) of >10 mg/L to ≤100 mg/L
	Algae / other aquatic plant species	ErC_{50} (72 or 96hr) of >10 mg/L to ≤100 mg/L

Source: United Nations (2019) Globally Harmonized System of Classification and Labelling of Chemicals (GHS), Eight Revised Edition

2.16.2 Biodegradation Assessment

The biodegradation of chemicals is assessed using the Cefas biodegradation criteria, which aligns with the categorisation outlined in the United Nations GHS Annex 9 Guidance on Hazards to the Aquatic Environment (2019). The below is used as a guide during the investigation of potential chemical alternatives. Preference is to select readily biodegradable chemicals.

Cefas categorises biodegradation into the following groups:

+ Readily biodegradable: results of >X% biodegradation in 28 days to an OSPAR harmonised offshore chemical notification format (HOCNF) accepted ready biodegradation protocol.
+ Moderately biodegradable: results >20% and <X% to an OSPAR HOCNF accepted ready biodegradation protocol.
+ Poorly biodegradable: results from OSPAR HOCNF accepted ready biodegradation protocol

Where X is equal to:

+ 60% in 28 days in OECD 306, Marine BODIS or any other acceptable marine protocols, or in the absence of valid results for such tests.
+ 60% in 28 days (OECD 301B, 301C, 301D, 301F, Freshwater BODIS) OR
+ 70% in 28 days (OECD 301A, 301E).

2.16.3 Bioaccumulation Assessment

The bioaccumulation of chemicals is assessed using the Cefas bioaccumulation criteria, which aligns with the categorisation outlined in the United Nations GHS Annex 9 Guidance on Hazards to the Aquatic Environment (2019). Preference is to select non bioaccumulative chemicals.

The following guidance is used by Cefas:

+ Non-bioaccumulative/non-bioaccumulating: Log Pow <3, or results from a bioaccumulation test (preferably using Mytilus edulis) demonstrates a satisfactory rate of uptake and depuration, and the molecular mass is ≥700.
+ Bioaccumulative/Bioaccumulates: Log Pow ≥3, or results from a bioaccumulation test (preferably using Mytilus edulis) demonstrates an unsatisfactory rate of uptake and depuration, and the molecular mass is <700.

All chemicals will be selected in accordance with the Santos Operations Chemical Selection, Evaluation and Approval Procedure (EA-91-II-10001) and Santos Drilling Fluid and Chemical Selection in Drilling Activities Procedure (EA-91-II-00007), as applicable.

Santos

3 Description of the Environment

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment.
Description of the environment 13(2) The environment plan must: a) describe the existing environment that may be affected by the activity; and b) include details of the particular relevant values and sensitivities (if any) of that environment. Note: The definition of environment in regulation 4 includes its social, economic and cultural features. 13(3) Without limiting paragraph (2)(b), 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) Commonwealth land within the meaning of that Act.

3.1 Environment that May Be Affected

This section summarises the key physical, biological, socio-economic and cultural characteristics of the existing environment that may be affected by the activity, both from planned and unplanned events associated with the activity. The description of the environment applies to the following areas (**Figure 3-1**):

+ Two operational areas:
  - A drilling operational area within which all the Spartan Development drilling activities will occur
  - A Spartan Development operational area which include all infrastructure and activities associated with the installation and pre-commissioning activities in Commonwealth Waters;
+ The area that may be affected (EMBA).

The EMBA encompasses the full range of environmental receptors that might be contacted by hydrocarbons in the highly unlikely event of a worst-case hydrocarbon spill (from a loss of well control). Most planned and unplanned events associated with the activity may affect the environment up to a few kilometres from the operational areas. A large unplanned hydrocarbon spill would extend substantially beyond this (**Section 7.6**).

3.1.1 Protected Matters Search Tool Reports

Protected Matters Search Tool (PMST) searches were undertaken on the operational areas (with a 20 km buffer to allow for the assessment of potential noise and light impacts) and the EMBA. The PMST searches were completed using a simplified subset of the EMBA coordinates to fit the constraints of the PMST search (the tool only allows ≤ 150 coordinate points), ensuring the EMBA encompasses the full range of environmental receptors that might be contacted by surface and subsurface hydrocarbons at the low exposure level in the highly unlikely event of a worst case oil spill.

On the first page of the PMST report, is a coarse graphic showing the area over which the search has been conducted. However, the granularity of this can make the output look different to the spatial area represented on figures within the EP.

The co-ordinates are also provided within the PMST report to allow for duplication of the search and verification if required. Santos do not have control over the PMST search tool output, but instead have provided the reports and coordinates to ensure transparency.

3.1.2 Determining the environment that may be affected

The EMBA for the Spartan Development activities was determined based on the outputs of stochastic hydrocarbon dispersion and fate modelling worst case spill scenario identified as relevant to the activity (**Section 7.5.1**). Stochastic modelling is created by overlaying hundreds of individual hypothetical oil spill simulations from an oil spill into a single map, with each simulation subject to a different set of metocean conditions drawn from historical records. Stochastic modelling is completed to reduce uncertainty in risk assessment and spill response planning.

The modelling considered four key physical or chemical phases of hydrocarbons that pose differing environmental and socioeconomic risks: surface, entrained, dissolved aromatic and shoreline accumulated hydrocarbons. The modelling used defined hydrocarbon exposure values, as relevant, to identifying an area that might be contacted by hydrocarbons, environment risk assessment and oil spill response planning, for the various hydrocarbon phases. Refer to **Table 3-1** for the exposure values used and to **Section 7.5.4** for further information about the reasons why these exposure values have been selected and how they relate to the risk assessment.

While the EMBA represents the largest possible spatial extent that could be contacted by any of the worst-case spill events modelled, an actual spill event is more accurately represented by only one of the simulations from the stochastic modelling, resulting in a much smaller spatial footprint in the event of an actual spill. Modelling of a single simulation, representative of a single spill event is termed deterministic modelling.

3.1.2.1 Hydrocarbon exposure values

The EMBA is based on stochastic modelling, using low exposure values (**Table 3-1**). The EMBA encompasses the outermost boundary of the overlaid worst-case spatial extent of the four hydrocarbon phases listed above for the surface and subsea credible spill scenarios.

+ The EMBA is defined by the low exposure values.
+ The Moderate Exposure Value Area (MEVA) is defined by the moderate exposure values.
+ The High Exposure Value Area (HEVA) is defined by the high exposure values.

The low exposure values are used as a predictive tool to set the outer boundaries of EMBAs and may not necessarily result in ecologically significant impacts. To inform the evaluation of potential environmental consequences of a hydrocarbon release (impact assessment), modelling is undertaken using higher exposure values (the concentrations at which environmental consequences may result). The higher exposure values are known as ‘moderate’ and ‘high’ are further explained in **Section 7.5.4**.

Applying the same method used to determine the EMBA, spatial areas were derived for moderate and high exposure values (**Figure 3-2**).

A low exposure threshold, which approximates a range of socio-economic effects, is considered to provide a conservative extent of potential impacts. Biological impacts are expected to occur within the moderate and high exposure values which represent a subset of the EMBAs. Refer to **Section 7.6** for further information about the spill trajectory modelling thresholds that have been selected. The MEVA is represented in this section to inform the impact assessment in **Section 7.6**.

Table 3-1: Spartan EMBA hydrocarbon exposure values

Hydrocarbon phase	Exposure Value		
	Low	Moderate	High
Floating (g/m^2)	1	10	50
Shoreline accumulation (g/m^2)	10	100	1,000
Dissolved aromatics (ppb)	10	50	400
Entrained (ppb)	10	100	-

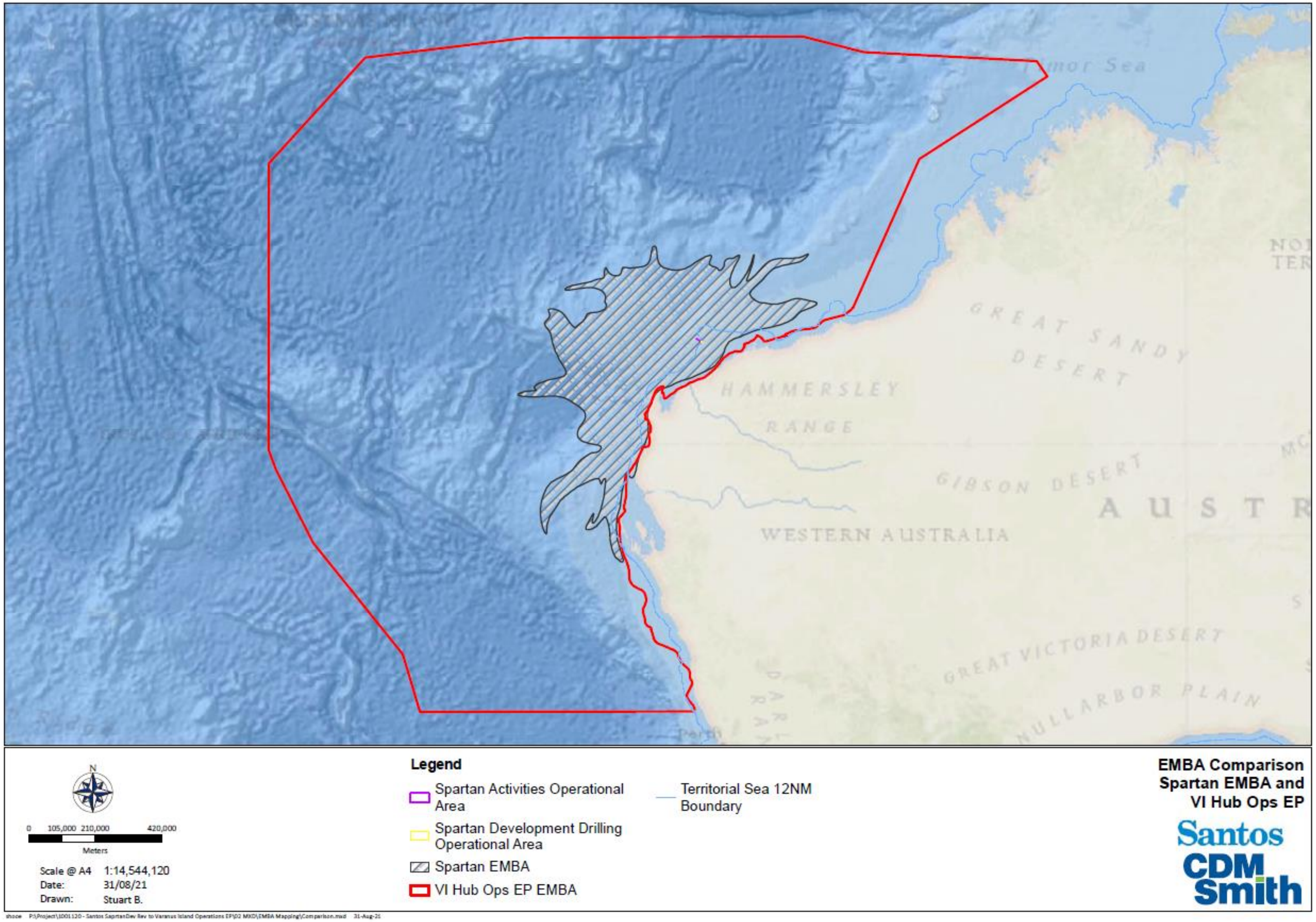

Figure 3-1: Comparison of Spartan EMBA versus the EMBA for the Varanus Island Hub Operations Commonwealth Waters EP

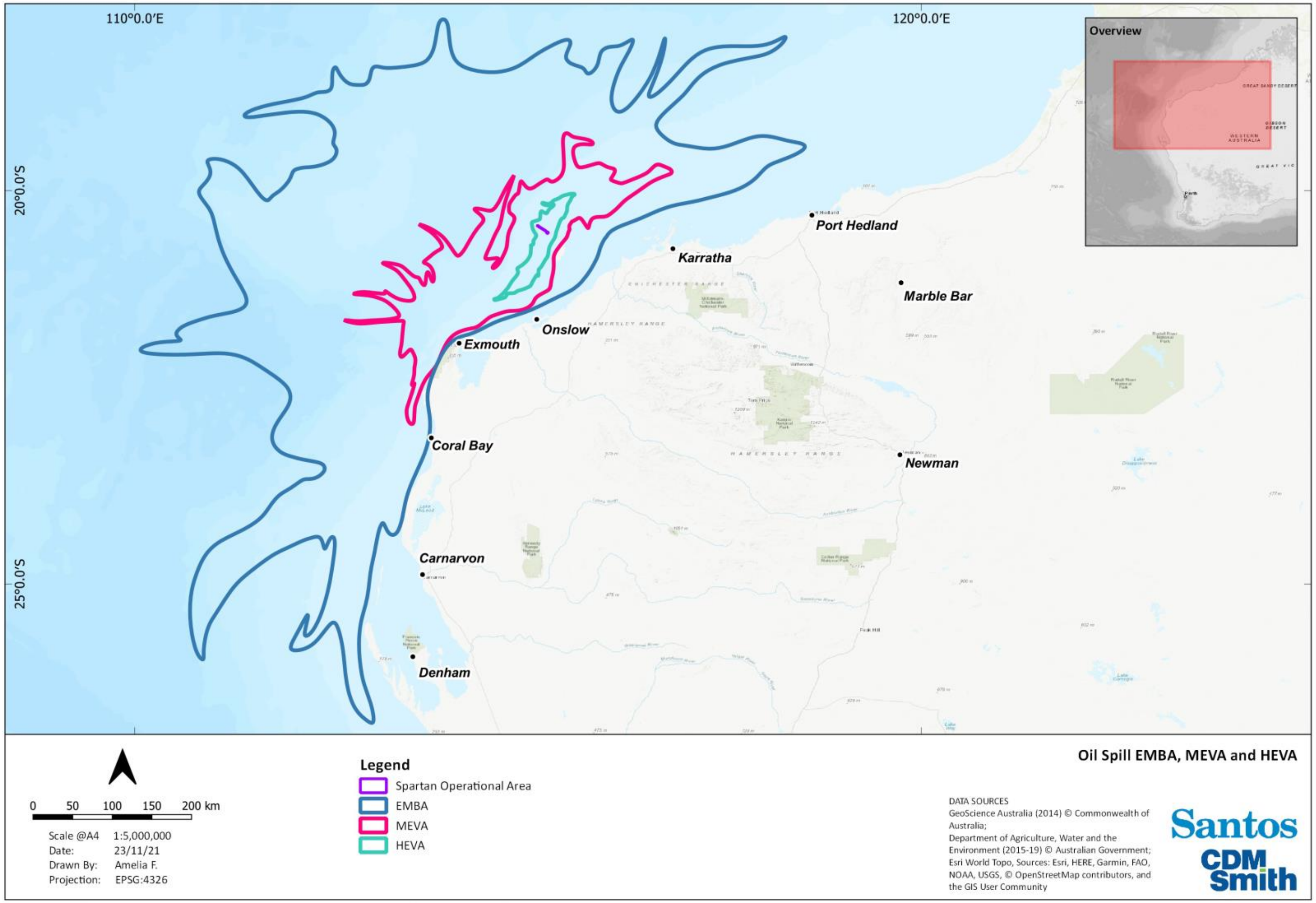

Figure 3-2: Overall EMBA, MEVA and HEVA for the LOWC scenarios

3.2 Environmental Values and Sensitivities

This section summarises environmental values and sensitivities including physical, biological, social, economic and cultural features within the marine and coastal environment that are relevant to the operational areas and the EMBA.

A summary of the information derived from the Department of Agriculture, Water and Environment (DAWE) PMST, Bioregional Plans and Fauna Recovery Plans relevant to the operational areas and EMBA is provided in this section. A detailed and comprehensive description of the environment (in accordance with regulation 13(1)(2) of the OPGGS(E)R is available in **Appendix C**. This draws upon existing knowledge and a comprehensive review of information about the marine environmental values and sensitivities in the region.

Copies of the DAWE PMST outputs for the operational areas and the EMBA are available in **Appendix D**.

The figures presented in this section of the EP Addendum have been zoomed to the extent of the data boundaries present within the EMBAs, to show all relevant data layers in a legible manner. Some data layers that sit within the map area but are not present within the EMBAs are not displayed.

3.2.1 Physical environment

3.2.1.1 Bioregions

Based on the Integrated Marine and Coastal Regionalisation of Australia, Version 4.0 (CoA, 2006), the regional descriptions relevant to the operational areas and the EMBA are provided in **Table 3-2** and **Figure 3-3**.

Table 3-2: Integrated Marine and Coastal Regionalisation of Australia 4.0 provincial bioregions relevant to the activity

Bioregion	Operational Area	EMBA
Northwest Shelf Province	✓	✓
Northwest Province	✗	✓
Northwest Transition	✗	✓
Central Western Transition	✗	✓
Central Western Shelf Transition	✗	✓
Central Western Shelf Province	✗	✓
Central Western Province	✗	✓

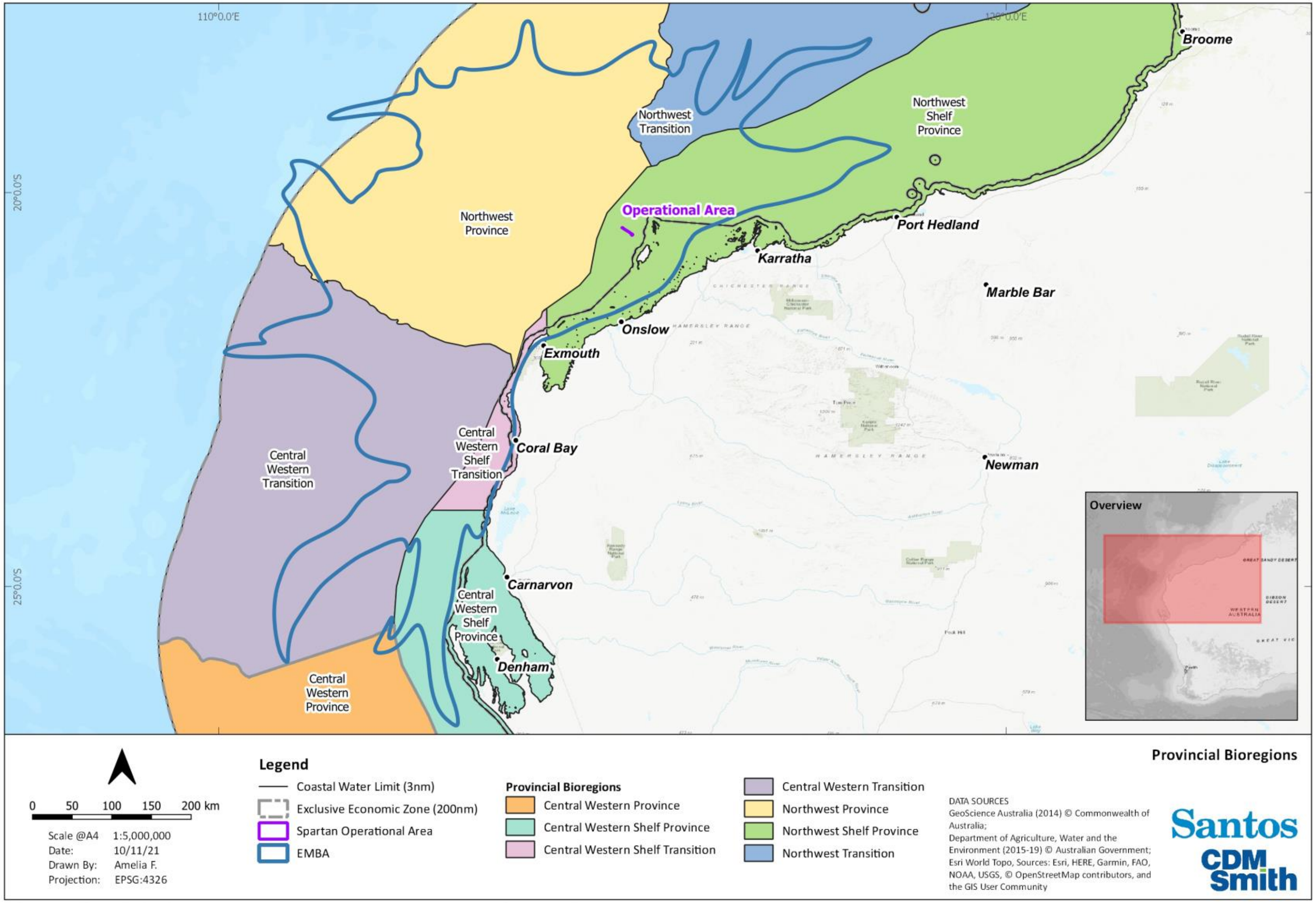

Figure 3-3: Integrated Marine and Coastal Regionalisation of Australia 4.0 provincial bioregions in relation to the EMBA

3.2.2 Benthic habitats

The presence of marine and coastal habitats in the operational area and the EMBA are summarised in **Table 3-3**.

A detailed description of these habitats with reference to the IMCRA provincial bioregions is provided in **Appendix C**. A summary of key benthic habitats, offshore reefs and islands, and shoals and banks is provided below.

The benthic (at or just below the seabed) habitats in waters in the operational area lie at depths ranging from approximately 48 m to 60 m. The operational area is likely to consist of soft sediment seabeds and sandy and muddy substrates, occasionally interspersed with hard substrates covered with sand veneers (DEWHA, 2008). Non-coral benthic invertebrates are likely to be the dominant community, albeit in low densities. Non-coral benthic invertebrates that occur in the operational area are likely to include sea cucumbers, urchins, crabs and polychaetes on soft substrate. Hard substrates are likely to contain sessile (fixed in one place) invertebrates, such as sponges and gorgonians (DEWHA, 2008).

There are no known offshore reefs or islands in or in close proximity (less than 20 km) to the operational area. However, there are a number of emergent oceanic reefs and islands in the EMBA, including Barrow Island, Montebello Islands, Lowendal Islands, Dampier Archipelago, Thevenard Islands, Muiron Islands and the Pilbara Southern Islands. A description of the values and sensitivities associated with these reefs and islands is provided in **Appendix C**.

A number of shoals and banks in the open offshore waters of the region have recognised environmental value. The key shoals and banks in the EMBA include Glomar Shoals and Rankin Bank. The closest bank feature to the operational area is Penguin Bank, located approximately 70 km south of the operational area.. The nearest key shoals to the operational area are the Glomar Shoals, located approximately 160 km northeast of the operational area. An understanding of these features has been gained from the Big Bank Shoals study (Heyward et al., 1997) and the PTTEP Australasia surveys initiated in response to the Montara incident (Heyward et al., 2010; Heyward et al., 2012).

The shoals and banks in the EMBA contain benthic habitats and associated fauna assemblages that are highly diverse compared to the surrounding relatively deep and bare seabed that constitutes the majority of the outer continental shelf in the region. These shoals and banks may act as important sources of larvae of important taxa such as fish and corals, which may be advected considerable distances (Shell, 2019). The shoals and banks support many of the same species found on emergent reef systems of the Indo-West Pacific region (Heyward et al., 2017a). This indicates a high level of ecological connectivity among the reef systems and between the shoals and banks. This is further supported by an analysis undertaken by the Australian Institute of Marine Science that compared benthic habitat community data from a number of shoals and banks in the Timor Sea and Bonaparte Gulf region. The analysis showed that neighbouring shoals and banks frequently share many attributes in terms of benthic community composition and species (Heyward et al., 2017b).

While the benthic communities on each shoal or bank reveal a degree of connectivity, it is acknowledged that they may vary in the abundance and diversity of dominant benthic species, with subsets of species featuring more prominently on some than others (Heyward et al., 2017b). This variability may reflect different disturbance events (e.g., cyclones, storm damage and coral bleaching) and recruitment histories, as well as potentially different ecosystem trajectories (Heyward et al., 2017b).

Table 3-3: Habitats in the EMBA Listed According to Presence in the Operational Area and IMCRA Provincial Bioregions of Australia

Category	Receptor	Operational Area Presence	EMBA Presence							Relevant Events that May Impact on the Receptors
			Northwest Province	Northwest Shelf Province	Northwest Transition	Central Western Transition	Central Western Shelf Transition	Central Western Shelf Province	Central Western Province	
Benthic Habitats	Coral reefs			✓	✓		✓	✓		Unplanned Condensate release due to subsea or surface well release. Diesel release from vessel collision.
	Seagrass			✓	✓		✓	✓		
	Macroalgae			✓	✓		✓	✓		
	Non-coral benthic invertebrates	✓	✓	✓	✓	✓	✓	✓	✓	Planned Seabed disturbance. Planned operational discharges. Unplanned Condensate release due to subsea or surface well release. Diesel release from vessel collision. Unplanned release of solids.
Shoreline Habitats	Mangroves			✓			✓	✓		Unplanned Condensate release due to subsea or surface well release. Diesel release from vessel collision.
	Intertidal platforms			✓			✓	✓		
	Sandy beaches			✓			✓	✓		
	Rocky shorelines			✓			✓	✓		

3.2.3 Protected and Significant areas

Protected and significant areas identified in the operational area and the EMBA are detailed in **Table 3-4** and **Figure 3-4** to **Figure 3-8** . These areas are further discussed in **Appendix C**.

3.2.3.1 Australian Marine Parks and State Marine Parks, Management Areas and Reserves

The operational area for drilling activities intercepts the Montebello Australian Marine Park (AMP) Multiple Use Zone (IUCN VI) (**Figure 3-4**). The boundary of the Montebello AMP is located approximately 390 m east of the Spartan well location (**Figure 3-5**). No State Marine Parks, Management Areas or Reserves intersect the operational area. AMPs are recognised under the EPBC Act for protecting and maintaining biological diversity and contributing to a national representative network of marine protected areas. Management plans for AMPs have been developed and came into force on 1 July 2018. Under these plans AMPs are allocated conservation objectives (International Union for Conservation of Nature [IUCN] Protected Area Category) based on the Australian IUCN reserve management principles in Schedule 8 of the EPBC Regulations 2000. These principles determine what activities are acceptable within a protected area under the EPBC Act. The management zones, associated with the AMPs, and the relevant objectives are detailed in **Table 3-5**.

The EMBA overlaps a number of AMPs and state marine parks, management areas and nature reserves. These areas are shown in **Figure 3-4** and **Figure 3-6** and are further discussed in **Appendix C**.

The management zones associated with the Australian marine parks identified in the operational area and EMBA and the relevant objectives are detailed in **Table 3-5**.

Table 3-4: Distance from Operational Area Boundary to Protected Areas, Key Ecological Features and Threatened Ecological Communities in the EMBA

Value/Sensitivity Name	Status, Zone or IUCN Classification	Presence in Operational Area	Presence in MEVA	Presence in EMBA	Distance to Operational Area (km)
Australian Marine Parks					
Montebello Marine Park	Multiple Use Zone (IUCN VI)	✓	✓	✓	0
Gascoyne Marine Park	Multiple Use Zone (IUCN VI)	✗	✓	✓	145
	Habitat Protection Zone (IUCN IV)	✗	✓	✓	281
	National Park Zone (IUCN II)	✗	✗	✓	353
Ningaloo Marine Park	Recreational Use Zone (IUCN IV)	✗	✓	✓	163
	National Park Zone (IUCN II)	✗	✓	✓	292
Shark Bay	Multiple Use Zone (IUCN VI)	✗	✗	✓	471
Abrolhos	Multiple Use Zone (IUCN VI)	✗	✗	✓	718

Value/Sensitivity Name	Status, Zone or IUCN Classification	Presence in Operational Area	Presence in MEVA	Presence in EMBA	Distance to Operational Area (km)
State Marine Parks, Management Areas and Reserves					
Barrow Island Marine Management Area	Unclassified (IUCN VI)	✗	✓	✓	15
Montebello Islands Marine Park	General Use Zone (IUCN VI)	✓	✓	✓	17
	Recreation Zone (IUCN IV)	✓	✓	✓	28
	Sanctuary Zone (IUCN 1a)	✓	✓	✓	19
Muiron Islands Marine Management Area	Unclassified (IUCN VI)	✗	✓	✓	145
	Conservation Area (IUCN IA)	✗	✓	✓	151
Ningaloo Marine Park	National Park Zone (IUCN II)	✗	✓	✓	164
	Sanctuary Zone (IUCN 1a)	✗	✓	✓	176
	Recreational Use Zone (IUCN IV)	✗	✓	✓	220
World and National Heritage Areas					
Barrow Island and the Montebello-Barrow Islands Marine Conservation Reserves	–	✓	✓	✓	14
The Ningaloo Coast	–	✓	✓	✓	145
Commonwealth Heritage Places					
Ningaloo Marine Area – Commonwealth Waters	–	✓	✓	✓	163
Wetlands of National Importance					
Key Ecological Features					

Value/Sensitivity Name	Status, Zone or IUCN Classification	Presence in Operational Area	Presence in MEVA	Presence in EMBA	Distance to Operational Area (km)
Ancient coastline at 125 m depth contour	–	✗	✓	✓	16
Continental slope demersal fish communities	–	✗	✓	✓	27
Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	–	✗	✓	✓	117
Exmouth Plateau	–	✗	✓	✓	120
Commonwealth Waters adjacent to Ningaloo Reef	–	✗	✓	✓	163
Glomar Shoals	–	✗	✗	✓	166
Western demersal slope and associated fisheries		✗	✗	✓	635

Table 3-5: Management zones for the Australian and State Marine Parks found in the environment that may be affected and the associated objectives

Management Zones	Objective
Australian Marine Parks	
Multiple Use (IUCN VI)	The objective is to provide for ecologically sustainable use and the conservation of ecosystems, habitats and native species.
Recreational Use (IUCN IV)	The objective is to provide for the conservation of ecosystems, habitats and native species in as natural a state as possible, while providing for recreational use.
Habitat Protection Zone (IUCN IV)	The objective is to provide for the conservation of ecosystems, habitats and native species in as natural a state as possible, while allowing activities that do not harm or cause destruction to seafloor habitats.
National Park Zone (IUCN II)	The objective is to protect natural biodiversity with its underlying ecological structure and supporting environmental processes, and to promote education and recreation.
Special Purpose Zone	The objective is to protect natural ecosystems and use natural resources sustainably, when conservation and sustainable use can be mutually beneficial.
State Marine Parks	

Sanctuary Zones	The primary purpose of sanctuary zones is for the protection and conservation of marine biodiversity. Sanctuary zones are 'no-take' areas managed solely for nature conservation and low-impact recreation and tourism.
Special Purpose Zones	*Special purpose (benthic protection) zone*: This zone has the priority purpose of conservation of benthic habitat. *Special purpose (shore-based activities) zone*: Special purpose zones in marine parks are managed for a priority purpose or use, such as a seasonal event (e.g., wildlife breeding, whale watching) or a commercial activity (e.g., pearling).
Recreation Zones	Recreation zones have the primary purpose of providing opportunities for recreational activities, including fishing, for visitors and for commercial tourism operators, where these activities are compatible with the maintenance of the values of the zone.
General Use Zones	Conservation of natural values is still the priority of general use zones, but activities such as sustainable commercial and recreational fishing, aquaculture, pearling and petroleum exploration and production may be permitted provided they do not compromise the ecological values of the marine park.

Oil and gas operations and associated oil spill response may be conducted in a Multiple Use Zone (IUCN VI) subject to the class approval and prescriptions in the North-west Marine Parks Network Management Plan (North-west MPNMP) (Director of National Parks, 2018). The Class Approval – Mining Operations and Greenhouse Gas Activities for the North-west MPNMP, which is applicable to petroleum-related activities, came into effect on 1 July 2018. Prescriptions/conditions of the North-west MPNMP and Class Approval for the North-west MPNMP that are considered relevant to the scope of this EP Addendum are provided in **Table 3-6**.

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Table 3-6: Prescriptions/conditions from the North-West Marine Parks Network Management Plan 2018 and associated Class approval – mining operations and greenhouse gas activities relevant to the activities in this Environment Plan Addendum

Prescription/ Condition Number	Prescription/Condition	Relevant Section of EP
North-West MPNMP (DNP, 2018a)		
4.2.9.8	Notwithstanding Section 4.2.9.1 (of the North-West MPNMP), actions required to respond to oil pollution incidents, including environmental monitoring and remediation, in connection with mining operations authorised under the OPGGS Act, may be conducted in all zones without an authorisation issued by the Director, provided that the actions are taken in accordance with: an environment plan that has been accepted by NOPSEMA, and the Director is notified in the event of oil pollution within a marine park, or where an oil spill response action must be taken within a marine park, so far as reasonably practicable, prior to response action being taken.	This EP **Section 4** (Stakeholder Consultation), reporting under Section 6 of the OPEP
Class Approval – Mining Operations and Green House Gas Activities – for North-West MPNMP (DNP, 2018a)		
1	Approved action must be conducted in accordance with: (a) an Environment Plan accepted under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations (2009)	The OPEP (some proposed response activities in the event of an oil pollution incident may be undertaken within the North-west Marine Park Network)
	(b) the EPBC Act	**Appendix B** (Legislation)
	(c) the EPBC Regulations	This EP
	(d) the North-west Network Management Plan	This table
	(e) any prohibitions, restrictions or determinations made under the EPBC Regulations by the Director of National Parks	Not applicable
	(f) all other applicable Commonwealth and state and territory laws (to the extent those laws are capable of operating concurrently with the laws and instruments described in paragraphs a to e)).	**Appendix B** (Legislation), and the OPEP

Prescription/ Condition Number	Prescription/Condition	Relevant Section of EP
2	If requested by the Director of National Parks, an Approved Person must notify the Director prior to conducting Approved Actions within Approved Zones. Note: the timeframe for prior notice will be agreed to by the Director of National Parks and the Approved Person.	**Section 8.10** (Reporting) and Section 6 of the OPEP
3	If requested by the Director of National Parks, an Approved Person must provide the Director with information relating to undertaking the Approved Actions (or gathered while undertaking the Approved Actions), that is relevant to the Director's management of the Approved Zones. Note: the information required, and timeframe within which it is required, will be agreed to by the Director of National Parks and the Approved Person.	Not applicable

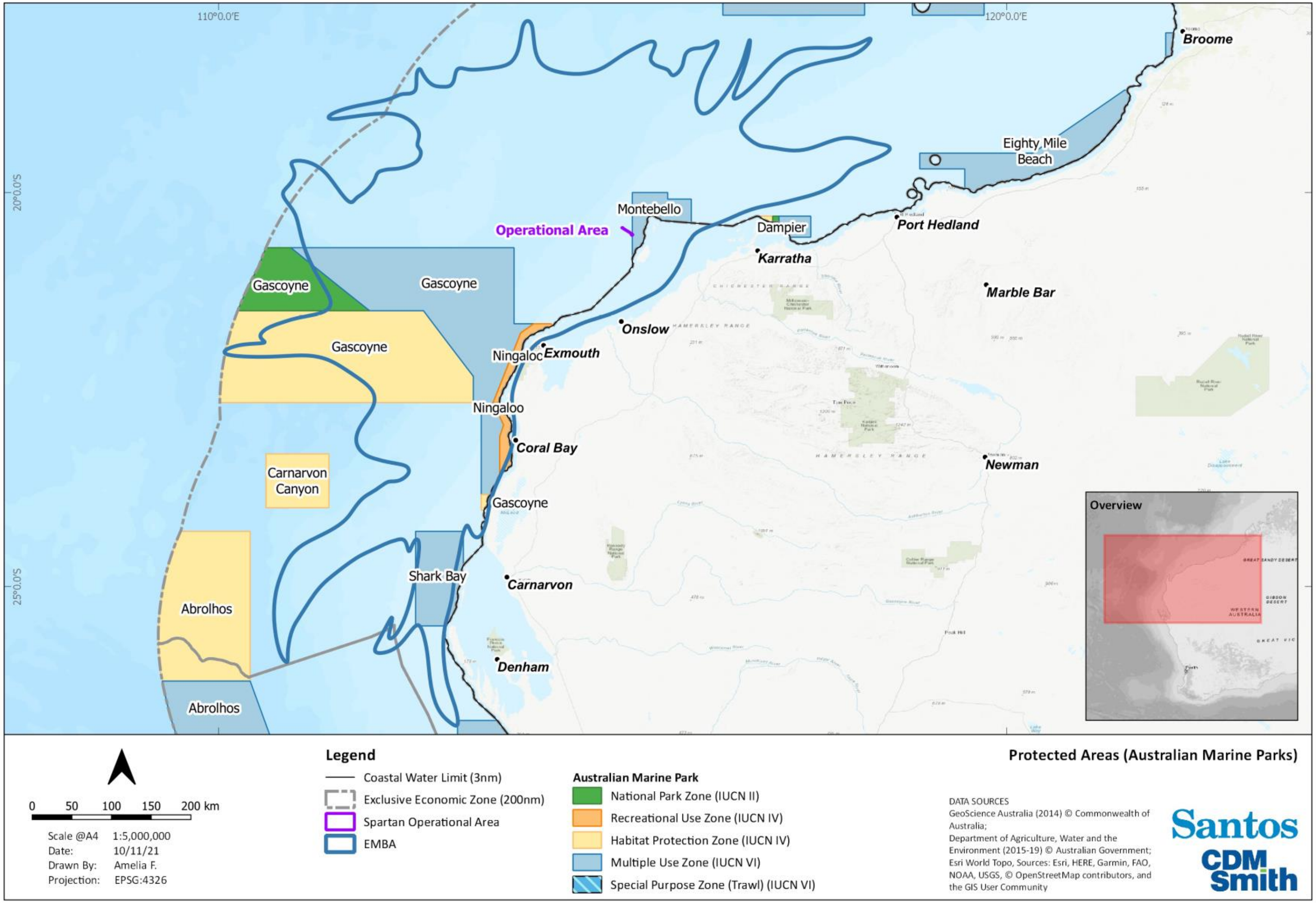

Figure 3-4: Australian Marine Parks within the environment that may be affected and operational area

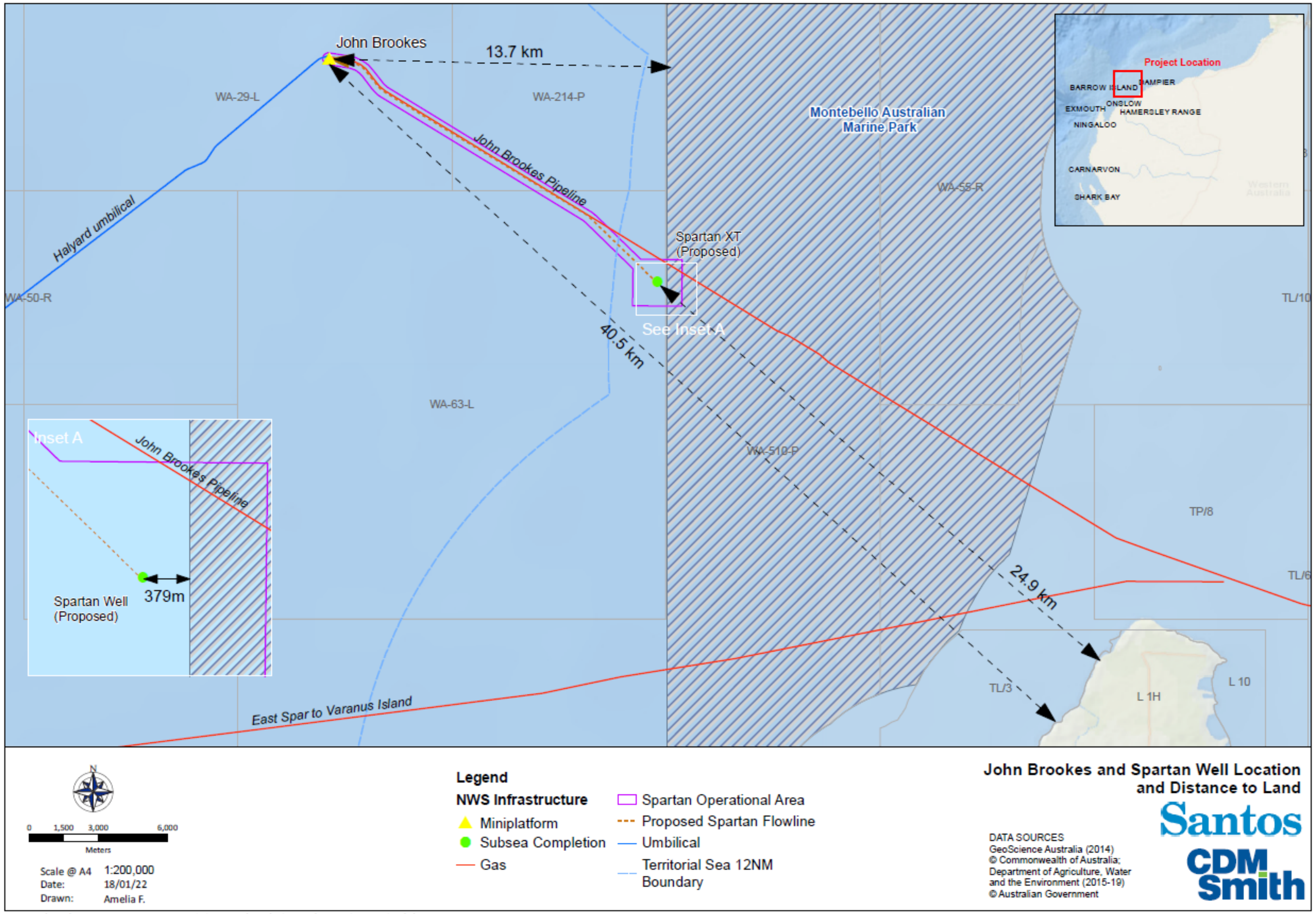

Figure 3-5: Operational area and Spartan well location in relation the Montebello AMP boundary

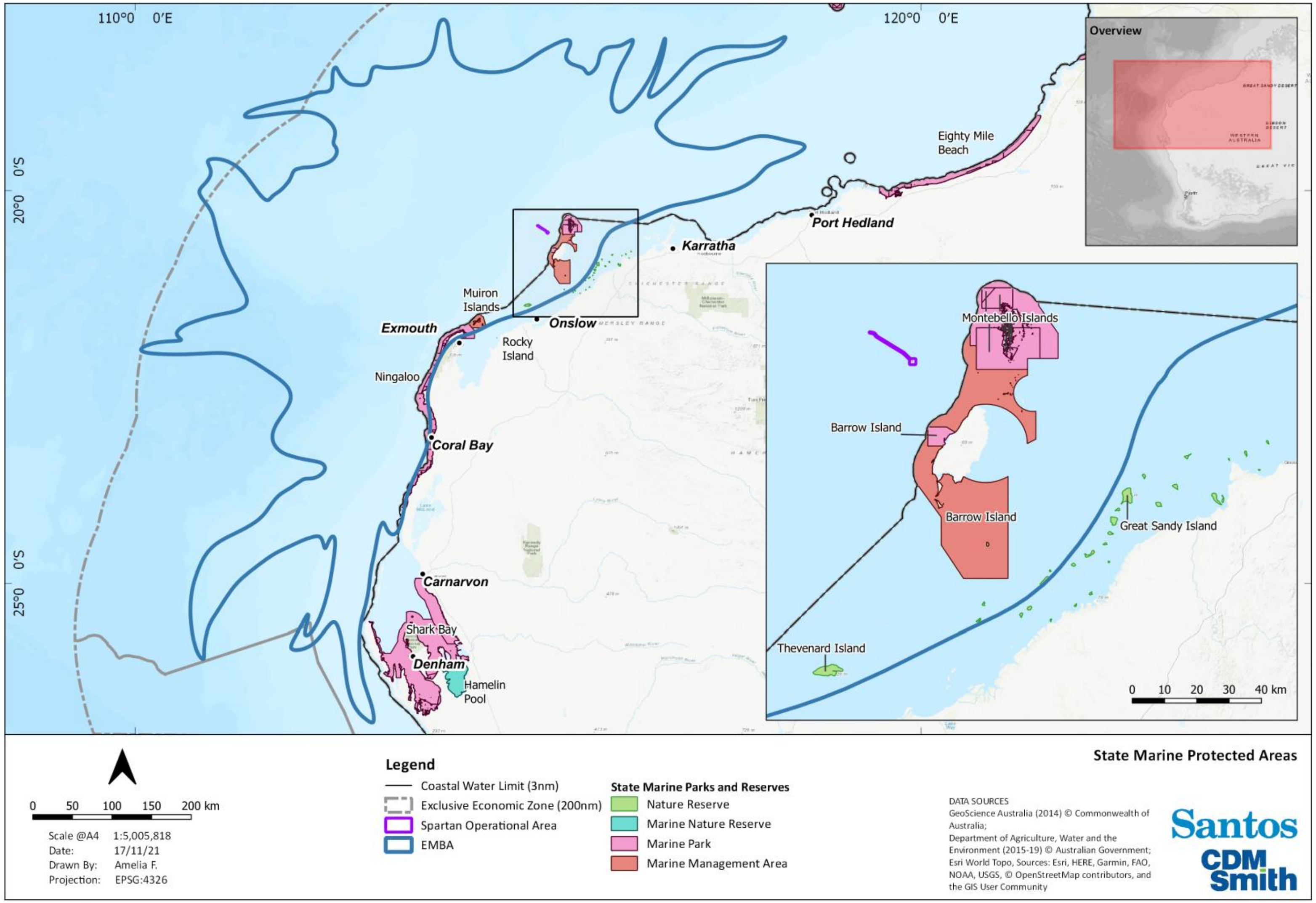

Figure 3-6: State Marine Protected Areas within and near the environment that may be affected and operational area

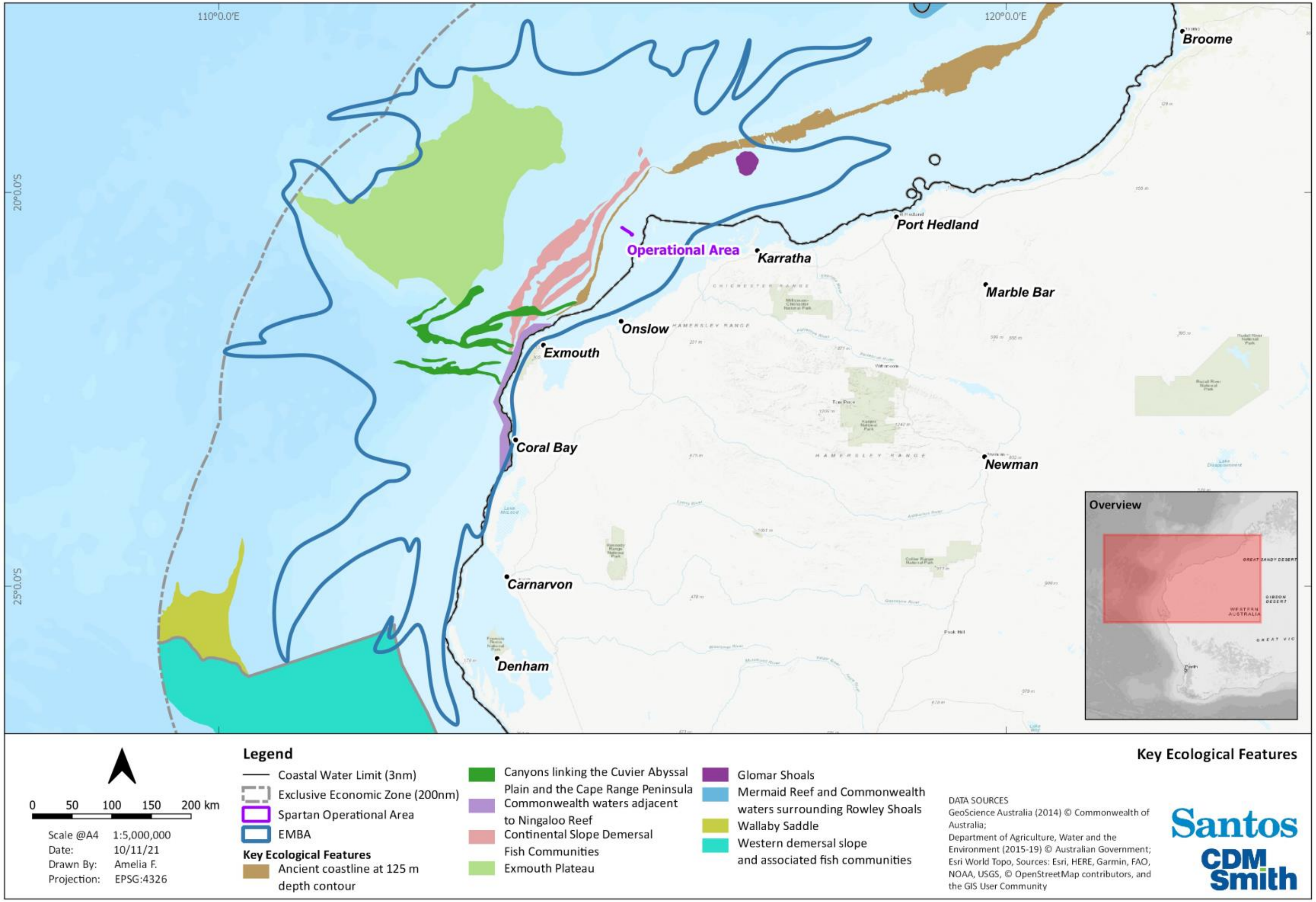

Figure 3-7: Key Ecological Features within and near the environment that may be affected and operational area

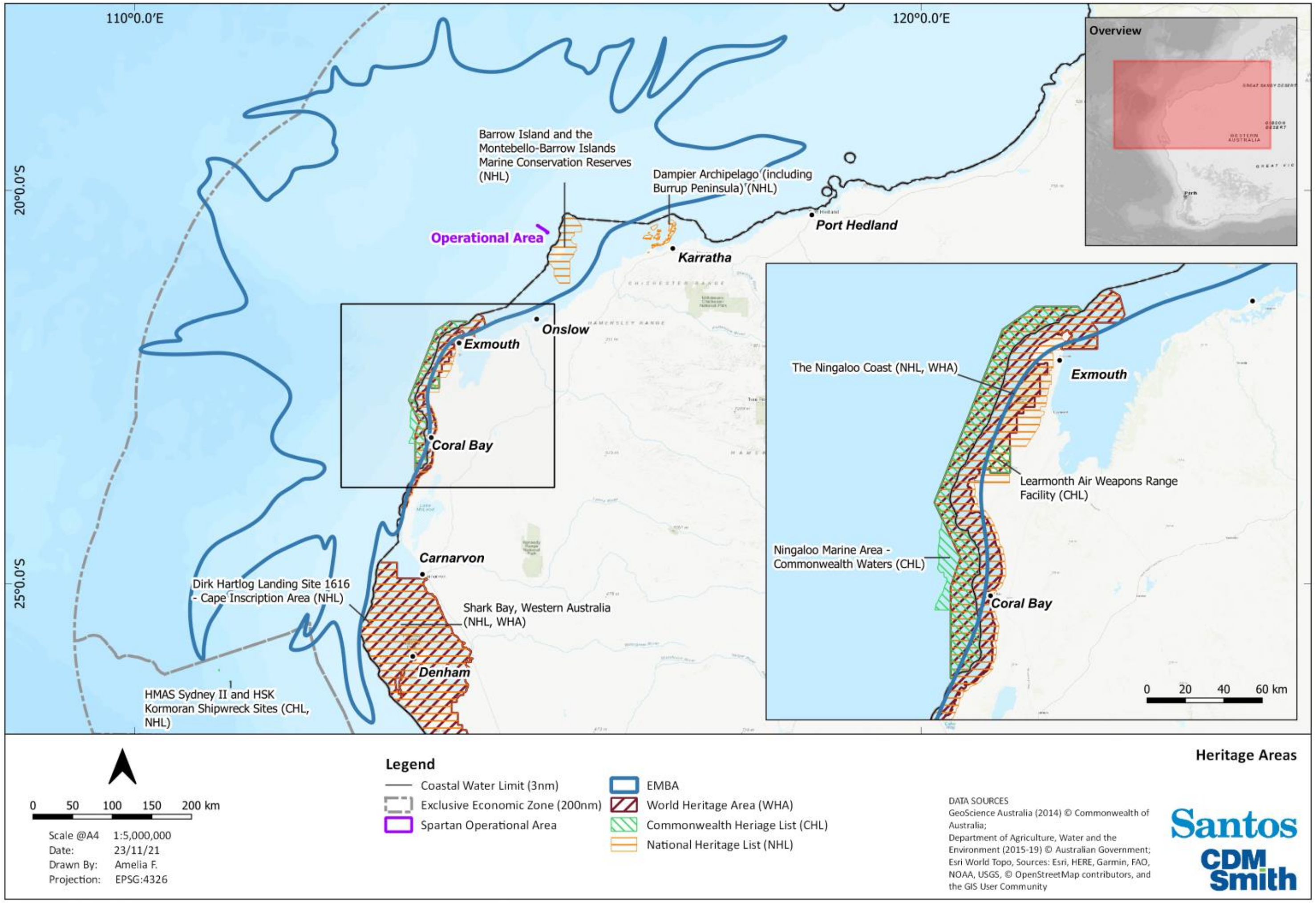

Figure 3-8: Heritage areas in the vicinity of the operational area and the environment that may be affected

3.2.4 Threatened and migratory fauna

The Protected Matters Search Tool (**Appendix D**) identified 22 listed threatened species and 38 migratory species under the EPBC Act 1999 in the operational area (including a 20 km buffer).

In the EMBA, 52 listed threatened species and 65 migratory species were identified as potentially occurring in marine or shoreline habitats.

An examination of the species profile and threats database showed that some listed threatened species are not expected to occur in significant numbers in the marine and coastal environments due to their terrestrial distributions. Species that may occur on shorelines include shorebirds, but terrestrial mammals, reptiles (such as pythons) and bird species that do not have habitats along shorelines have been excluded. These species will not come into contact with any potential oil spill and therefore are not discussed further.

Those listed as threatened species groups or vulnerable species groups and that have been identified as potentially being present in the operational area, MEVA or the EMBA and the relevant planned and unplanned events that may impact them are discussed in **Table 3-7**.

Appendix C provides a comprehensive description of species that may be present within the EMBA.

Table 3-7: Environmental Values and Sensitivities – Threatened and Migratory Marine Fauna

Value/Sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant Events
Common Name	Scientific Name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
Protected Species and Communities: Fish and Sharks									
Whale shark	*Rhincodon typus*	V, M	✓	Foraging, feeding or related behaviour known to occur within area Overlap with foraging BIA	✓	Foraging, feeding or related behaviour known to occur within area Overlap with foraging BIAs	✓	Foraging, feeding or related behaviour known to occur within area Overlap with foraging BIAs	<u>Planned</u> Light emissions; Noise emissions; Planned operational discharges; Drilling and cement discharges Planned chemical and hydrocarbon discharges Spill response operations. <u>Unplanned</u> Hydrocarbon releases;
Grey nurse shark (west coast population)	*Carcharias taurus (west coast population)*	V	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area	
Great white shark	*Carcharodon carcharias*	V, M	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	✓	Foraging, feeding or related behaviour known to occur within area Overlaps with foraging BIA (Abrolhos Islands)	

Value/Sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant Events
Common Name	Scientific Name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
Dwarf sawfish	*Pristis clavata*	V, M	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area	Non-hydrocarbon releases; Marine fauna interaction; and Introduction of invasive marine species.
Green sawfish	*Pristis zijsron*	V, M	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area	
Narrow sawfish	*Anoxypristis cuspidata*	M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	✓	Species or species habitat known to occur within area	
Shortfin mako	*Isurus oxyrinchus*	M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	
Longfin mako	*Isurus paucus*	M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	
Oceanic Whitetip Shark	*Carcharhinus longimanus*	M	✓	Species or species habitat	✓	Species or species habitat	✓	Species or species habitat	

Value/Sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant Events
Common Name	Scientific Name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
				likely to occur within area		likely to occur within area		likely to occur within area	
Reef manta ray	*Manta alfredi*	M	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area	
Giant manta ray	*Manta birostris*	M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	✓	Species or species habitat known to occur within area	
Blind gudgeon	*Milyeringa veritas*	V	X	N/A	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area	<u>Planned</u> Planned operational discharges; Drilling and cement discharges Planned chemical and hydrocarbon discharges Spill response operations. <u>Unplanned</u>
Blind cave eel	*Ophisternon candidum*	V	X	N/A	✓	Species or species habitat known to occur within area	✓	Species or species habitat known to occur within area	
Porbeagle (Mackerel shark)	*Lamna nasus*	M	X	N/A	X	N/A	✓	Species or species habitat may occur within area	

Value/Sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant Events
Common Name	Scientific Name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
									Hydrocarbon releases; Non-hydrocarbon releases
Protected Species and Communities: Marine Mammals									
Humpback whale	*Megaptera novaeangliae*	V, M	✓	Species or species habitat known to occur within area Overlap with BIA for migration	✓	Congregation or aggregation known to occur within area Overlap with BIA for migration	✓	Congregation or aggregation known to occur within area Overlap with BIA for migration	<u>Planned</u> Light emissions; Noise emissions; Planned operational discharges; Drilling and cement discharges Planned chemical and hydrocarbon discharges Spill response operations. <u>Unplanned</u>
Blue whale	*Balaenoptera musculus*	E, M	✓	Species or species habitat likely to occur within area Overlap with BIA for distribution	✓	Migration route known to occur within area Overlap with BIA for distribution, migration and foraging	✓	Migration route known to occur within area Overlap with BIA for distribution, migration and foraging	
Sei whale	*Balaenoptera borealis*	V, M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	✓	Foraging, feeding or related behaviour likely	

Value/Sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant Events
Common Name	Scientific Name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
								to occur within area	Hydrocarbon releases; Non-hydrocarbon releases; Marine fauna interaction; and Introduction of invasive marine species.
Fin whale	*Balaenoptera physalus*	V, M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	✓	Foraging, feeding or related behaviour likely to occur within area	
Bryde's whale	*Balaenoptera edeni*	M	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	✓	Species or species habitat likely to occur within area	
Orca, killer whale	*Orcinus orca*	M	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	
Spotted bottlenose dolphin	*Tursiops aduncus (Arafura/Timor Sea populations)*	M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	✓	Species or species habitat known to occur within area	
Dugong	*Dugong dugon*	M	✓	Species or species habitat likely to occur within area	✓	Breeding known to occur within area Overlaps with BIA for foraging and breeding,	✓	Breeding known to occur within area Overlaps with BIA for foraging and breeding,	

Value/Sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant Events
Common Name	Scientific Name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
						calving and nursing		calving and nursing	
Sperm whale	*Physeter macrocephalus*	M	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	
Indo-Pacific humpback dolphin	*Sousa chinensis*	M	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	✓	Species or species habitat known to occur within area	
Southern right whale	*Eubalaena australis*	E	X	N/A	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	Planned Planned operational discharges; Drilling and cement discharges Planned chemical and hydrocarbon discharges Spill response operations. Unplanned
Antarctic minke whale	*Balaenoptera bonaerensis*	M	X	N/A	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	

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Value/Sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant Events
Common Name	Scientific Name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
									Hydrocarbon releases; Non-hydrocarbon releases
		Protected Species and Communities: Marine Reptiles							
Short-nosed seasnake	*Aipysurus apraefrontalis*	CE	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	✓	Species or species habitat known to occur within area	Planned Light emissions; Noise emissions; Planned operational discharges; Drilling and cement discharges Planned chemical and hydrocarbon discharges Spill response operations. Unplanned
Leaf-scaled snake	*Aipysurus foliosquama*	CE	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	✓	Species or species habitat may occur within area	
Loggerhead turtle	*Caretta caretta*	E, M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	✓	Breeding known to occur within area Overlaps with BIAs and critical habitats	
Green turtle	*Chelonia mydas*	V, M	✓	Congregation or aggregation known to occur within area	✓	Breeding known to occur within area	✓	Breeding known to occur within area	

Value/Sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant Events
Common Name	Scientific Name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
				Overlaps with internesting BIA		Overlaps with BIAs and critical habitats		Overlaps with BIAs and critical habitats	Hydrocarbon releases; Non-hydrocarbon releases; Marine fauna interaction; and Introduction of invasive marine species.
Leatherback turtle	*Dermochelys coriacea*	E, M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	
Hawksbill turtle	*Eretmochelys imbricata*	V, M	✓	Congregation or aggregation known to occur within area Overlaps with internesting habitat	✓	Breeding known to occur within area Overlaps with BIAs and critical habitats	✓	Breeding known to occur within area Overlaps with BIAs and critical habitats	
Flatback turtle	*Natator depressus*	V, M	✓	Congregation or aggregation known to occur within area Overlap with internesting BIA and internesting critical habitat	✓	Breeding known to occur within area Overlaps with BIAs and critical habitats (including mating, aggregation, foraging and internesting).	✓	Breeding known to occur within area Overlaps with BIAs and critical habitats (including mating, aggregation, foraging and internesting).	

Value/Sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant Events
Common Name	Scientific Name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
		Protected Species and Communities: Marine Birds							
Curlew sandpiper	*Calidris ferruginea*	CE, M	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	✓	Species or species habitat known to occur within area	Planned Light emissions; Noise emissions; Planned operational discharges; Drilling and cement discharges Planned chemical and hydrocarbon discharges Spill response operations. Unplanned Hydrocarbon releases;
Red knot	*Calidris canutus*	E, M	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	✓	Species or species habitat known to occur within area	
Southern giant petrel	*Macronectes giganteus*	E, M	✓	Species or species habitat may to occur within area	✓	Species or species habitat may to occur within area	✓	Species or species habitat may occur within area	
Eastern curlew	*Numenius madagascariensis*	CE, M	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	✓	Species or species habitat known to occur within area	
Christmas Island White-tailed Tropic Bird	*Phaethon lepturus fulvus*	E, M	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	

Value/Sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant Events
Common Name	Scientific Name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
Australian fairy tern	*Sternula nereis*	V	✓	Breeding known to occur within area Overlaps with breeding BIA	✓	Breeding known to occur within area Overlaps with breeding BIAs	✓	Breeding known to occur within area Overlaps with breeding BIAs	Non-hydrocarbon releases; Marine fauna interaction.
Common noddy	*Anous stolidus*	M	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	✓	Species or species habitat likely to occur within area	
Fork-tailed swift	*Apus pacificus*	M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	
Streaked shearwater	*Calonectris leucomelas*	M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	
Lesser frigatebird	*Fregata ariel*	M	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	✓	Species or species habitat known to occur within area	
Roseate tern	*Sterna dougallii*	M	✓	Foraging, feeding or related	✓	Foraging, feeding or related	✓	Foraging, feeding or related	

Value/Sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant Events
Common Name	Scientific Name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
				behaviour likely to occur within area Overlaps with breeding BIA		behaviour likely to occur within area Overlaps with breeding BIA		behaviour likely to occur within area Overlaps with breeding BIA	
Common sandpiper	*Actitis hypoleucos*	M	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	✓	Species or species habitat known to occur within area	
Sharp-tailed sandpiper	*Calidris acuminata*	M	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	✓	Species or species habitat known to occur within area	
Pectoral sandpiper	*Calidris melanotos*	M	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	
Osprey	*Pandion haliaetus*	M	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	✓	Breeding known to occur within area	
Wedge-tailed shearwater	*Ardenna pacifica*	M	✓	Was not identified by the Protected Matter Search Tool; however, this	✓	Breeding known to occur within area	✓	Breeding known to occur within area	

Value/Sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant Events
Common Name	Scientific Name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
				area overlaps with breeding BIA		Overlaps with breeding and foraging BIA		Overlaps with breeding and foraging BIA	
Australian lesser noddy	*Anous tenuirostris melanops*	V	X	N/A	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	Planned Planned operational discharges; Drilling and cement discharges Planned chemical and hydrocarbon discharges Spill response operations. Unplanned Hydrocarbon releases; Non-hydrocarbon releases
Greater Sand Plover	*Charadrius leschenault*	V	X	N/A	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	
Amsterdam albatross	*Diomedea amsterdamensis*	E	X	N/A	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	
Wandering albatross	*Diomedea exulans*	V	X	N/A	✓	Species or species habitat likely to occur within area	✓	Species or species habitat likely to occur within area	
Northern Siberian bar-tailed godwit	*Limosa lapponica menzbierii*	CE, M	X	N/A	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	
Northern giant petrel	*Macronectes halli*	V	X	N/A	✓	Species or species habitat	✓	Species or species habitat	

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Value/Sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant Events
Common Name	Scientific Name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
						may occur within area		may occur within area	
Abbott's booby	*Papasula abbotti*	E	X	N/A	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	
Night parrot	*Pezoporus occidentalis*	E	X	N/A	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	
Soft-plumaged petrel	*Pterodroma mollis*	V	X	N/A	✓	Species or species habitat may occur within area	✓	Foraging, feeding or related behaviour known to occur within area	
Australian painted snipe	*Rostratula australis*	E	X	N/A	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	
Indian yellow-nosed albatross	*Thalassarche carteri*	V	X	N/A	✓	Species or species habitat may occur within area	✓	Foraging, feeding or related behaviour may occur within area	

Value/Sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant Events
Common Name	Scientific Name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
Shy albatross	*Thalassarche cauta*	E	X	N/A	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	
Campbell albatross	*Thalassarache impavida*	V	X	N/A	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	
Black-browed albatross	*Thalassarche melanophris*	V	X	N/A	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	
White-capped albatross	*Thalassarche cauta steadi*	V	X	N/A	✓	Species or species habitat may occur within area	✓	Foraging, feeding or related behaviour likely to occur within area	
Flesh-footed shearwater	*Ardenna carneipes*	V	X	N/A	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	
Greater frigatebird	*Fregata minor*	M	X	N/A	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	

Value/Sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant Events
Common Name	Scientific Name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
Caspian tern	*Sterna caspia*	M	X	N/A	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	
Bridled tern	*Onychoprion anaethetus*	M	X	N/A	✓	Species or species habitat may occur within area	✓	Foraging, feeding or related behaviour likely to occur within area Overlaps foraging (provisioning young) BIA	
White-tailed tropicbird	*Phaethon lepturus*	M	X	N/A	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	
Oriental plover	*Charadrius veredus*	M	X	N/A	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	
Oriental pratincole	*Glareola maldivarum*	M	X	N/A	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	

Value/Sensitivity		EPBC Act Status	Operational Area		MEVA		EMBA		Relevant Events
Common Name	Scientific Name		Presence	Type of Presence	Presence	Type of Presence	Presence	Type of Presence	
Asian Dowitcher	*Limnodromus semipalmatus*	M	X	N/A	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	
Bar-tailed godwit		M	X	N/A	✓	Species or species habitat may occur within area	✓	Species or species habitat may occur within area	
Greater crested tern	*Thalasseus bergii*	M	X	N/A	✓	Species or species habitat may occur within area	✓	Breeding known occur within area	
Common greenshank	*Tringa nebularia*	M	X	N/A	✓	Species or species habitat may occur within area	✓	Species or species habitat likely to occur within area	

3.2.4.1 Biologically important areas

BIAs, such as aggregation, breeding, resting, nesting or feeding areas or known migratory routes, for marine fauna species in the operational areas and the EMBA are identified in **Table 3-8**. **Figure 3-9** to **Figure 3-16** show BIAs in the operational areas and EMBA. BIAs are further described in **Appendix C**.

DAWE may make recovery plans for threatened fauna listed under the EPBC Act. The Act requires that 'habitat critical to the survival of the listed threatened species' is identified in recovery plans. Critical habitat within the EMBA relevant to for marine reptiles and is listed in **Table 3-8**.

Santos

Table 3-8: Biologically important areas identified in the operational area, environment that may be affected and MEVA

Fauna group	Species	BIA Area	Presence in Operational Area	Presence in MEVA	Presence in EMBA	Habitat critical within EMBA
Sharks and rays	Whale shark	Foraging	✓	✓	✓	N/A
		Foraging (high density prey)	✗	✓	✓	
Marine mammals	Pygmy blue whale	Foraging	✗	✓	✓	
		Migration	✗	✓	✓	
		Distribution	✓	✓	✓	
	Humpback whale	Resting	✗	✗	✓	
		Calving	✗	✗	✗	
		Nursing	✗	✗	✗	
		Migration (north and south)	✓	✓	✓	
		Calving buffer	✗	✗	✗	
	Dugong	Breeding	✗	✓	✓	
		Calving	✗	✓	✓	
		Nursing	✗	✓	✓	
		Foraging	✗	✓	✓	
Marine reptiles	Green turtle	Aggregation	✗	✓	✓	Montebello Islands, Ningaloo coast and Dampier Archipelago, 20km internesting buffer.
		Mating	✗	✓	✓	
		Nesting	✗	✓	✓	

Fauna group	Species	BIA Area	Presence in Operational Area	Presence in MEVA	Presence in EMBA	Habitat critical within EMBA
		Internesting	✓	✓	✓	
		Internesting buffer (incl. critical habitat)	✓	✓	✓	
		Foraging	✗	✓	✓	
		Basking	✗	✓	✓	
	Loggerhead turtle	Nesting	✗	✓	✓	Ningaloo coast, Muiron Islands, 20km internesting buffer
		Internesting	✗	✓	✓	
		Internesting buffer	✗	✓	✓	
		Foraging	✗	✗	✗	
	Hawksbill turtle	Mating	✗	✓	✓	Montebello Islands, Lowendal Islands, Ningaloo Coast and Dampier Archipelago, 20km internesting buffer
		Nesting	✗	✓	✓	
		Internesting	✓	✓	✓	
		Internesting buffer (incl. critical habitat)	✗	✓	✓	
		Foraging	✗	✓	✓	
		Migration corridor	✗	✗	✗	
	Flatback turtle	Mating	✗	✓	✓	Barrow Island, Montebello Islands and Dampier Archipelago, 60km internesting buffer
		Nesting	✗	✓	✓	
		Internesting	✗	✓	✓	
		Internesting buffer (incl. critical habitat)	✓	✓	✓	

Fauna group	Species	BIA Area	Presence in Operational Area	Presence in MEVA	Presence in EMBA	Habitat critical within EMBA
		Foraging	✗	✓	✓	
		Aggregation	✗	✓	✓	
		Migration corridor	✗	✗	✗	
Birds	Lesser frigatebird	Breeding/foraging	✗	✗	✓	N/A
	Wedge-tailed shearwater	Breeding/foraging	✓	✓	✓	
	Roseate tern	Breeding/foraging	✗	✓	✓	
		Foraging (provisioning young)	✗	✗	✗	
	Bridled tern	Foraging	✗	✗	✓	
	Australian fairy tern	Breeding/foraging	✗	✓	✓	

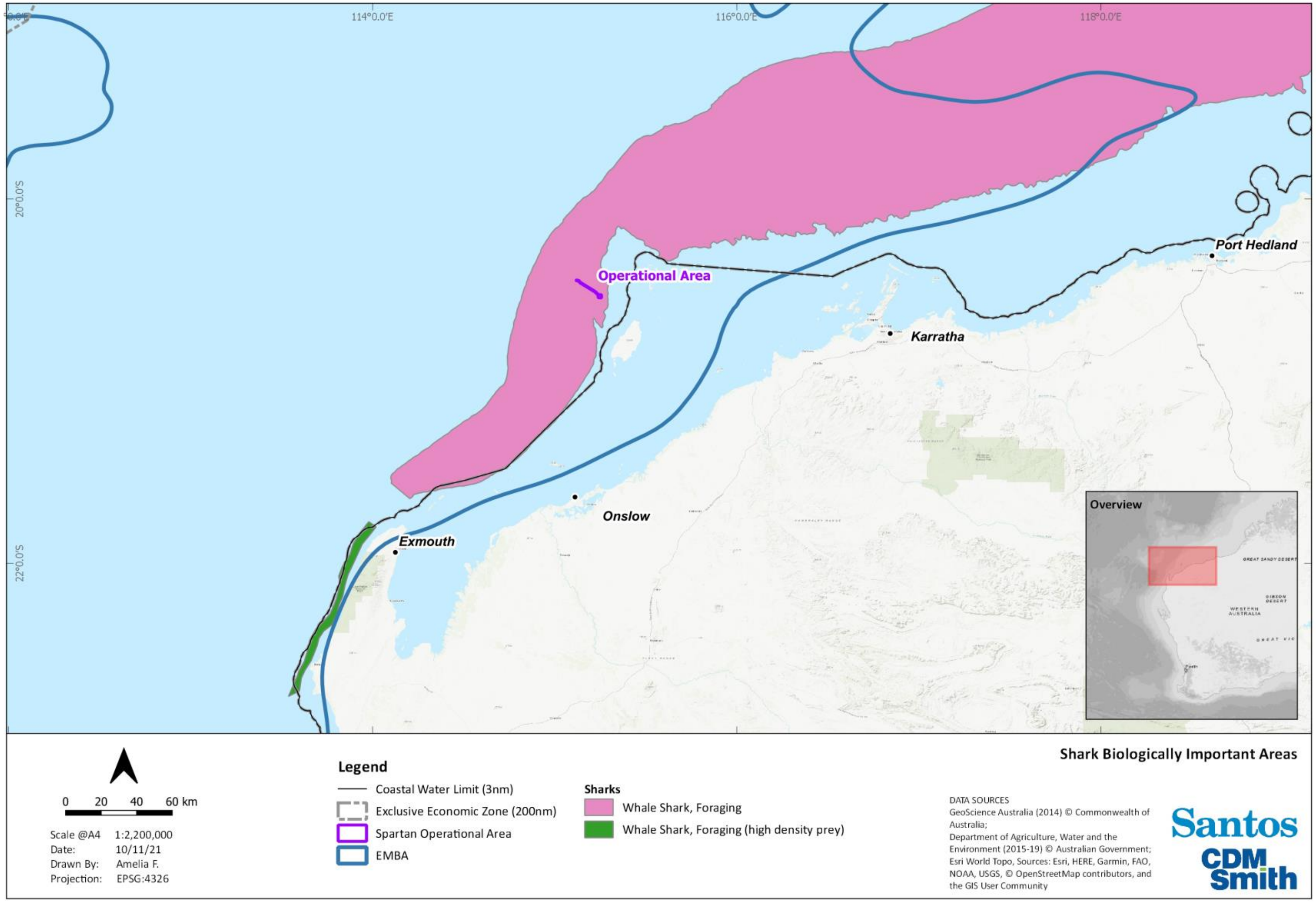

Figure 3-9: Biologically important areas for protected Whale Sharks within the vicinity of the EMBA and operational area

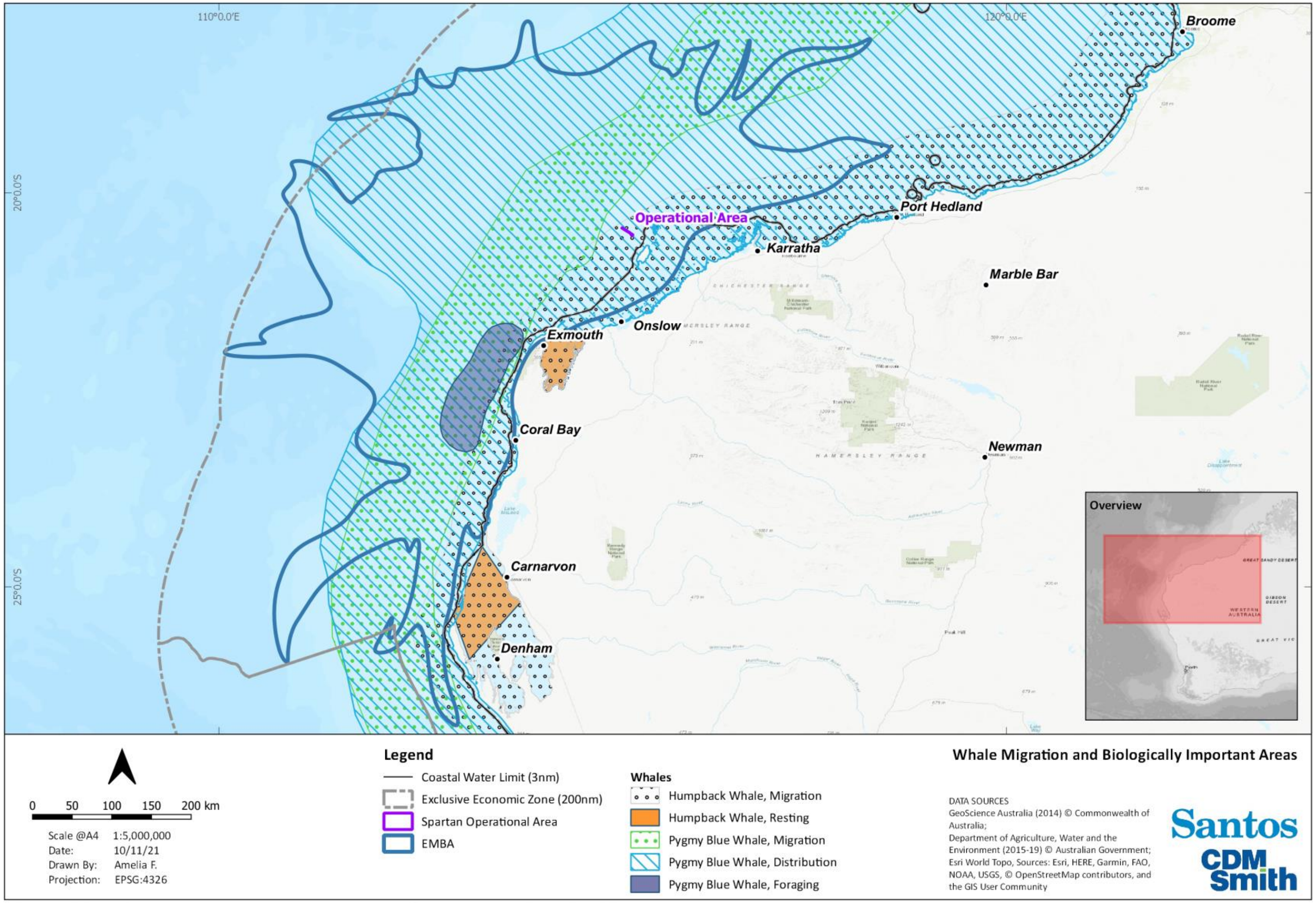

Figure 3-10: Biologically important areas for protected cetaceans within the vicinity of the EMBA and operational area

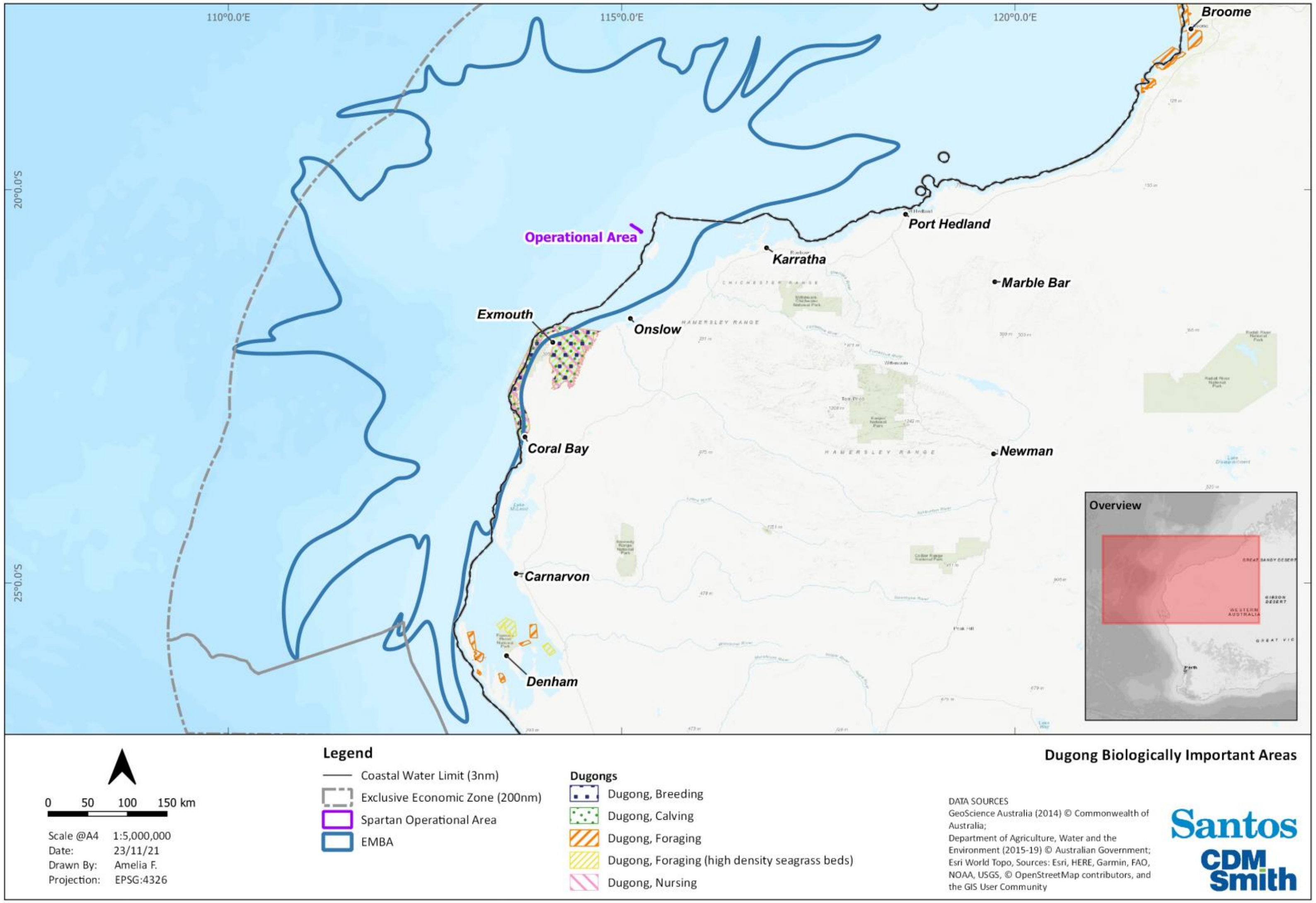

Figure 3-11: Biologically important areas for dugong within the vicinity of the EMBA and operational area

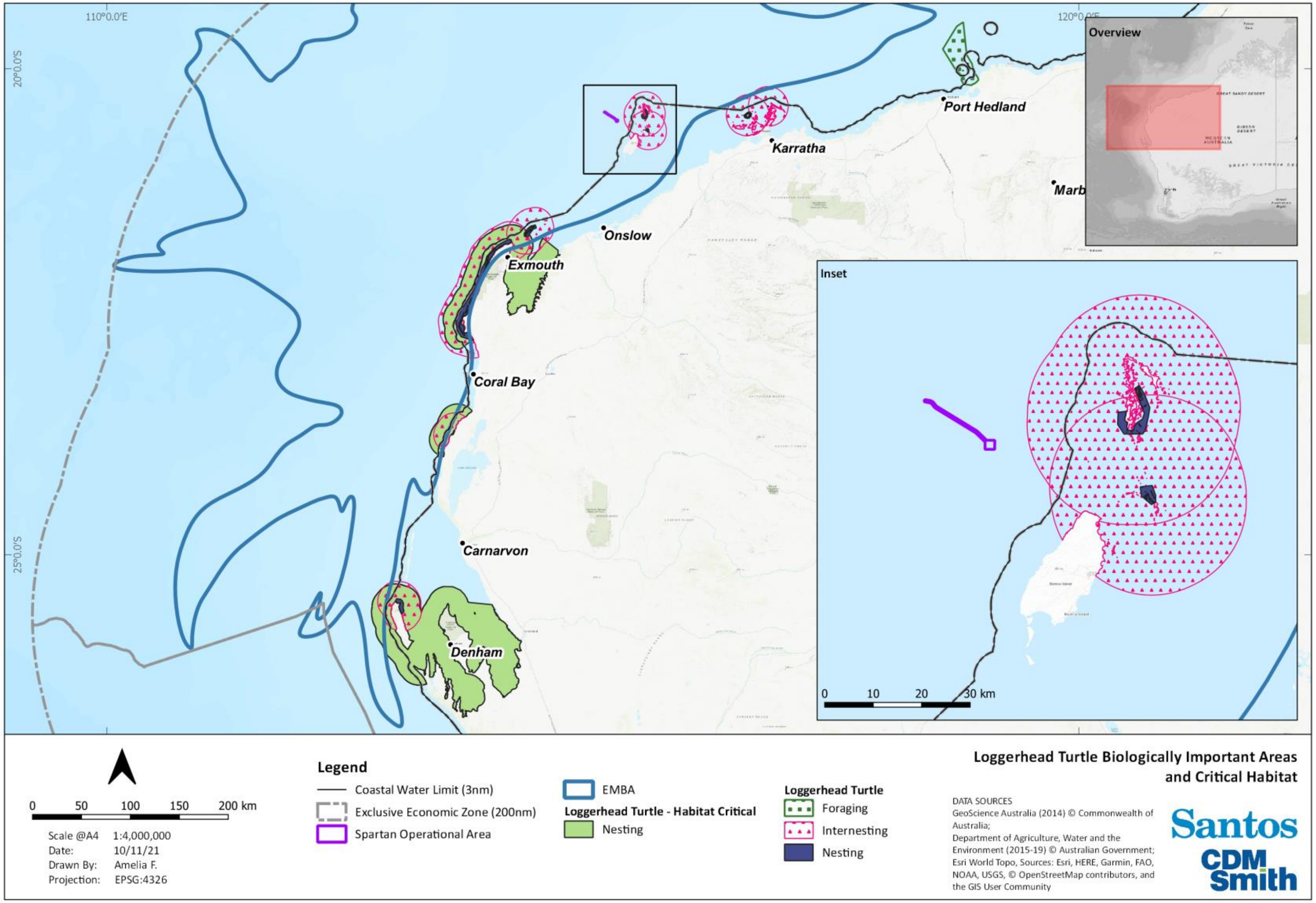

Figure 3-12: Biologically important areas for Loggerhead turtles within the vicinity of the EMBA and operational area

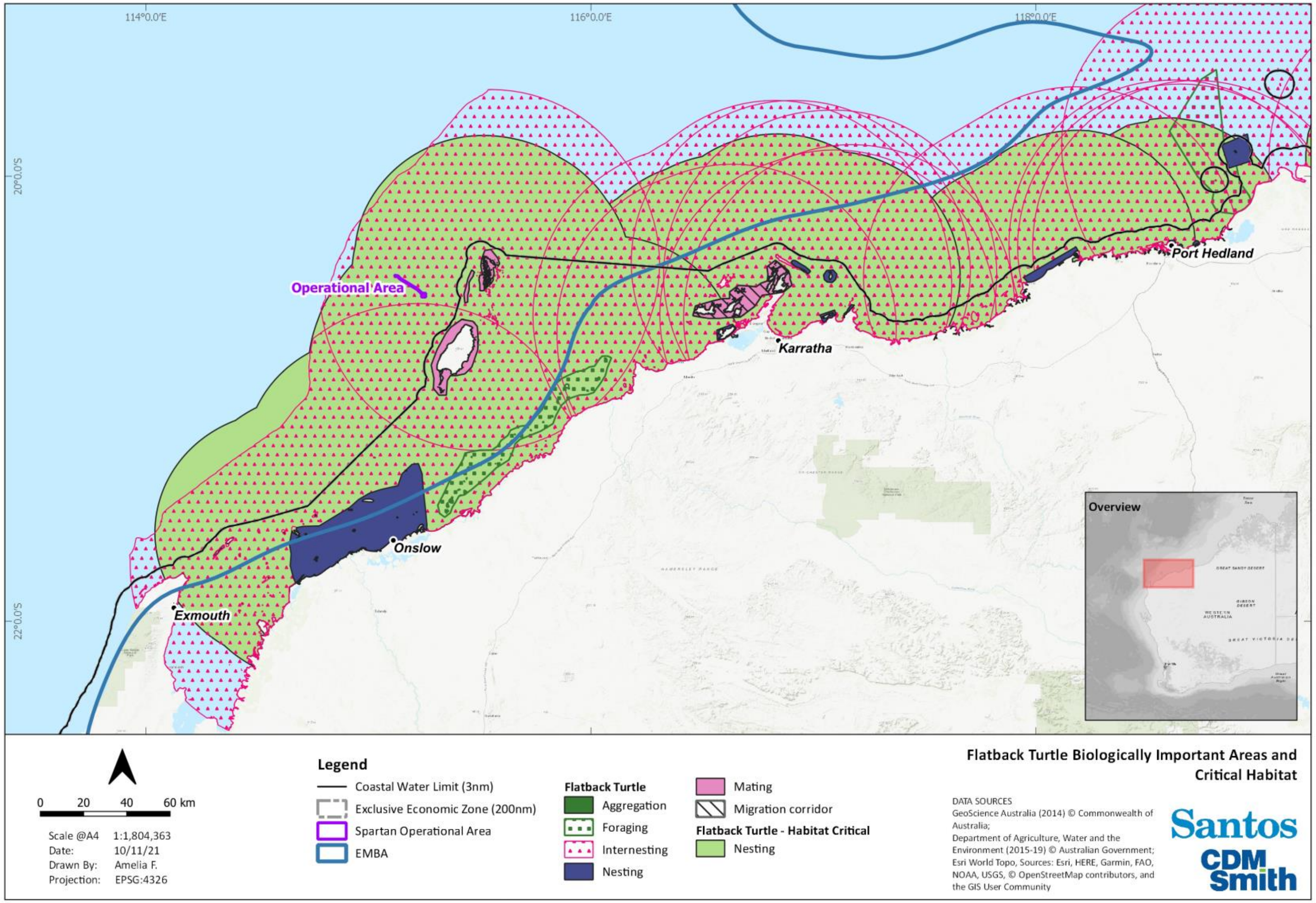

Figure 3-13: Biologically important areas for flatback turtles within the vicinity of the EMBA and operational area

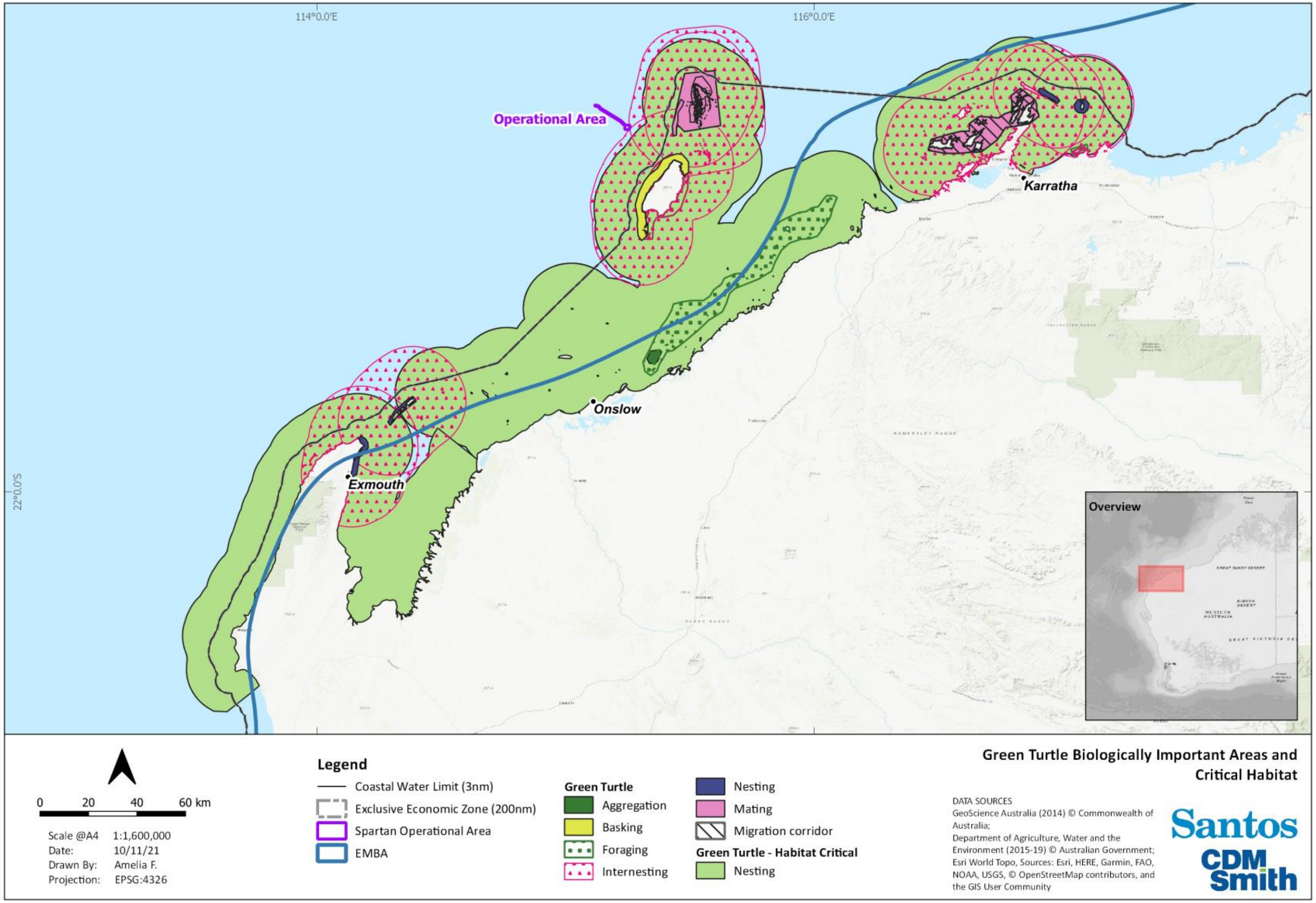

Figure 3-14: Biologically important areas for green turtles within the vicinity of the EMBA and operational area

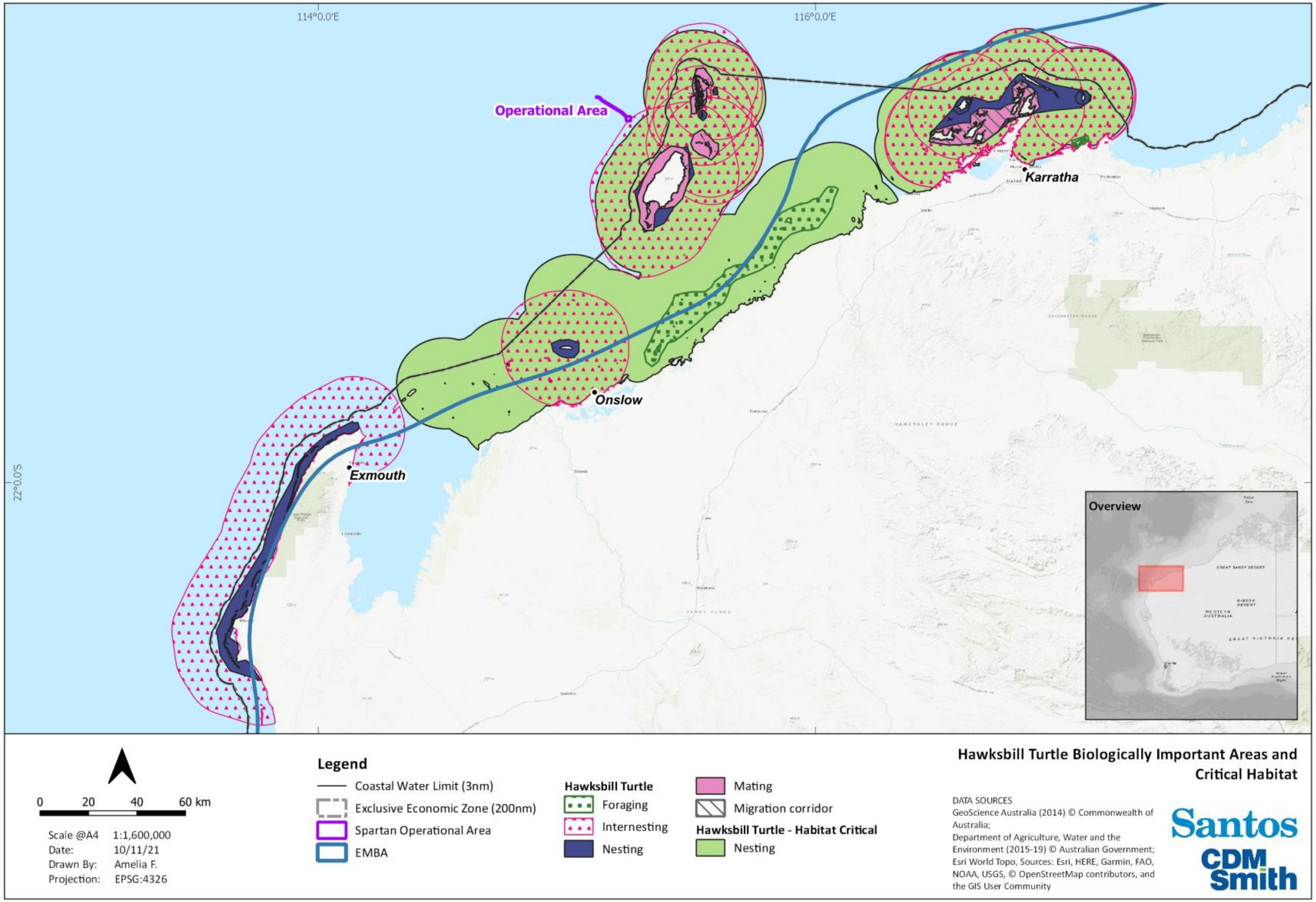

Figure 3-15: Biologically important areas for hawksbill turtles within the vicinity of the EMBA and operational area

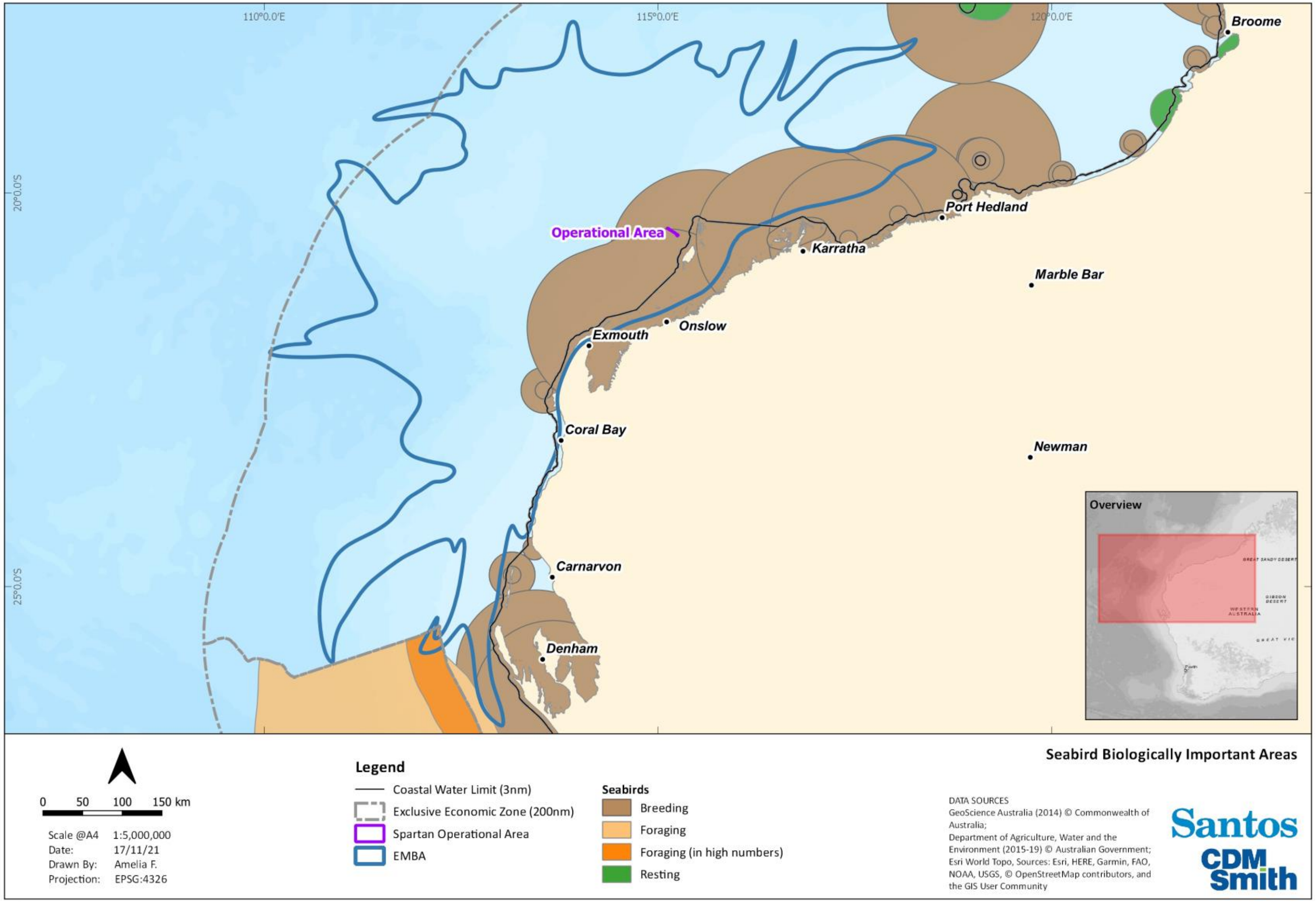

Figure 3-16: Biologically important areas for seabirds within the vicinity of the EMBA and operational area

3.2.4.2 Recovery plans

Recovery Plans set out the research and management actions necessary to stop the decline of and support the recovery of listed threatened species. **Table 3-9** summarises the actions relevant to the activity with more information on the specific requirements of the relevant plans of management (including conservation advices, recovery plans and management plans for marine fauna) that would be applicable to the activity, and demonstrates where current management requirements have been considered.

Species that occur in the EMBA only may be affected by marine pollution (from unplanned hydrocarbon release). However, species that occur in the operational areas have the potential to be impacted by planned (e.g., noise emissions) and unplanned (e.g., vessel strike) events.

Table 3-9: Relevant threats identified in Recovery Plans, Conservation Advice and Management Plans for species that occur or may occur within the operational areas and environment that may be affected

Receptor	Recovery Plan, Conservation Advice or Management Plan	Threats/Strategies Identified as Relevant to the Activity	Addressed Where Relevant for Receptor Groups in EP Section
All Vertebrate Fauna			
All vertebrate fauna	Threat Abatement Plan for Impacts of Marine Debris on Vertebrate wildlife of Australia's coasts and oceans (DoEE, 2018)	Marine debris	**7.1**
Fish/Sharks/Rays			
Dwarf sawfish	Approved Conservation Advice for *Pristis clavata* (Dwarf Sawfish) (DEWHA, 2009)	Habitat degradation and modification	**6.6, 6.7, 7.1, 7.6, 7.7**
	Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015a)		
	Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015a)		
Green sawfish	Commonwealth Conservation Advice on *Pristis zijsron* (green sawfish) (DEWHA, 2008a)	Habitat degradation and modification	**6.6, 6.7, 7.1, 7.6, 7.7**
	Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015a)		
Great white shark	Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013a)	Ecosystem effects as a result of habitat modification and climate change	**6.6, 6.7, 7.1, 7.6, 7.7**
Grey nurse shark	Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) (DoE, 2014b)	Pollution and disease	**6.6, 6.7, 7.1, 7.6, 7.7**
		Ecosystem effects – habitat modification and climate change	**6.6, 6.7, 7.1, 7.6, 7.7**
	Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015a)		
Whale shark		Vessel strike	**7.3**

Receptor	Recovery Plan, Conservation Advice or Management Plan	Threats/Strategies Identified as Relevant to the Activity	Addressed Where Relevant for Receptor Groups in EP Section
	Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015a)	Habitat disruption from mineral exploration, production and transportation	**6.6, 6.7, 7.6, 7.7**
Blind gudgeon	Approved Conservation Advice for *Milyeringa veritas* (blind gudgeon) (DEWHA, 2008b)	Habitat degradation and modification (as relevant to unplanned discharges, given the habitat of this species)	**7.6, 7.7**
Blind cave eel	Approved Conservation Advice for *Ophisternon candidum* (blind cave eel) (DEWHA, 2008d)	Habitat degradation and modification (as relevant to unplanned discharges, given the habitat of this species)	**7.6, 7.7**
Marine Mammals			
Blue whale	Blue Whale Conservation Management Plan 2015-2025 (DoE, 2015b)	Noise interference	**6.1**
		Habitat modification	**6.6, 6.7, 7.6, 7.7**
		Vessel disturbance	**7.3**
Southern right whale	Conservation Management Plan for the Southern Right Whale 2011-2021 (DSEWPaC, 2012)	Vessel disturbance	**7.3**
		Habitat modification	**7.6, 7.7**
		Noise interference	**6.1**
Fin whale	Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015b)	Anthropogenic noise and acoustic disturbance	**6.1**
		Habitat degradation including pollution (increasing port expansion and coastal development)	**6.6, 6.7, 7.6, 7.7**
		Pollution (persistent toxic pollutants)	**6.6, 6.7, 7.6, 7.7**
		Vessel strike	**7.3**

Receptor	Recovery Plan, Conservation Advice or Management Plan	Threats/Strategies Identified as Relevant to the Activity	Addressed Where Relevant for Receptor Groups in EP Section
Sei whale	Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (TSSC, 2015c)	Anthropogenic noise and acoustic disturbance	**6.1**
		Habitat degradation including pollution (increasing port expansion and coastal development)	**6.6, 6.7, 7.6, 7.7**
		Pollution (persistent toxic pollutants)	**6.6, 6.7, 7.6, 7.7**
		Vessel strike	**7.3**
		Human disturbance and direct killing	**7.3**
		Habitat degradation including coastal development and port expansion	**7.6, 7.7**
Humpback whale	Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015d)	Noise interference	**6.1**
		Vessel strike	**7.3**
		Habitat degradation including coastal development and port expansion	**6.6, 6.7, 7.6, 7.7**
Reptiles			
All marine turtles	National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (DoEE, 2020)	Light pollution	**6.2**
Short-nosed seasnake	Approved Conservation Advice for *Aipysurus apraefrontalis* (Short-nosed Sea Snake) (DSEWPaC, 2011a)	Deteriorating water quality	**6.6, 6.7, 7.6, 7.7**
		Marine debris	**7.1**
		Loss of habitat	**7.6, 7.7**
		Vessel disturbance	**7.3**
		Deteriorating water quality	**6.6, 6.7, 7.6, 7.7**

Receptor	Recovery Plan, Conservation Advice or Management Plan	Threats/Strategies Identified as Relevant to the Activity	Addressed Where Relevant for Receptor Groups in EP Section
Loggerhead turtle	Recovery Plan for Marine Turtles in Australia 2017 to 2027 (DoEE, 2017a)	Marine debris	**7.1**
		Loss of habitat	**7.6, 7.7**
		Vessel disturbance	**7.3**
		Light pollution	**6.2**
Green turtle	Recovery Plan for Marine Turtles in Australia 2017 to 2027 (DoEE, 2017a)	Deteriorating water quality	**6.6, 6.7, 7.6, 7.7**
		Marine debris	**7.1**
		Loss of habitat	**7.6, 7.7**
		Vessel disturbance	**7.3**
		Light pollution	**6.2**
Leatherback turtle	Recovery Plan for Marine Turtles in Australia 2017 to 2027 (2017)	Deteriorating water quality	**6.6, 6.7, 7.6, 7.7**
		Marine debris	**7.1**
		Loss of habitat	**7.6, 7.7**
		Vessel disturbance	**7.3**
		Light pollution	**6.2**
Hawksbill turtle	Recovery Plan for Marine Turtles in Australia 2017 to 2027 (DoEE, 2017a)	Deteriorating water quality	**6.6, 6.7, 7.6, 7.7**
		Marine debris	**7.1**
		Loss of habitat	**7.6, 7.7**
		Vessel disturbance	**7.3**
		Light pollution	**6.2**
Flatback turtle		Deteriorating water quality	**6.6, 6.7, 7.6, 7.7**

Receptor	Recovery Plan, Conservation Advice or Management Plan	Threats/Strategies Identified as Relevant to the Activity	Addressed Where Relevant for Receptor Groups in EP Section
	Recovery Plan for Marine Turtles in Australia 2017 to 2027 (DoEE, 2017a)	Marine debris	**7.1**
		Loss of habitat	**7.6, 7.7**
		Noise Interference	**6.1**
		Vessel disturbance	**7.3**
		Light pollution	**6.2**
Birds			
All seabirds and shorebirds	National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (DoEE, 2020)	Light pollution	**6.2**
Giant-petrels and albatrosses	National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC, 2011b)	Marine pollution	**7.6, 7.7**
Curlew sandpiper	Approved Conservation Advice for *Calidris ferruginea* (Curlew Sandpiper) (DoE, 2015c)	Habitat loss and degradation from pollution	**7.6, 7.7**
Eastern curlew	Approved Conservation Advice for *Numenius madagascariensis* (Eastern Curlew) (DoE, 2015d)	Habitat loss and degradation from pollution	**7.6, 7.7**
Australian fairy tern	Approved Conservation Advice for *Sternula nereis nereis* (Fairy Tern) (DSEWPaC, 2011c)	Habitat loss, disturbance and modifications Oil spills affecting breeding habitat	**7.6, 7.7**
Red knot	Approved Conservation Advice *Calidris canutus* (Red Knot) (TSSC, 2016a)	Habitat loss, disturbance and modifications Direct mortality (bird strike)	**7.6, 7.7**
Greater sand plover	Approved Conservation Advice *Charadrius leschenaultii* (Greater Sand Plover) (TSSC, 2016c)	Habitat loss and degradation from pollution	**7.6, 7.7**

Receptor	Recovery Plan, Conservation Advice or Management Plan	Threats/Strategies Identified as Relevant to the Activity	Addressed Where Relevant for Receptor Groups in EP Section
Lesser sand plover	Approved Conservation Advice *Charadrius mongolus* (Lesser Sand Plover) (TSSC, 2016d)	Habitat loss and degradation from pollution	**7.6, 7.7**
Christmas Island frigatebird	Approved Conservation Advice *Fregata andrewsi* (Christmas Island Frigatebird((TSSC, 2016e) National recovery plan for the Christmas Island Frigatebird (*Fregata andrewsi*) (Hill and Dunn, 2004)	Habitat loss, disturbance and modifications	**7.6, 7.7**
Australian lesser noddy	Approved Conservation Advice for *Anous tenuirostris melanops* (Australian Lesser Noddy) (TSSC, 2015g)	Habitat loss, disturbance and modifications	**7.6, 7.7**
Abbott's booby	Approved Conservation Advice for *Papasula abbotti* (Abbott's Booby) (TSSC, 2015h)	Habitat loss, disturbance and modifications	**7.6, 7.7**
Soft-plumaged petrel	Approved Conservation Advice for *Pterodroma mollis* (Soft-Plumaged Petrel) (TSSC, 2015i)	Habitat loss, disturbance and modifications	**7.6, 7.7**
Australian painted snipe	Approved Conservation Advice for *Rostratula australis* (Australian Painted Snipe) (DSEWPaC, 2013c)	Habitat loss, disturbance and modifications	**7.6, 7.7**

3.2.5 Socio economic receptors

The operational area is located approximately 155 km west of Dampier. Socio-economic activities that may occur in the operational areas include commercial fishing, oil and gas exploration and production, and, to a lesser extent, recreational fishing and tourism, as summarised in **Table 3-10**.

Table 3-10: Socio-economic activities that may occur in the operational areas

Value/Sensitivity	Description	Operational Area Presence	Relevant Events Within Operational Area	Relevant Events Within EMBA
Commercial fisheries – Commonwealth (**Figure 3-17**)	The management areas for three Commonwealth fisheries overlap the operational area (**Table 3-11**): + the Western Tuna and Billfish Fishery; + the Southern Bluefin Tuna Fishery; and + the Western Skipjack Tuna Fishery Although the fishery management zones overlap the operational area, activity within or near the operational area is not expected: + Since 2005, there has been fewer than five vessels active in the Western Tuna and Billfish Fishery, down from 50 active vessels in 2000 (ABARES Fishery Status Reports, 2019). + The Southern Bluefin Tuna Fishery is only active in waters offshore of south and south eastern Australia, confirmed in consultation with the Australia Southern Bluefin Tuna Association in consultation for previous Santos offshore activities (ABARES Fishery Status Reports, 2019). There has been no fishing effort in the Skipjack Tuna Fishery	✓	**<u>Planned</u>** Interaction with other users (**Section 6.5**)	**<u>Unplanned</u>** Unplanned hydrocarbon spills (**Sections 7.6** to **7.8**)

Value/Sensitivity	Description	Operational Area Presence	Relevant Events Within Operational Area	Relevant Events Within EMBA
	since the 2009 season, during which activity concentrated off South Australia (ABARES Fishery Status Reports, 2019).			
Commercial fisheries – State (**Figure 3-18** and **Figure 3-19**)	State fisheries management zones that overlap the operational area are (**Table 3-11**): + the Pilbara Trap, Line and Fish Trawl Managed Fisheries; + the Mackerel Fishery Area 2; + the Onslow Prawn Limited Entry Fishery; + Pearl Oyster Managed Fishery; and + Pilbara Developing Crab Fishery.	✓	**Planned** Interaction with other users (**Section 6.5**)	**Unplanned** Unplanned hydrocarbon spills (**Sections 7.6** to **7.8**)
Oil and gas (**Figure 3-20**)	Various petroleum exploration and production activities have been undertaken within the North West Shelf. The John Brookes pipeline, associated with Varanus Island Hub Operations passes through the operational area. Outside of the operational area, but within the permit areas the East Spar pipeline is crossed by four pipelines, two flowlines and two umbilicals owned by Chevron. The Pluto gas pipeline transects the southwest corner (approximately 6 km from the operational area). Vessels servicing oil and gas operations in the region may pass through the area en-route to facilities; however, since vessel transit is not classed as a petroleum activity, potential impacts to vessels are discussed under ‘Shipping’ below. Oil and gas facilities occur within the EMBA, as do permits	✓	**Planned** Interaction with other users (**Section 6.5**)	**Unplanned** Unplanned hydrocarbon spills (**Sections 7.6** to **7.8**)

Value/Sensitivity	Description	Operational Area Presence	Relevant Events Within Operational Area	Relevant Events Within EMBA
	operated by other titleholders. Thus, oil and gas activities could be impacted by unplanned events.			
Shipping **(Figure 3-21)**	Shipping using North West Shelf waters includes iron ore carriers, oil tankers and other vessels proceeding to or from the ports of Dampier, Port Walcott and Port Hedland; however, these are predominantly heading north from these ports. The proposed operational area does not overlap any major shipping lanes (more than 50 km away), although vessel traffic may be encountered throughout the operational area as commercial vessels transit around the Montebello Islands and support vessels conduct operations with the offshore infrastructure.	✓	**Planned** Interaction with other users (**Section 6.5**)	**Unplanned** Unplanned hydrocarbon spills (**Sections 7.6** to **7.8**)
Recreational fishing	Within the operational area, there are no known natural seabed features that would aggregate fishes and that are typically targeted by recreational fishers. Given the water depths and distance from the nearest mainland, it is unlikely recreational fishing would occur in the vicinity. Recreational fishing does occur within the EMBA and therefore could be impacted by a loss of well control.	–	**N/A**	**Unplanned** Unplanned hydrocarbon spills (**Sections 7.6** to **7.8**)
Defence **(Figure 3-22)**	A defence training area overlaps the operational area. In consultation, Defence has advised no concerns with this proposed activity.	✓	**N/A**	**N/A**
Shipwrecks	One hundred and thirty three shipwrecks are sited within the	–	**N/A**	**Unplanned**

Value/Sensitivity	Description	Operational Area Presence	Relevant Events Within Operational Area	Relevant Events Within EMBA
	EMBA. The closest shipwreck to the operational area is located approximately 31 km away.			Unplanned hydrocarbon spills (**Sections 7.6** to **7.8**)
Tourism	Owing to the water depths of the operational area, planned events are not predicted to have an impact on tourism. There are sources of marine-based tourism within the EMBA. Aquatic recreational activities, such as boating, diving and fishing, occur near the coast and Montebello Islands. These activities are concentrated in the vicinity of the population centres, such as Exmouth, Dampier and Onslow. The EMBA encompasses the Montebello Islands Marine Park, Barrow Island Marine Park and Marine Management Area; shoreline accumulation of oil may also occur within the Ningaloo Marine Park and Muiron Islands Marine Management Area (**Section 3.2.3**). Thus, ecotourism based on specific local values (game fish, nearshore reef snorkelling and diving) could be impacted by unplanned events.	–	**N/A**	**<u>Unplanned</u>** Unplanned hydrocarbon spills (**Sections 7.6** to **7.8**)
Cultural Heritage	No known sites of Aboriginal Heritage significance occur within the operational area. Within the EMBA, Barrow Island, Montebello Islands, Exmouth, Ningaloo Reef and the adjacent foreshores have a long history of occupancy by Indigenous communities.	–	**N/A**	**N/A**

3.2.5.1 Commercial fisheries

Offshore and coastal waters in the North West Marine Region support a valuable and diverse commercial fishing industry. The major fisheries in the Pilbara region target tropical finfish, large pelagic fish, crustaceans (prawns and scampi) and pearl oysters (Patterson et al., 2019).

These NWS region fisheries are managed by either the Department of Primary Industries and Regional Development (DPIRD) (State fisheries) with specific management plans, regulations and a variety of subsidiary regulatory instruments under the Fish Resources Management Act 1994; or by Australian Fisheries Management Authority (AFMA) that manages Commonwealth fisheries (within the 200 nautical mile Australian Fishing Zone).

Commonwealth and State fishery management areas overlapping with the operational area and the EMBA are illustrated in **Figure 3-17** to **Figure 3-19**. **Table 3-11** describes each of these fisheries.

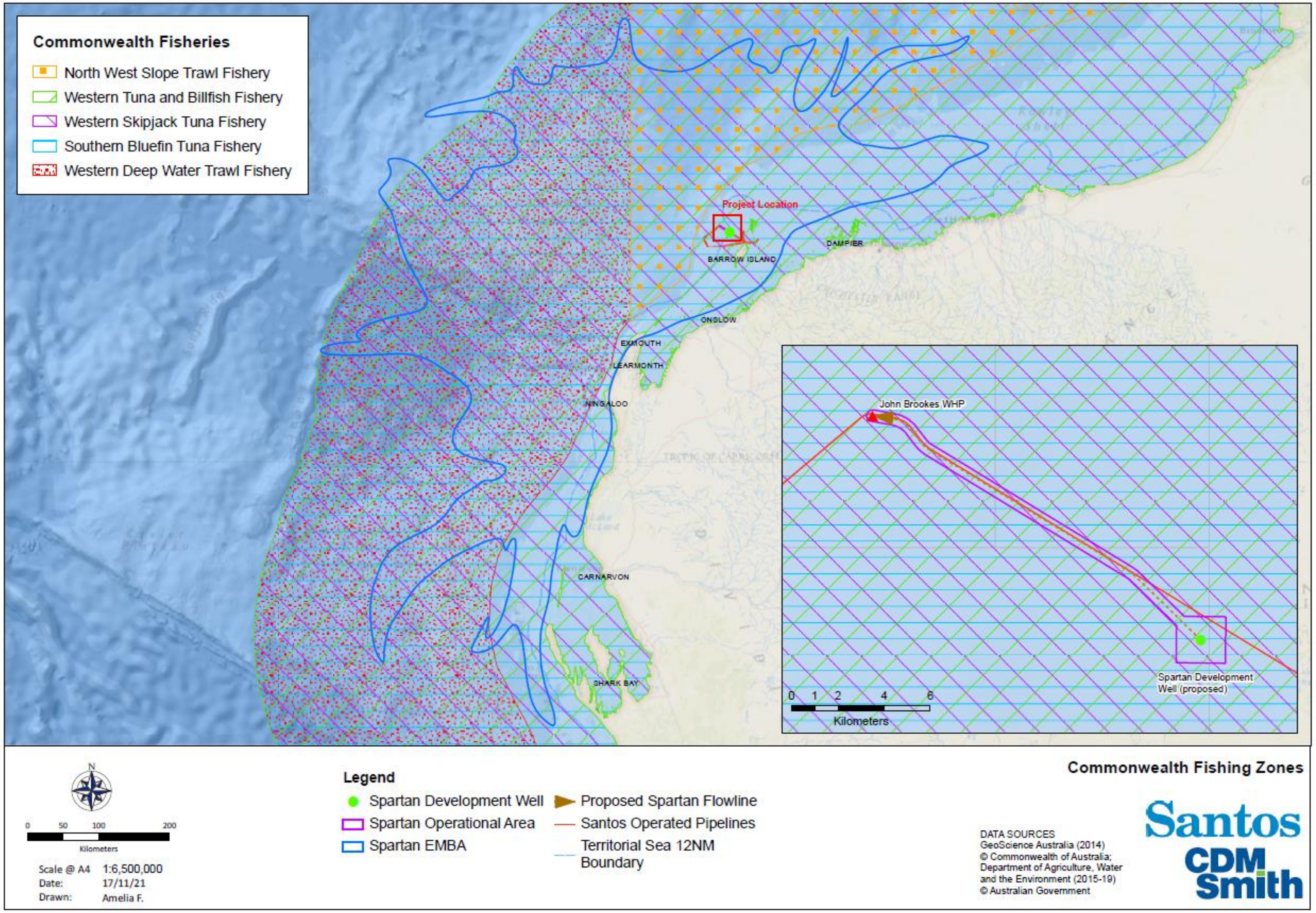

Figure 3-17: Commonwealth commercial fisheries within the environment that may be affected and operational area

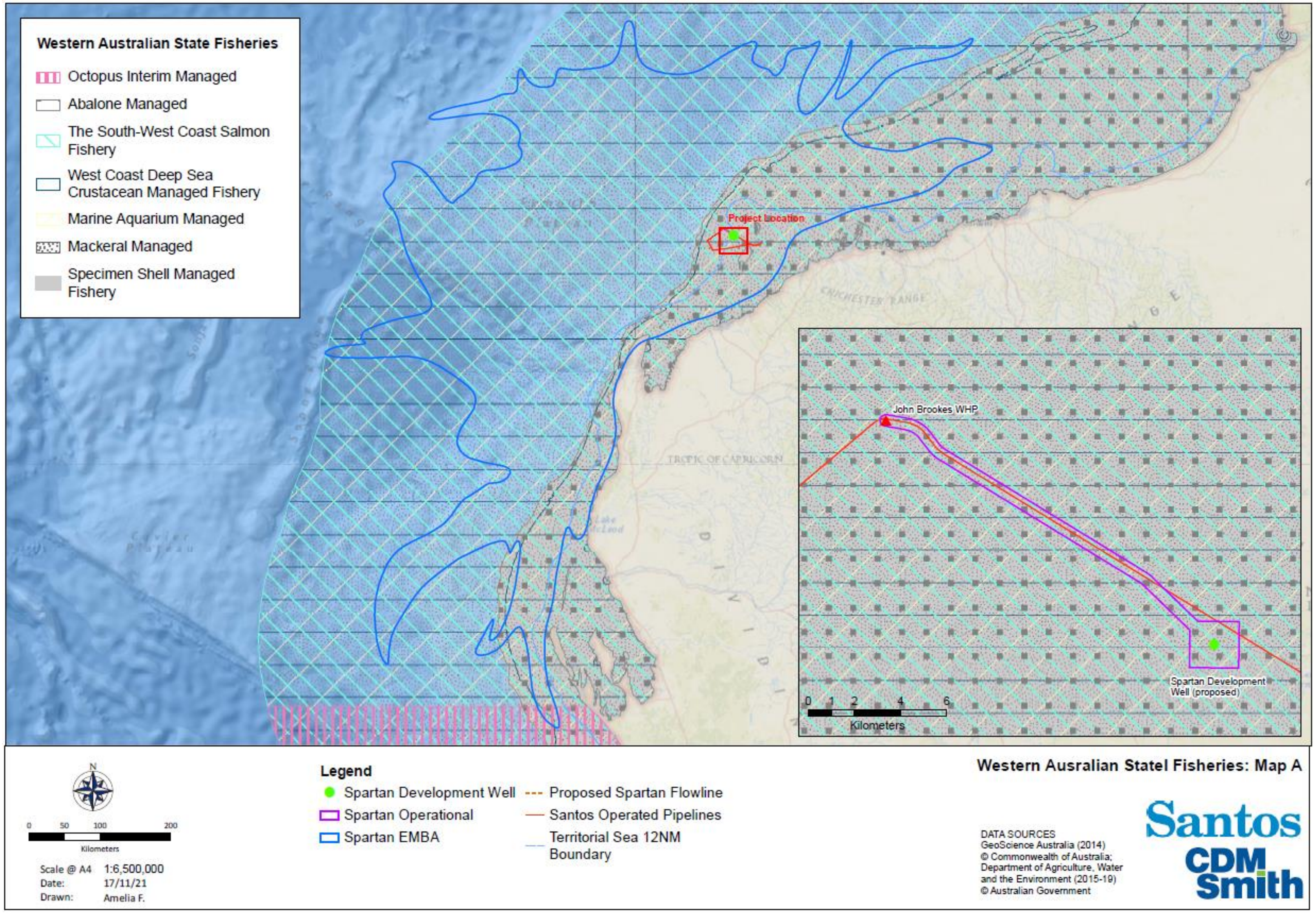

Figure 3-18: State commercial fisheries within the environment that may be affected and the operational area

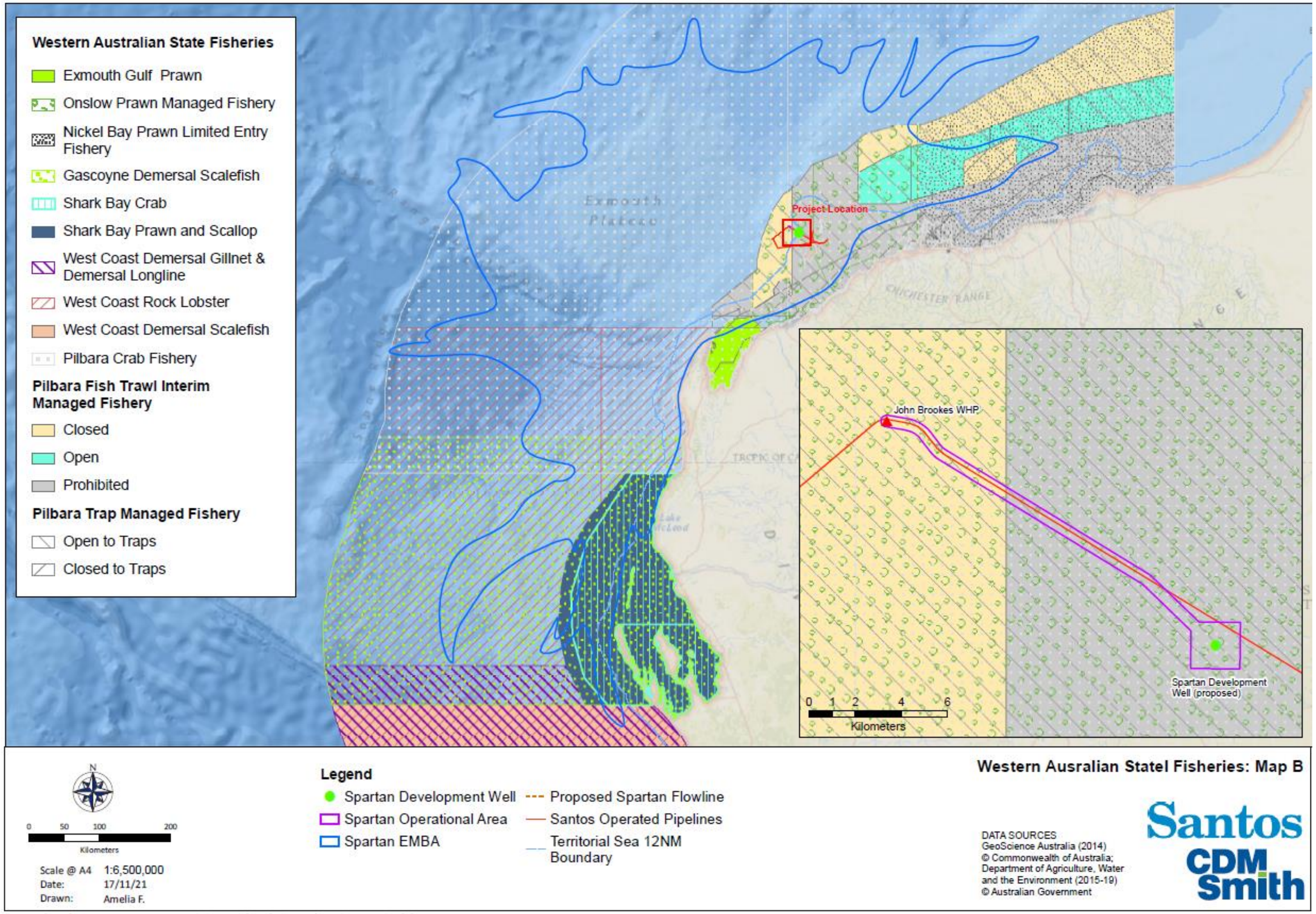

Figure 3-19: State commercial fisheries within the environment that may be affected and the operational area

Table 3-11: Commonwealth and State Managed Fisheries Permitted within the operational area and environment that may be affected

Fishery	Overlap: Op Area	Overlap: EMBA	Description	Relevant Events within the Operational Areas
Commonwealth Managed Fisheries				
Western Tuna and Billfish Fishery	✓	✓	Extends westward from Cape York Peninsula (142°30' E) off Queensland to 34° S off the WA west coast. It also extends eastward from 34° S off the west coast of WA across the Great Australian Bight to 141° E at the South Australian–Victorian border. Since 2005, there has been fewer than five vessels active in the Western Tuna and Billfish Fishery each year, which has reportedly declined from 50 active vessels in 2000 (Williams *et al.*, 2019). Fishing activity in the Western Tuna and Billfish Fishery concentrates in waters off southwest Western Australia, and off South Australia (Williams *et al.*, 2019).	No active commercial fishing in or near the operational area in the past years.
Southern Bluefin Tuna	✓	✓	Since 1992 juvenile Southern Bluefin Tuna have been targeted in the Great Australian Bight and waters off South Australia.	No active commercial fishing effort reported in WA, as fishing efforts are concentrated off South Australia.
Western Skipjack Tuna Fishery	✓	✓	There has been no fishing effort since the 2009 season in South Australia. No current effort on the NWS.	There has been no effort in the fishery since the 2008-09 fishing season (Patterson *et al.*, 2019).
North West Slope Trawl	✗	✓	Extends from 114° E to approximately 125° E off the WA coast between the 200 m isobath and the outer limit of the Australian Fishing Zone. Targets scampi and prawns.	N/A

Fishery	Overlap		Description	Relevant Events within the Operational Areas
	Op Area	EMBA		
Western Deepwater Trawl Fishery	✗	✓	Demersal trawl seaward of the 200 m isobaths. Fishing effort for a diverse range of tropical and temperate species.	N/A
State Managed Fisheries (North-west Bioregion)				
Exmouth Gulf Prawn Managed Fishery	✗	✓	Sheltered waters of Exmouth Gulf. Essentially the western half of the Exmouth Gulf (eastern part is a nursery ground). The Muiron Islands and Point Murat provide the western boundary; Serrurier Island provides the northern limit.	N/A
Nickol Bay Prawn Managed Fishery	✗	✓	Primarily targets banana prawns using otter trawl methods along the western part of the North West Shelf in coastal shallow waters.	N/A
Onslow Prawn Limited Entry Fishery	✓	✓	The boundaries of this fishery are 'all the Western Australian waters between the Exmouth Prawn Fishery and the Nickol Bay Prawn Fishery east of 114°39.9' on the landward side of the 200 m depth isobath'. Prawn trawling activities focus on inshore areas between Onslow and Karratha. Only five days of fishing effort was undertaken (one boat) in 2017, and total landings were negligible (Kangas *et al*., 2019).	As prawn trawling activities focus on inshore, shallow waters, planned events are not expected to impact fishing activities.

Fishery	Overlap		Description	Relevant Events within the Operational Areas
	Op Area	EMBA		
Pearl Oyster Fishery	✓	✓	The Pearl Oyster Fishery licence area extends from 114°10’ E near Exmouth to the WA/Northern Territory border, and out to the edge of the Australian Fishing Zone (200 nautical miles). The licence area is subdivided into four zones. The operational area is located within Zone 1 for the fishery. Zone 1 extends from 114°10’ E to 119°30’ E. There was no active fishing in Zone 1 of the Pearl Oyster Managed Fishery since 2016, however a small number of culture shells have been taken, which is restricted to shallow diving depths.	Given the water depths of the operational area, disruption to fishing activities are unlikely to occur.
Pilbara Demersal Scalefish Fisheries (includes trap and trawl fisheries)	✓	✓	Use a combination of vessels, effort allocations (time), gear limits, plus spatial zones (including extensive trawl closures) as management measures. The Trawl Fishery lands the largest component of the catch of demersal finfish in the Pilbara (and North Coast Bioregion) comprising more than 50 scalefish species. In comparison, the trap fishery retains a subset of about 45 to 50 scalefish species.	The operational area intersects trap and trawl fisheries. The operational area overlaps the prohibited and closed zones of the Pilbara Fish Trawl Interim Managed Fishery, however, this area is open to trap fishing. FishCube data did not identify any active trap fishing in the operational area. Once installed, Spartan infrastructure will be in close proximity to existing John Brookes infrastructure and marked on nautical charts, and there is only a 500 m exclusion zone during installation and drilling activities, impact due to planned activities is expected to be minimal.

Fishery	Overlap		Description	Relevant Events within the Operational Areas
	Op Area	EMBA		
Pilbara Line Fishery	✓	✓	The Pilbara Line Fishery fishing boat licensees are permitted to operate anywhere within 'Pilbara waters', bounded by a line commencing at the intersection of 21° 56' S latitude and the high water mark on the western side of the North West Cape on the mainland of Western Australia west along the parallel to the intersection of 21° 56' S latitude and the boundary of the Australian Fishing Zone and north to longitude 120° E. In the 2018 season there were nine individual licences in the Pilbara Line Fishery, held by seven operators (Newman *et al*., 2019).	In the 2018 season there were nine individual licences in the Pilbara Line Fishery, held by seven operators. According to FishCube data less than three vessels were active during the season, and no active fishing within the operational area.
Pilbara Crab Managed Fishery	✓	✓	The boundaries of this fishery includes waters between 114°39.9' E and 120° E, and on the landward side of the 200 m depth isobath.	Crabbing activity along the Pilbara coast is centred largely on the inshore waters from Onslow through to Port Hedland, with most commercial and recreational activity occurring in and around Nickol Bay (Gaughan and Santoro, 2018).
Mackerel Managed Fishery	✓	✓	Trolling or handline. Near-surface trolling gear from vessels in coastal areas around reefs, shoals and headlands.	The bulk of the total catch is taken in the Kimberley area therefore disruption is unlikely. FishCube data identified that this fishery has been active near to the operational area over the less 10 years, however less than three vessels were active in the area.
Western Coast Rock Lobster	✗	✓	This fishery targets the western rock lobster between Shark Bay and Cape Leeuwin. Baited traps (pots) and with a commercial and recreational fishing season.	N/A

Fishery	Overlap		Description	Relevant Events within the Operational Areas
	Op Area	EMBA		
West Coast Demersal Scalefish (Interim) Managed Fishery	✗	✓	Handline and drop line for west coast inshore and offshore demersal species.	N/A
Shark Bay Scallop, Crab and Prawn Limited Entry Fishery	✗	✓	Low opening otter trawls. The boundaries of the Shark Bay Prawn Managed Fishery and the Shark Bay Scallop managed Fishery are located in and near the waters of Shark Bay.	N/A
Gascoyne Demersal Scalefish	✗	✓	Mechanised handlines. Unlikely to occur.	N/A
State Managed Fisheries (Whole of State)				
Marine Aquarium Fish Fishery	✓	✓	All year. Effort in the operational areas is unlikely due to the depth and the dive-based method of collection. Unlikely to occur.	Disruption to fishing activities unlikely given water depths fisheries operate in.
Specimen Shell Managed Fishery	✓	✓	All year. Effort in the operational areas is unlikely due to the depth and the dive-based method of collection. Unlikely to occur.	
West Coast Deep Sea Crustacean Managed Fishery	✓	✓	Baited pots targeting crabs, occurs between Cape Leeuwin and the Northern Territory border on the seaward side of the 150 m isobath. There were six vessel operating in 2017 (How and Orme, 2019).	Given that fishing effort is concentrated south of Exmouth, interaction with fishers during the activity is unlikely.

Fishery	Overlap		Description	Relevant Events within the Operational Areas
	Op Area	EMBA		
Abalone Managed Fishery	✓	✓	The commercial fishery harvest method is a single diver working off a 'hookah' (surface-supplied breathing apparatus) using an abalone 'iron' to prise the shellfish off rocks.	Disruption is unlikely to occur in the operational areas due to depths and method of collection.
South-West Coast Salmon Fishery	✓	✓	There are currently six licences. Licensees are not restricted to specific beaches but in practice only a few beaches are fished (DEH, 2004). In 2018 there were three active vessels in this fishery (Stewart *et al.*, 2018).	Given the methods of fishing and level of effort and catch in previous years, interaction with fishers are not expected during the activity.

3.2.5.2 Recreational fisheries

The operational area occurs in the Gascoyne Coast Bioregion, which is a focal point for winter recreational fishing and is a key component of many tourist visits. Angling activities include beach and cliff fishing (e.g., Steep Point and Quobba), embayment and shallow-water boat angling (e.g., Shark Bay, Exmouth Gulf and Ningaloo lagoons), and offshore boat angling for demersal and larger pelagic species (e.g., off Ningaloo and the Montebello Islands).

The predominant target species include the tropical species, such as emperors, tropical snappers, groupers, mackerels, trevallies and other game fish. Temperate species at the northern end of their ranges, such as pink snapper, tailor and whiting, also provide significant catches, particularly in Shark Bay (WAFIC, 2016).

3.2.5.3 Petroleum industry

There are several exploration and production permits and leases throughout the Western Australian and Commonwealth Waters in the operational area and the EMBA, as shown in **Figure 3-20**.

There are also domestic gas plants on Varanus Island in the North West Shelf, Devil Creek Gas Plant onshore and Macedon Gas Plant in the Pilbara region, and an oil facility near Dongara called Cliff Head.

3.2.5.4 Shipping

The operational area does not overlap any designated shipping routes (AMSA, 2021), with the nearest shipping fairway approximately 20 km away. Commercial shipping moves through the offshore waters en-route to or from the marine terminals at Barrow and Varanus Islands. Shipping using NWS waters includes iron ore carriers, oil tankers and other vessels proceeding to or from the ports of Dampier, Port Walcott and Port Hedland (**Figure 3-21**). Large cargo vessels carrying freight bound or departing from Fremantle, transit along the WA coastline heading north and south in deeper waters.

3.2.5.5 Tourism

Given the water depths of the operational area and the lack of notable seabed features, there are no known tourism-based activities in the surrounding waters of the operational areas.

Popular water-based activities that may occur in the EMBA include fishing, swimming, snorkelling, diving, surfing, windsurfing, kiting and boating. Within the EMBA these activities are concentrated in the vicinity of the population centres such as Exmouth, Dampier, Onslow, Point Samson and Port Hedland

Seasonal nature-based tourism, such as humpback whale watching, whale shark encounters and tours of turtle hatching, mainly occurs around Ningaloo Reef and Cape Range National Park (Tourism Western Australia, 2014). Seasonal aggregations of whale sharks, manta rays, sea turtles and whales, as well as the annual mass spawning of coral, attract large numbers of visitors to Ningaloo each year (CALM, 2005).

Given the water depths of the operational area and the lack of notable seabed features, there are unlikely to be any tourism-based activities in the surrounding waters of the operational area. The nearest area where recreation is likely to occur is the Montebello Islands, which are located approximately 30 km from the operational area.

3.2.5.6 Defence

A defence training area overlaps the operational area (**Figure 3-22**). In consultation, Defence has advised no concerns with this proposed activity.

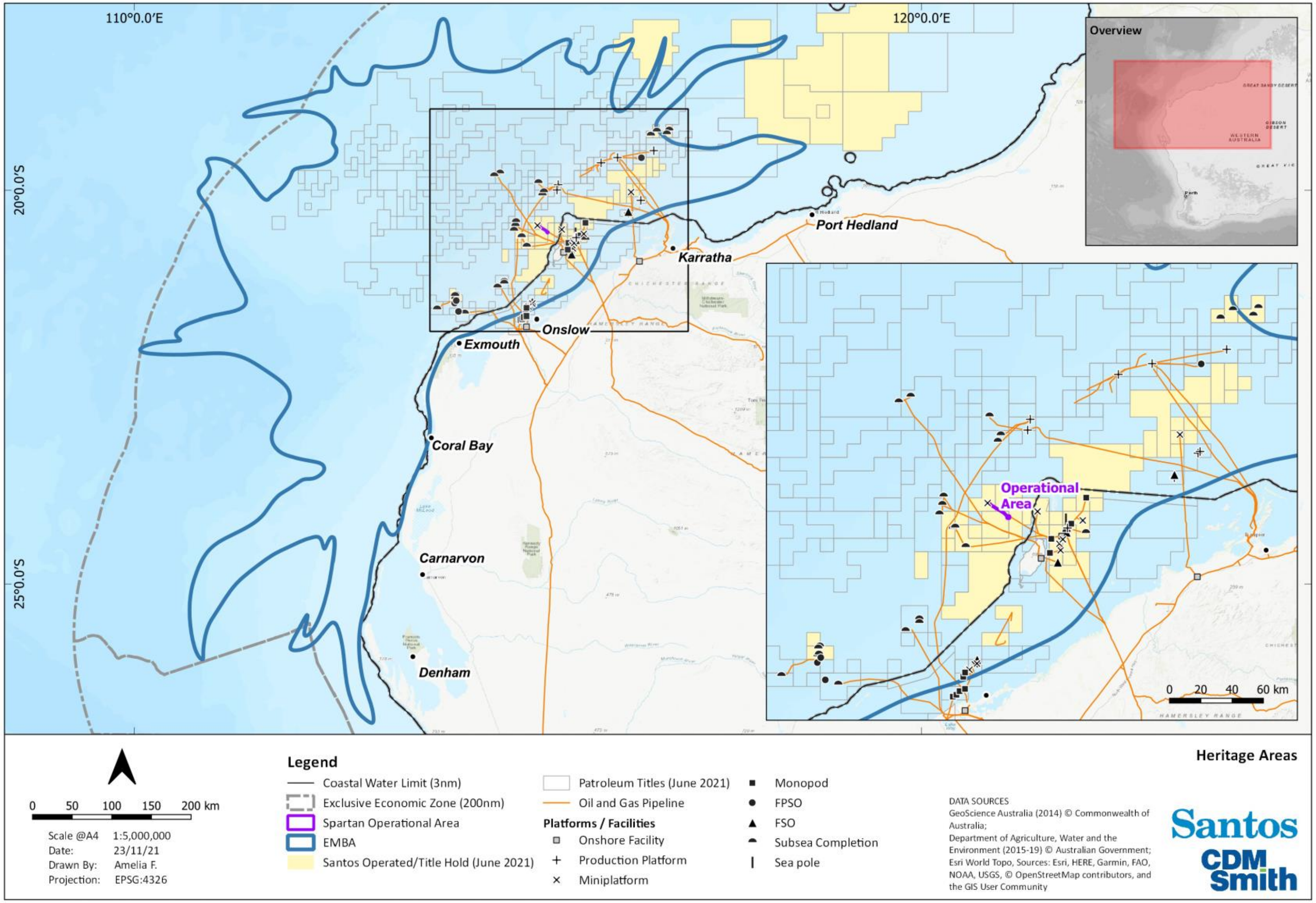

Figure 3-20: Existing oil and gas infrastructure within the environment that may be affected

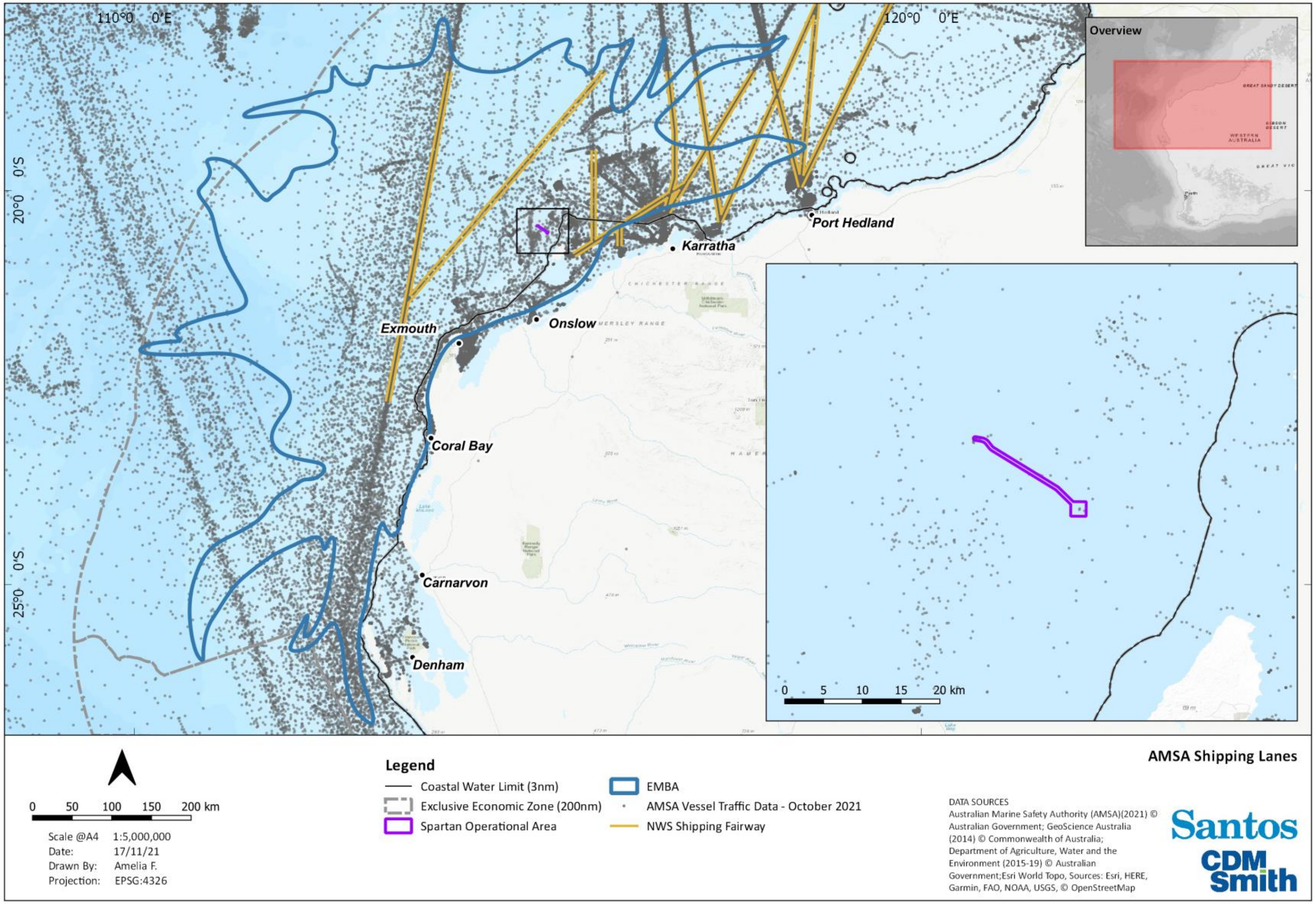

Figure 3-21: Australian Maritime Safety Authority ship locations and shipping routes within and close to the environment that may be affected

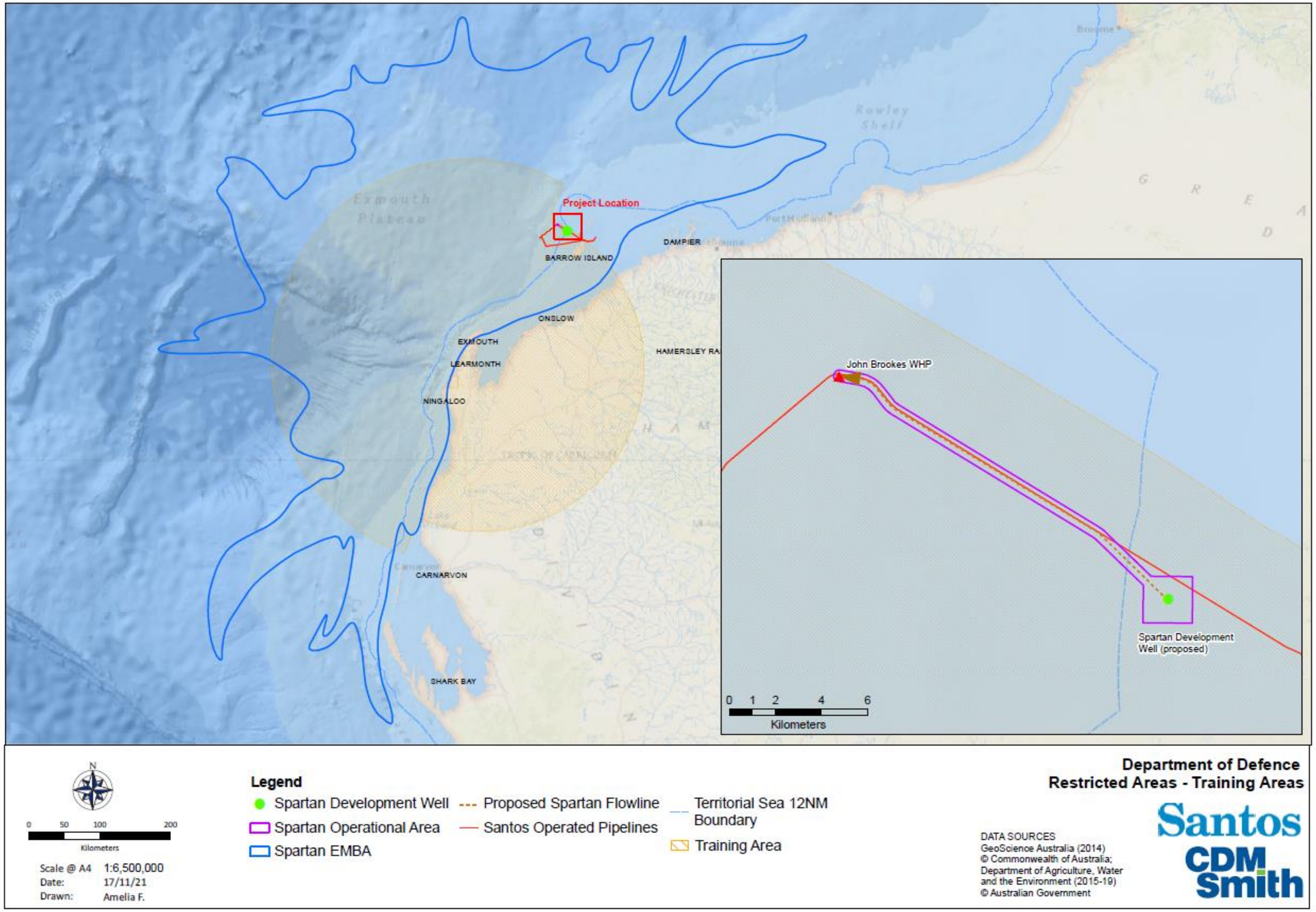

Figure 3-22: Department of Defence training areas within the operational area and environment that may be affected

4 Stakeholder Consultation

OPGGS(E)R 2009 Requirements
Regulation 9AB
If the Regulator's provisional decision under Regulation 9AA is that the environment plan includes material apparently addressing all the provisions of Division 2.3 (Contents of an environment plan), the Regulator must publish on the Regulator's website as soon as practicable: (a) the plan with the sensitive information part removed; and (b) the name of the titleholder who submitted the plan; and (c) a description of the activity or stage of the activity to which the plan relates; and (d) the location of the activity; and (e) a link or other reference to the place where the accepted offshore project proposal (if any) is published; and (f) details of the titleholder's nominated liaison person for the activity.
Regulation 14(9)
The implementation strategy must provide for appropriate consultation with: (b) relevant authorities of the Commonwealth, a State or Territory; and (c) other relevant interested persons or organisations.
Regulation 16
The environment plan must contain the following: (d) report on all consultations between the operator and any relevant person, for Regulation 11A, that contains: (i) a summary of each response made by a relevant person; and (ii) an assessment of the merits of any objection or claim about the adverse impact of each activity to which the environment plan relates; and (iii) a statement of the operator's response, or proposed response, if any, to each objection or claim; and (iv) a copy of the full text of any response by a relevant person.

4.1 Summary

Stakeholders in **Table 4-1** were informed of activities covered in this EP commencing in September 2021, principally via provision of a Spartan VI Operations Hub Environment Plan Revision consultation package. The package was distributed to identified stakeholders, including provision of maps showing the Operational Area relevant to specific stakeholder interests where relevant.

Santos' Quarterly Consultation Update issued in November 2021 also contained reference to the Spartan VI Operations Hub Environment Plan Revision and this update is provided to a number of the stakeholders identified in Table 4-2**.**

Based on Santos' experience with previous activities in the basin and from subsequent stakeholder feedback and regulator discussions, the primary stakeholder issues of concern for this activity are:

+ interaction with other marine users and commercial fishers (addressed in **Section 6.5**).

Santos notes that information provided to stakeholders referenced some activities taking place in Retention Lease WA-33-R. This petroleum permit has been converted to a Production Licence. Santos has chosen not to provide an update to stakeholders as there has been no change to planned activities and the Operational Areas. There has also been no change to the spatial dimensions of the petroleum permit in the conversion to a Production Licence.

Santos has considered all stakeholder responses and assessed the merits of all objections and claims about the potential impact of the proposed activity. The process adopted to assess these claims is outlined in **Section 4.4**. A summary of Santos' response statements to the objections and claims is provided in **Table 4-2** and any specific commitments made as a result of stakeholder consultation are listed in **Table 8-2,** or **Table 8-4** if it is a notification requirement. Control measures and environmental performance standards for the proposed activity are listed in **Table 8-2.**

Santos considers that consultation with relevant stakeholders has been adequate to inform the development of this EP. Notwithstanding this, Santos recognises the importance of ongoing stakeholder consultation, and this is described in **Section 4.5.**

4.2 Stakeholder Identification

Santos understands retaining a broad licence to operate depends on the development and maintenance of positive and constructive relationships with a comprehensive group of stakeholders in the community, government, non-government, other business sectors and other users of the marine environment. Fostering effective consultation between Santos and relevant stakeholders is an important part of this process.

Santos began the stakeholder identification process for this EP with a review of its stakeholder database, including stakeholders consulted for other recent activities in the area. The list of stakeholders was then reviewed and refined based on the defined operational areas (refer to **Section 2.1)** and the relevance of the stakeholder according to Regulation 11A of the OPGGS (E) Regulations and NOPSEMA Bulletin #2 Clarifying statutory requirements and good practice consultation (November, 2019).

More specifically, stakeholders for this EP were identified through:

+ regular review of legislation applicable to petroleum and marine activities
+ identification of marine user groups and interest groups active in the area (e.g., commercial fisheries, other oil and gas producers, merchant shipping)
+ a review of the most recent DPIRD FishCube data as required
+ updated fishing licence holder contact details, from these identified fisheries, as provided by DPIRD
+ discussions with identified stakeholders to identify other potentially impacted persons
+ active participation in industry bodies and collaborations (e.g., APPEA, AMOSC, National Energy Resources Australia)

Currently identified stakeholders and an assessment of their relevance under the OPGGS (E) Regulations for the purposes of consultation for this activity are listed in **Table 4-1**.

Table 4-1: Assessment of relevance of identified stakeholders for the proposed activity

Stakeholder	Relevant to Activity	Relevance/reason for engagement
Commonwealth Government Departments/Agencies		
Australian Border Force (Maritime Border Command)	Considered relevant persons under Regulation 11A(1) (a)	Maritime Border Command is Australia's lead civil maritime security authority and ensures Australia's maritime safety.
Australian Fisheries Management Authority	Considered relevant persons under Regulation 11A(1) (a)	AFMA is responsible for managing Commonwealth fisheries and is a relevant agency where the activity has the potential to impact on fisheries resources in AFMA-managed fisheries. The operational area intersects Commonwealth-managed fisheries. While there has been no recent fishing effort in these fisheries, Santos has consulted AFMA given its interest in petroleum activities where licence holders are entitled to fish.
Australian Hydrographic Office (AHO)	Considered relevant persons under Regulation 11A(1) (a)	The AHO is the part of the Commonwealth Department of Defence responsible for maintaining and disseminating nautical charts, including the distribution of Notice to Mariners. The operational area is in Commonwealth waters.
Australian Maritime Safety Authority (AMSA) – maritime safety	Considered relevant persons under Regulation 11A(1) (a)	AMSA is the statutory and control agency for maritime safety and vessel emergencies in Commonwealth Waters. AMSA is a relevant agency when proposed offshore activities may impact on the safe navigation of commercial shipping in Australian waters. The operational area is in Commonwealth waters.
Australian Maritime Safety Authority (AMSA) – marine pollution	Considered relevant persons under Regulation 11A(1) (a)	AMSA is the statutory and control agency for marine pollution Commonwealth Waters. The operational area is in Commonwealth waters.
Department of Defence (Defence)	Considered relevant persons under Regulation 11A(1) (a)	Defence is a relevant agency where the proposed activity may impact operational requirements; encroach on known training areas and/or restricted airspace, or when nautical products or other maritime safety information is required to be updated. The operational area is in Commonwealth waters.

Stakeholder	Relevant to Activity	Relevance/reason for engagement
Department of Agriculture, Water and the Environment – Biosecurity (marine pests)	Considered relevant persons under Regulation 11A(1) (a)	The DAWE (marine pests) has primary policy and regulatory responsibility for managing biosecurity for incoming goods and conveyances, including biosecurity for marine pests. The Department is the relevant agency where an offshore activity has the potential to transfer marine pests between installations and mainland Australia. The operational area is in Commonwealth waters.
Department of Agriculture, Water and the Environment – Fisheries	Considered relevant persons under Regulation 11A(1) (a)	DAWE (fisheries) has primary policy responsibility for promoting the biological, economic and social sustainability of Australian fisheries. The Department is the relevant agency where the activity has the potential to negatively impact fishing operations and/or fishing habitats in Commonwealth waters. The operational area intersects Commonwealth-managed fisheries. While there has been no recent fishing effort in these fisheries, Santos has consulted DAWE given its interest in petroleum activities where licence holders are entitled to fish.
Department of Agriculture, Water and the Environment –Biosecurity (vessels, aircraft and personnel)	Considered relevant persons under Regulation 11A(1) (a)	DAWE (vessels and aircraft) has inspection and reporting requirements to ensure that all conveyances (vessels, installations and aircraft) arriving in Australian territory comply with international health regulations and that any biosecurity risk is managed. The department is the relevant agency where the titleholder's activity involves: + the movement of aircraft or vessels between Australia and offshore petroleum activities either inside or outside Australian territory + the exposure of an aircraft or vessel (which leaves Australian territory not subject to biosecurity control) to offshore petroleum activities.
Department of Industry Science, Energy and Resources (DISER)	Considered relevant persons under Regulation 11A(1) (a)	DISER is the department of the relevant Commonwealth Minister and is required to be consulted under subregulation 11A (1) of the Environment Regulations.
Director of National Parks (DNP)	Considered relevant persons under Regulation 11A(1) (a)	The DNP is the statutory authority responsible for administration, management and control of Commonwealth marine reserves (CMRs). The Director of National Parks is a relevant person for consultation where: + the activity or part of the activity is within the boundaries of a proclaimed Commonwealth marine reserve + activities proposed to occur outside a reserve may impact on the values within a

Stakeholder	Relevant to Activity	Relevance/reason for engagement
		Commonwealth marine reserve, and/or + an environmental incident occurs in Commonwealth waters surrounding a Commonwealth marine reserve and may impact on the values within the reserve.
State Government Departments/Agencies		
Department of Biodiversity, Conservation and Attractions (DBCA)	Considered relevant persons under Regulation 11A(1) (b)	DBCA is a relevant State agency responsible for the management of State marine parks and reserves and protected marine fauna and flora.
Department of Mines, Industry Regulation and Safety (DMIRS)	Considered relevant persons under Regulation 11A(1) (c)	DMIRS is the department of the relevant State Minister and is required to be consulted under subregulation 11A (1) of the Environment Regulations.
Department of Primary Industries and Regional Development	Considered relevant persons under Regulation 11A(1) (b)	DPIRD is responsible for managed West Australian State fisheries. The operational area intersects State-managed fisheries, of which the Mackerel Managed Fishery (Area 2) has been active in the Operational Area.
Department of Transport (DoT)	Considered relevant persons under Regulation 11A(1) (b)	DoT is the control agency for marine pollution emergencies in State waters.
Industry Bodies		
Australian Petroleum Production & Exploration Association (APPEA)	Considered relevant persons under Regulation 11A(1) (e)	Peak industry association for companies that explore and produce oil and gas in Australia. APPEA has facilitated industry-wide discussion aimed at enhancing and strengthening Australia's offshore oil and gas decommissioning framework.
Australian Southern Bluefin Tuna Industry Association (ASBTIA)	Considered relevant persons under Regulation 11A(1) (e)	ASBTIA represents the Australian southern bluefin tuna industry. ASBTIA is also listed on the AFMA website as a contact for petroleum operators to use when consultation with Commonwealth fishing operators is required. The operational area intersects the Southern Bluefin Tuna Fishery. While there has been no recent fishing effort, Santos has consulted ASBTIA on behalf of licence holders who are entitled to fish in the Operational Area.
Commonwealth Fisheries Association (CFA)	Considered relevant persons under Regulation 11A(1) (e)	The CFA was engaged as a representative body for Commonwealth fisheries. The operational areas intersect with several Commonwealth-managed fisheries. The CFA is

Stakeholder	Relevant to Activity	Relevance/reason for engagement
		also listed on the AFMA website as a contact for petroleum operators to use when consultation with fishing operators is required. The operational area intersects the Western Skipjack Tuna Fishery. While there has been no recent fishing effort, Santos has consulted CFA on behalf of licence holders who are entitled to fish in the Operational Area.
Marine Tourism WA (MTWA)	Considered relevant persons under Regulation 11A(1) (e)	MTWA represents the charter sector in WA. MTWA is identified as being able to assist in reaching its membership to inform them of activity timing should this be requested. While marine tourism is unlikely in the operational area, Santos has consulted MTWA on behalf of member companies who are entitled to undertake activities in the Operational Area.
Pearl Producers Association (PPA)	Considered relevant persons under Regulation 11A(1) (e)	The PPA is the peak representative organisation of The Australian South Sea Pearling Industry. PPA membership includes all *Pinctada maxima* pearl oyster licensees that operate within the Australian North-west Bioregion. While there is no recent fishing effort in the operational area, Santos has consulted PPA based on previous request to be kept informed on Santos activities.
Recfishwest	Considered relevant persons under Regulation 11A(1) (e)	Recfishwest is the peak body representing recreational fishers in WA. Recfishwest is identified as being able to assist in reaching its membership to inform of activity timing should this be requested. While recreational fishing is unlikely in the operational area, Santos has consulted Recfishwest on behalf of recreational fishers who are entitled to undertake activities in the Operational Area.
Tuna Australia	Considered relevant persons under Regulation 11A(1) (e)	Represents statutory fishing right owners, holders, fish processors and sellers, and associate members of the Eastern & Western tuna and billfish fisheries. The operational area intersects the Western Billfish and Tuna Fishery. While there has been no recent fishing effort, Santos has consulted Tuna Australia on behalf of licence holders who are entitled to fish in the Operational Area.

Western Australian Fishing Industry Council	Considered relevant persons under Regulation 11A(1) (e)	WAFIC is the peak industry body representing the interests of the WA commercial fishing, pearling and aquaculture sector. The operational area intersects State-managed fisheries, of which the Mackerel Managed Fishery (Area 2) has been active in the Operational Area.
Commercial Fisheries – State Managed		
Mackerel Managed Fishery Area 2	Considered relevant persons under Regulation 11A(1) (d)	The operational area intersects the Mackerel Managed Fishery. DPIRD information indicates recent fishing effort (**Section 6.5)** and licence holders in this fishery should be consulted.
Other industry		
Chevron	Considered relevant persons under Regulation 11A(1) (d)	Finder is a nearby titleholder.
Other stakeholders		
Australian Marine Oil Spill Centre (AMOSC)	Considered relevant persons under Regulation 11A(1) (d)	AMOSC operates Australia's major oil spill response equipment stockpile on behalf of the Australian oil and gas industry.

Santos

4.3 Stakeholder Consultation

The approach to stakeholder consultation for this EP follows the process adopted by Santos for all its EPs. This includes:

+ providing more information to commercial fishers, targeted to their fishery, in the initial consultation packs
+ clearly identifying and maintaining current lists of 'relevant' persons
+ clearly documenting and tracking notification commitments to relevant persons.

Stakeholders, wherever possible, were provided personal emails with information tailored to their functions, interests and activities, including outlining why they have been identified as a relevant stakeholder.

The consultation package contains details such as an activity summary, location map, coordinates, water depth, distance to key regional features, exclusion zone details and estimated timing and duration. This consultation package outlined potential risks and impacts together with a summary of proposed management control measures.

Where relevant, individual fishing licence holders and representative bodies were also provided a map and information relevant to their specific fishery.

The intent of providing this level of information early in the consultation process was to facilitate each party proceeding with their business in a safe and efficient manner, and without loss or conflict, by minimising the extent of interruption by the activities on commercial fishing operators' activities to the lowest practicable level.

A summary of stakeholder consultation material is provided in **Table 4-2**.

Stakeholders were afforded at least six weeks to review consultation packs, although Santos accepted stakeholder feedback after this period.

4.4 Assessment of Stakeholder Objections and Claims

A summary of the stakeholder consultation undertaken for this EP, including Santos' assessment of all stakeholder comments received, is outlined in **Table 4-2**.

Full transcripts between Santos and stakeholders are provided in the *Spartan VI Operations Hub Environment Plan Revision Sensitive Stakeholder Information Report* (EA-60-RI-10003.03) as a confidential submission to NOPSEMA.

Santos adopted the following process to address objections and claims received during the consultation process:

1. Santos acknowledged receipt of all comments made by stakeholders.
2. Santos assessed the merits of all objections and claims made by stakeholders. This included assessing all reasonably available options for resolving or mitigating the degree to which a stakeholder's functions, interests or activities may be affected. Control measures were proposed and adopted where reasonably practicable.
3. Santos responded to all stakeholder objections and claims, and advised the stakeholder how each of their objections and claims would be addressed in the EP.

4. As soon as possible, or on publication of the EP on the NOPSEMA website, Santos advised all stakeholders, or their representative industry body that the EP was available for public review and comment.

A similar process was applied to information provided and requests made by stakeholders not deemed to be an objection or claim.

Santos recognises the importance of ensuring a high degree of transparency in how a titleholder manages ongoing stakeholder consultation during the life of an EP. As such, should additional stakeholder comments be received to those described in **Table 4-2**, Santos will assess the comments using the above process and update the EP to document the assessment of additional objections or claims.

In relation to stakeholder consultation Santos is of the opinion that Regulation 10A of the OPGGS(E) Regulations has been met.

Table 4-2: Consultation summary for Activity

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><th colspan="3">Commonwealth departments/agencies</th></tr>
<tr><td rowspan="3">Australian Fisheries Management Authority (AFMA)</td><td colspan="2">AFMA was provided the consultation package via email on 8 September 2021.
AFMA was sent a follow up email on 26 October 2021 acknowledging that while feedback had not been provided on this occasion, Santos had consulted the following representative organisations on behalf of relevant Commonwealth fishing licence holders:
• Australian Southern Bluefin Tuna Industry Association, representing Southern Bluefin Tuna Fishery licence holders
• Tuna Australia, representing Western Tuna and Billfish Fishery licence holders
• Commonwealth Fisheries Association, representing Western Skipjack Tuna Fishery licence holders
Santos has consulted associations as outlined in Table 4.1 on the basis that these fisheries have not been active in the Operational Area in recent years.
This stakeholder also receives Santos’ Quarterly Consultation Update for WA.
Santos has also consulted DAWE given its interests in the management of Commonwealth fisheries.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future</td></tr>
<tr><th>Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests</th><th>Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests</th></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td>Australian Hydrographic Office (AHO)</td><td colspan="2">AHO was provided the consultation package via email on 8 September 2021.
AHO acknowledged receipt of information 9 September 2021.
No formal response has been received from the AHO.
AHO notification requirements, as requested by AMSA and Defence (refer this table), are addressed in Table 8-4.
This stakeholder also receives Santos’ Quarterly Consultation Update for WA.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
</table>

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests	Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests
	No assessment required.	No response required.
Australian Maritime Safety Authority (AMSA) – maritime safety	AMSA was provided the consultation package via email on 8 September 2021. AMSA responded on 9 September 2021 requesting timely and relevant Maritime Safety Information is promulgated for the area and nature of operations as follows: + Contact the AHO at datacentre@hydro.gov.au no less than four weeks before operations, with details relevant to the operations. The AHO will promulgate the appropriate Notice to Mariners, which will ensure other vessels receive information on activities. **[REQUEST 001]** + Notify AMSA's Joint Rescue Coordination Centre (JRCC) by email rccaus@amsa.gov.au for promulgation of radio-navigation warnings at least 24-48 hours before operations commence. The JRCC will require vessel details (including name, callsign and Maritime Mobile Service Identity (MMSI)), satellite communications details (including INMARSAT-C and satellite telephone numbers), area of operation, requested clearance from other vessels and any other information that may contribute to safety at sea. JRCC will also need to be advised when operations start and end. **[REQUEST 002]** + Provide updates to both the Australian Hydrographic Office and the JRCC on progress and, importantly, any changes to the intended operations. **[REQUEST 003]** + Exhibit appropriate lights and shapes to reflect the nature of operations –we remind vessels of their obligation to comply with the International Rules for Preventing Collisions at Sea (COLREGs), in particular, the use of appropriate lights and shapes to reflect the nature of your operations (e.g., restricted in the ability to manoeuvre). Vessels should also ensure their navigation status is set correctly in the ship's Automatic Identification System (AIS) unit. **[REQUEST 004]** + To obtain a vessel traffic plot showing AIS traffic data for your area of interest, please visit AMSA's spatial data gateway and Spatial@AMSA portal to download digital data sets and maps. **[INFORMATION 001]** Santos responded to AMSA on 20 October 2021 and addressed the matters raised in its feedback of 9 September 2021 (refer assessment of stakeholder objections, claims, information and requests below). This stakeholder also receives Santos' Quarterly Consultation Update for WA. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	

Santos

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests	Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests
	[REQUEST 001] Santos will notify the AHO no less than four weeks before operations commence where practicable. Notification requirements are addressed in **Table 8-4**.	Santos responded to AMSA confirming the notifications requirements would be addressed in the EP.
	[REQUEST 002] Santos will notify AMSA's JRCC at least 24–48 hours before operations commence for each activity and advise when operations start and end. Notification requirements are addressed in **Table 8-4.**	Santos responded to AMSA confirming the notifications requirements would be addressed in the EP.
	[REQUEST 003] Santos will notify both AHO and AMSA's JRCC on any changes to the intended operations. Notification requirements are addressed in **Table 8-4**.	Santos responded to AMSA confirming the notifications requirements would be addressed in the EP.
	[REQUEST 004] Santos noted the advice on obligations to comply with COLREGs, in particular, the use of appropriate lights and shapes to reflect the nature of operations and this is addressed in **Section 6.2**.	Santos responded to AMSA and noted the information provided.
	[INFORMATION 001] Santos notes the information provided on traffic data.	Santos responded to AMSA and noted the information provided.
Australian Maritime Safety Authority (AMSA) – marine pollution	AMSA was provided the consultation package via email on 8 September 2021. No formal response has been received from AMSA. Management of oil spill preparedness is addressed in the Oil Pollution Emergency Plan in Section 3 and Section 4**.** Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests	Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests
	No assessment required.	No response required.
Department of Agriculture, Water and the Environment (DAWE) – Biosecurity (marine pests)	DAWE was provided the consultation package via email on 29 November 2021. No formal response has been received from the DAWE. Management of invasive marine pest species is addressed in **Section 7.2**. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests	Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests
	No assessment required.	No response required.
Department of Agriculture, Water and the Environment (DAWE) – fisheries	DAWE was provided the consultation package via email on 8 September 2021. No formal response has been received from the DAWE. Santos has assessed the impact to fish and commercial fisheries in **Section 6** and **Section 7**. While there has been no recent fishing effort in these fisheries, Santos has also consulted AMFA and representative bodies given their interest in petroleum activities where licence holders are entitled to fish. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))
	No assessment required.	No response required.
Department of Agriculture, Water and the Environment (DAWE)	DAWE was provided the consultation package via email on 29 November 2021. No formal response has been received from the DAWE. Management of vessels, aircraft and personnel is addressed in **Section 7.2**	

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
– Biosecurity (vessels, aircraft and personnel)	Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))
	No assessment required.	No response required.
Department of Defence (DoD)	DoD was provided the consultation package via email on 8 September 2021. DOD responded on 13 October 2021 and provided the following information and requests: + The proposed activities are within the North West Exercise Area (NWXA) and restricted airspace. **[INFORMATION 001]** + Unexploded ordnance (UXO) may be present on and in the sea floor within the NWXA. Santos must, therefore, inform itself as to the risks associated with conducting activities in the area. **[INFORMATION 002]** + All activities in the area are conducted at its own risk **[INFORMATION 003]** + The Commonwealth of Australia, represented by the Department of Defence, takes no responsibility for **[INFORMATION 004]**: + reporting the location and type of UXO that may be in the areas + identifying or removing any UXO from these areas + any loss or damage suffered or incurred by Santos or any third party arising out of, or directly related to, UXO in the area. + Defence requires a minimum of five weeks notification prior to the commencement of activities to ensure Santos activities do not conflict with Defence training. **[REQUEST 001]** + Ensure that activities undertaken within Restricted Airspace comply with the relevant Notice to Airmen (NOTAM) restrictions and liaison with Defence and the airspace controlling agency if restricted airspace is activated. **[REQUEST 002]** + Ensure continued liaison with the Australian Hydrographic Service (AHS), including notification three weeks prior to the commencement of activities. **[REQUEST 003]** Santos responded to AMSA on 20 October 2021 and addressed the matters raised in its feedback of 13 October 2021 (refer assessment of stakeholder objections, claims, information and requests below). This stakeholder also receives Santos' Quarterly Consultation Update for WA. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	Assessment of the merits of objections and claims (OPGGS(E) Regulation 16 (b)(ii)), information and requests	Statement of response, or proposed response, to the objections and claims (OPGGS(E) Regulation 16 (b)(iii)), and information and requests
	[INFORMATION 001] Santos notes the information provided on activity location and proximity to the NWXA.	Santos responded to DoD and noted the information provided.
	[INFORMATION 002] Santos notes the information provided on the potential presence of UXOs on seafloor in the NWXA.	Santos responded to DoD and noted the information provided.
	[INFORMATION 003] Santos notes DoDs advice on activity risk.	Santos responded to DoD and noted the information provided.
	[INFORMATION 004] Santos notes DoDs advice on responsibilities with respect to UXOs.	Santos responded to DoD and noted the information provided.
	[REQUEST 001] Santos notes DoDs request to be notified five weeks prior to the start of activities. Notification requirements are addressed in **Table 8-4.**	Santos confirmed its preference to align the required notifications to AHS and Defence with required notifications to other stakeholders, where feasible to do so. Santos advised it would contact DoD a minimum of four weeks prior to the commencement of activities but would revert to the requested five weeks notification if not acceptable to DoD.
	[REQUEST 002] Santos will comply with relevant Notice to Airmen (NOTAM) restrictions and liaise with the airspace controlling agency if restricted airspace is activated. Notification requirements are addressed in **Table 8-4.**	Santos confirmed that any activities undertaken within Restricted Airspace would comply with the relevant Notice to Airmen (NOTAM) requirements.
	[REQUEST 003] Santos notes DoDs request for the AHO to be notified three weeks prior to the start of activities. Notification requirements are addressed in **Table 8-4.**	Santos confirmed it had engaged AMSA and AHS for the proposed activities and will contact the AHS no less than four weeks before the commencement of activities.

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
Director of National Parks (DNP)	The DNP was provided consultation package via email on 8 September 2021. DNP responded on 6 October 2021 and provided the following information and requests: + Based on the factsheet provided, DNP noted that first proposed activity, WA-33-R, is located in the Montebello Marine Park (MMP), which forms part of the North-west Network of Marine Parks, and the second activity, subsea installation, is located 0.135 km from MMP. **[INFORMATION 001]** + DNP requested that in preparing the EP, Santos should consider the specific values of the MMP, including (but not limited to) **[REQUEST 001]** + examples of ecosystems representative of the Northwest Shelf Province; + biologically important areas include breeding habitat for seabirds; internesting, foraging, mating, and nesting habitat for marine turtles; a migratory pathway for humpback whales and foraging habitat for whale sharks. + DNP welcomed the use of a pre-lay survey using either ROV, SSS or MBES to identify and avoid any environmentally sensitive seabed features. DNP requested that the results of the survey are shared with the Director of National Parks along with any decision to avoid specific areas deemed to be environmentally sensitive should this be required. **[REQUEST 002]** + DNP advised that mining operations (excluding the construction and operation of pipelines) are <u>not allowed</u> in Habitat Protection Zones, Recreational Use Zones, National Park Zones or Sanctuary Zones. Mining operations are defined in the Management Plan (aligning with Section 355 [2] of the EPBC Act), being **[INFORMATION 002]**: + operations or activities connected with, or incidental to, the mining or recovery of minerals or the production of materials from minerals, including: ▪ prospecting and exploring for minerals; and ▪ milling, refining, treatment and processing of minerals; and ▪ storage and disposal of minerals and materials produced from minerals; + the construction and use of towns, camps, dams, pipelines power lines or other structures for the purposes of operations or activities	

	described in paragraph a); + the performance of any other work for the purposes of operations or activities described in paragraph a). + DNP advised that the North West Marine Parks Network Management Plan 2018 came into effect on 1 July 2018 and provided further information on values for Montebello marine park. DNP noted that the management plan allows for mining authorisation to be given through a class approval for the Multiple Use Zone of the Montebello Marine Park. The class approval requires an accepted Environment Plan (EP) under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009. DNP advised Santos to be aware of its obligations under the class approval (including conditions) and that NOPSEMA was the assessor of environmental management arrangements for activities authorised by the class approval. **[INFORMATION 003]**: + DNP advised that it has worked with NOPSEMA to develop and publish a guidance note, outlining to titleholders aspects that need to be considered and evaluated in preparing an EP. In taking into account Australian marine parks, DNP expected titleholders to consider the impacts and risks of activities in the context of the management plan objectives and values. This includes the representativeness of the relevant values and the activity footprint on the representative area of the Australian marine park. DNP requested that titleholders ensure that EPs **[REQUEST 003]**: + identifies and manages all impacts and risks on Australian marine park values (including ecosystem values) to an acceptable level and has considered all options to avoid or reduce them to as low as reasonably practicable. + clearly demonstrates that the activity will not be inconsistent with the management plan. + In the case of an emergency response, the 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 as soon as possible. Notification should be provided to the 24-hour Marine Compliance Duty Officer. The notification should include **[REQUEST 004]**: + titleholder details + time and location of the incident (including name of marine park likely to be effected) + proposed response arrangements as per the Oil Pollution Emergency Plan (e.g. dispersant, containment, etc.) + confirmation of providing access to relevant monitoring and evaluation reports when available; and + contact details for the response coordinator. + Note that the DNP may request daily or weekly Situation Reports, depending on the scale and severity of the pollution incident. + DNP requested notification if the EP is accepted. If accepted, DNP requested notification at least 10 days prior to all activities occurring within the marine park (excluding transiting) and at the conclusion of that activity, with notification information being consistent with its guidance note. **[REQUEST 005]**: Santos responded to DNP on 6 December 2021 and addressed the matters raised in their correspondence of 6 October 2021. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))
	[INFORMATION 001] Santos notes DNPs confirmation of the location of planned activities.	Santos responded to DNP, clarifying that while the Operational Area intersects the Multiple Use Zone of the Montebello Marine Park (MMP), only support vessel activities are planned to take place within the MMP, with the well location outside of the MMP. Santos advised it will notify DNP should there be any change to the well location resulting in additional activities with the MMP.
	[REQUEST 001] Santos notes DNPs request for the identification and management of the specific values of the MMP. Santos has identified these values in **Section 3.2.3**	Santos responded to DNP and confirmed had identified the specific values of the MMP in preparation of the EP.
	[REQUEST 002] Santos notes DNPs request that the results of any pre-lay surveys are shared with DNP along with any decision to avoid specific areas deemed to be environmentally sensitive should this be required.	Santos responded to DNP, noting its feedback on pre-lay surveys prior to MODU arrival. Santos confirmed a pre-lay survey had already completed and no sensitive features were observed.
	[INFORMATION 002] Santos notes DNPs advice that mining operations (excluding the construction and operation of pipelines) are not allowed in Habitat Protection Zones, Recreational Use Zones, National Park Zones or Sanctuary Zones.	Santos responded to DNP, advising that no activities were planned to take place within the MMP.
	[INFORMATION 003] Santos notes DNPs advice about the Australian Marine Parks North-West Marine Parks Network Management Plan (2018) and values of the MMP. Santos also notes DNPs advice on authorisations to undertake mining operations in an Australian Marine Park. Santos has identified these values in **Section 3.2.3**	Santos responded to DNP, advising that no activities were planned to take place within the MMP and that it had referenced the Australian Marine Parks North-West Marine Parks Network Management Plan (2018) in preparing the EP given the proximity of some activities to the MMP.
	[REQUEST 003] Santos has considered NOPSEMA Guidance Note Petroleum Activities and Australian Marine Parks (N-04750-GN1785 A620236, 03/06/2020).	Santos responded to DNP and confirmed it has followed the NOPSEMA guidance note in preparation of the EP.

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	Santos has identified the relevant Australian Marine Park and its values (**Section 3.2.3**).	
	[REQUEST 004] Santos has addressed DNP emergency notification requirements in **Table 8-4** of the EP and Section 6 of the OPEP.	Santos responded to DNP the OPEP for the activity includes DNPs notification requirements. These can be found in Section 7 of the OPEP.
	[REQUEST 005]: Santos notes DNPs requested notification if the EP is accepted and, if accepted, notification at least 10 days prior to all activities occurring within the marine park (excluding transiting) and at the conclusion of that activity, with notification information being consistent with its guidance note. Notification requirements are addressed in **Table 8-4.**	Santos responded to DNP acknowledging its notification requests.
Department of Industry Science, Energy and Resources (DISER)	DISER was provided the consultation package via email on 8 September 2021. No formal response has been received from DISER. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
State departments/agencies		
Department of Biodiversity and Conservation Attractions (DBCA)	DBCA was provided the consultation package via email on 8 September 2021. DBCA responded on 14 October 2021 and provided the following information and requests: + DBCA reiterated comments provided to Santos for previously consulted activities on the need for comprehensive baseline monitoring of ecologically sensitive receptors and oil spill response preparedness, given the proximity of planned activities to the Montebello Islands Conservation Park and Marine Park, Lowendal Islands Nature Reserve, and Barrow Island Nature Reserve, Marine Park and Marine Management Area. **[REQUEST 001]** + DBCA welcomed any additional information in relation to its monitoring or oil spill response preparedness for the planned activities.	

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="5"></td><td colspan="2">[REQUEST 002]
+ DBCA advised any activities requiring access to reserves managed by DBCA under the CALM Act or requiring the taking / disturbance of threatened fauna listed under the BC Act in State waters may require additional approvals under this legislation, and early consultation with DBCA was recommended. [INFORMATION 001]
Santos responded on 26 October 2021 and addressed the matters raised in their correspondence of 14 October 2021.
This stakeholder also receives Santos' Quarterly Consultation Update for WA.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><th>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</th><th>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</th></tr>
<tr><td>[REQUEST 001] Santos notes DBCAs request for baseline monitoring of ecologically sensitive receptors and oil spill response preparedness given the proximity of planned activities to the Montebello Islands Conservation Park and Marine Park, Lowendal Islands Nature Reserve, and Barrow Island Nature Reserve, Marine Park and Marine Management Area.
These are addressed in Section 17 and Appendix Q of the OPEP</td><td>Santos responded to DBCA acknowledging advising that EP will consider any impacts on these sensitive receptors and the Oil Pollution Emergency Plan will address baseline monitoring and oil spill preparedness.</td></tr>
<tr><td>[REQUEST 001] Santos notes DBCAs request for additional information in relation to its monitoring or oil spill response preparedness for the planned activities.</td><td>There is no additional information on monitoring or oil spill response preparedness at the time of consultation. Management of oil spill preparedness is addressed in the Oil Pollution Emergency Plan in Section 3 and Section 4.</td></tr>
<tr><td>[INFOIRMATION 001] Santos notes DBCAs advice on access to reserves managed by DBCA under the CALM Act or requiring the taking / disturbance of threatened fauna.</td><td>Santos responded to DBCA advising it was not planning to access any of the reserves but acknowledged that any activities requiring access to reserves managed by DBCA under the CALM Act or requiring the taking / disturbance of threatened fauna listed under the BC Act in State waters, may require additional approvals and consultation with DBCA will be sought.</td></tr>
<tr><td></td><td colspan="2">DMIRS was provided the consultation package via email on 8 September 2021.</td></tr>
</table>

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
WA Department of Mines, Industry Regulation and Safety (DMIRS)	No formal response has been received from DISER. This stakeholder also receives Santos' Quarterly Consultation Update for WA. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
WA Department of Primary Industries & Regional Development (DPIRD)	DMIRS was provided the consultation package via email on 8 September 2021. No formal response has been received from DPIRD. Santos has assessed the impact to fish and commercial fisheries in **Section 6** and **Section 7**. This stakeholder also receives Santos' Quarterly Consultation Update for WA. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
WA Department of Transport (DoT)	DoT was provided the consultation package via email on 8 September 2021. DoT responded on 21 September 2021 advising: + if there is a risk of a spill impacting State waters from the activity, please ensure that the Department of Transport is consulted as outlined in the Department of Transport Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (July 2020). **[REQUEST 001]** Santos responded to DoT on 20 October 2021 noting its consultation expectations and that a copy of the OPEP would be provided upon submission of the EP to NOPSEMA. This stakeholder also receives Santos' Quarterly Consultation Update for WA.	

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="3"></td><td colspan="2">Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>[REQUEST 001] Santos will ensure consultation with the DoT as outlined in the Department of Transport Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (July 2020).</td><td>Santos responded to DoT and acknowledged the request.</td></tr>
<tr><td colspan="3">Industry Bodies</td></tr>
<tr><td rowspan="3">Australian Petroleum Production & Exploration Association (APPEA)</td><td colspan="2">APPEA was provided the consultation package via email on 8 September 2021.
No formal response has been received from APPEA.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td>Australian Southern Bluefin Tuna Industry Association (ASBTIA)</td><td colspan="2">ASBTIA was provided the consultation package via email on 8 September 2021.
No formal response has been received from ASBTIA.
This stakeholder also receives Santos’ Quarterly Consultation Update for WA.
All listed fisheries are described in Section 3.2.5, and potential impact to fisheries, fish habitat and commercial fishers are discussed in Section 6 and Section 7.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
</table>

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Commonwealth Fisheries Association (CFA)	CFA was provided the consultation package via email on 8 September 2021. No formal response has been received from CFA. This stakeholder also receives Santos' Quarterly Consultation Update for WA. All listed fisheries are described in **Section 3.2.5**, and potential impact to fisheries, fish habitat and commercial fishers are discussed in **Section 6 and Section 7.** Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Marine Tourism WA (MTWA)	MTWA was provided the consultation package via email on 14 September 2021 following a phone call to understand the potential for charter boat activity in the region. No formal response has been received from MTWA. This stakeholder also receives Santos' Quarterly Consultation Update for WA. All listed fisheries are described in **Section 3.2.5**, and potential impact to fisheries, fish habitat and commercial fishers are discussed in **Section 6 and Section 7.** Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td></td><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td rowspan="3">Pearl Producers Association (PPA)</td><td colspan="2">PPA was provided the consultation package via email on 8 September 2021.
No formal response has been received from PPA.
This stakeholder also receives Santos’ Quarterly Consultation Update for WA.
All listed fisheries are described in Section 3.2.5, and potential impact to fisheries, fish habitat and commercial fishers are discussed in Section 6 and Section 7.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td rowspan="3">Recfishwest</td><td colspan="2">Recfishwest was provided the consultation package via email on 8 September 2021.
No formal response has been received from Recfishwest.
This stakeholder also receives Santos’ Quarterly Consultation Update for WA.
All listed fisheries are described in Section 3.2.5, and potential impact to fisheries, fish habitat and commercial fishers are discussed in Section 6 and Section 7.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td>Tuna Australia</td><td colspan="2">Tuna Australia was provided the consultation package via email on 1 September 2021.
No formal response has been received from Tuna Australia.</td></tr>
</table>

<table>
<tr><th>Stakeholder</th><th colspan="2">Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))</th></tr>
<tr><td rowspan="3"></td><td colspan="2">This stakeholder also receives Santos’ Quarterly Consultation Update for WA.
All listed fisheries are described in Section 3.2.5, and potential impact to fisheries, fish habitat and commercial fishers are discussed in Section 6 and Section 7.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>No assessment required.</td><td>No response required.</td></tr>
<tr><td rowspan="3">Western Australian Fishing Industry Council (WAFIC)</td><td colspan="2">WAFIC was provided the consultation package via email on 8 September 2021.
WAFIC was sent a follow up email on 19 November 2021.
WAFIC responded on 23 November 2021 and sought confirmation that the Oil Pollution Emergency Plan considered the following aspects [REQUEST 001]:
+ Baseline scientific data on aquatic organisms and the aquatic environment
+ Detailed post spill scientific monitoring of aquatic organisms and aquatic environment
+ Communication strategy that considers the commercial fishing industry in the event of a spill event
+ Support to the commercial fishing industry with regards to traceability of fish products to manage tainting risks, if required.
+ Financial assistance to the commercial fishing industry in the event of a spill event.
Santos responded to WAFIC on 6 December 2021 and addressed the matters raised in their correspondence of 23 November 2021.
Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.</td></tr>
<tr><td>Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))</td><td>Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))</td></tr>
<tr><td>[REQUEST 001] Santos has considered WAFIC’s request for information about it its Oil Pollution Emergency Plan.</td><td>Santos responded to WAFIC and confirmed:</td></tr>
</table>

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
		• The OPEP will include an overview of Santos' Scientific Monitoring Plan, which includes a description of the approach to collecting baseline data. • The OPEP will include an overview of the process for scientific monitoring post spills. • In the event of a major spill, notifications will be made if applicable to State and Commonwealth Government fisheries agencies, including the Australian Fisheries Management Authority and WA Department of Primary Industries and Regional Development (Fisheries). WAFIC is listed as a key stakeholder in Santos' communications register and would be contacted in the event of an oil spill. • There is a dedicated Scientific Monitoring Plan for Seafood Quality which aims to identify potential human health risks due to the presence of hydrocarbon concentrations in the flesh of targeted seafood species for consumption. • If any claims are received from parties who consider themselves affected by our activities, we would seek to respond to these claims in a timely and respectful manner.
Commercial fisheries – State Managed		
Mackerel Managed Fishery Area 2	Licence holders in the Mackerel Managed Fishery were provided the consultation package via letter on 8 September 2021, as well as a map showing the location of the operational area relevant to the fishery. No formal responses have been received from licence holders. All listed fisheries are described in **Section 3.2.5**, and potential impact to fisheries, fish habitat and commercial fishers are discussed in **Section 6 and Section 7.** Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	

Santos

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Other industry		
Chevron	Equinor was provided the consultation package via email on 8 September 2021. Equinor responded on 1 September 2021 advising it had transferred the WA-542-P permit to Finder Energy and was no longer a stakeholder in the area. Santos provided the consultation package to Finder Energy via email on 4 September 2021. No formal response has been received from Finder Energy. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**
	No assessment required.	No response required.
Other stakeholders		
Australian Marine Oil Spill Centre (AMOSC)	AMOSC was provided the consultation package via email on 9 September 2021. No formal response has been received from AMOSC. This stakeholder also receives Santos' Quarterly Consultation Update for WA. Santos considers the level of consultation to be adequate and will address any comments from this stakeholder should they arise in the future.	
	Assessment of the merits of objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(ii))	**Statement of response, or proposed response, to the objections, claims, information and requests (OPGGS(E) Regulation 16 (b)(iii))**

Stakeholder	Stakeholder Consultation Summary (OPGGS(E) Regulation 16 (b)(i))	
	No assessment required.	No response required.

4.5 Ongoing Consultation

Stakeholder consultation for this activity will be ongoing and Santos will work with stakeholders before, during and after the activity. Should new stakeholders be identified (**Section 4.2**), they will be added to the stakeholder database and included in all future correspondence as required, including activity-specific notifications.

Santos, as a marine user, understands there will be the need to interact and communicate with other marine users to ensure mutual and individual stakeholder goals are met. Santos has identified the need for ongoing engagement with the fishing industry, as committed to in **Section 8.9**.

To this end, Santos commits to the following ongoing stakeholder consultation process:

1. *Prior to commencement of the activity, Santos will notify all relevant stakeholders listed, or as revised, in **Table 8-4**. The notification will include information on activity timing, vessel movements and vessel details.*

2. *Upon completion of the activity, Santos will provide a cessation notification to the relevant stakeholders listed, or as revised, in **Table 8-4**. The final cessation notification will advise stakeholders that the activity has ended.*

3. *Santos' Quarterly Consultation Update (see **Section 4.6**) will include the Bedout Exploration Drilling activity. This consultation will cease once the activity has ended.*

Up to date knowledge of stakeholders will be managed as described in **Section 8.11**.

Where practicable and if available, Santos will endeavour to use the WAFIC consultation services to help distribute activity notifications to relevant commercial fishers.

Santos will assess any additional stakeholder objections or claims in accordance with **Section 4.4**.

4.6 Quarterly Consultation Update

Activities covered under this EP will be included in Santos' Quarterly Consultation Update until they can be listed as a 'completed activity', with updates scheduled for approximately March, June, September and December annually.

The Quarterly Consultation Update is circulated to a broad group of Santos stakeholders, including many of the stakeholders identified in **Table 4-2**.

If stakeholders request additional information or raise concerns on any activity listed in a Quarterly Consultation Update, a dialogue with these stakeholders can continue during or post the preparation of an EP and will be recorded for future reference. Santos commits to respond and address any comments to the satisfaction of both parties and keep any consultation on file during and post acceptance of an EP.

Activities covered under this EP will be included in Santos' Quarterly Consultation Update until they can be listed as a 'completed activity', with updates scheduled for approximately March, June, September and December annually.

The Quarterly Consultation Update is circulated to a broad group of Santos stakeholders, including many of the stakeholders identified in **Table 4-2**.

If stakeholders request additional information or raise concerns on any activity listed in a Quarterly Consultation Update, a dialogue with these stakeholders can continue during or post the preparation of an EP and will be recorded for future reference. Santos commits to respond and address any comments to the satisfaction of both parties and keep any consultation on file during and post acceptance of an EP.

4.7 Addressing Consultation Feedback

Santos' Consultation Coordinator is available before, during and after the activity to ensure opportunities for stakeholders to provide feedback are available.

Santos will maintain records of all stakeholder consultation related this this EP and activity.

5 Environmental Impact and Risk Assessment

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment
Evaluation of environmental impacts and risks 13(5) The environment plan must include: (a) details of the environmental impacts and risks for the activity; and (b) an evaluation of all the impacts and risks, appropriate to the nature and scale of each impact or risk; and (c) details of the control measures that will be used to reduce the impacts and risks of the activity to as low as reasonably practicable and an acceptable level. 13(6) To avoid doubt, the evaluation mentioned in paragraph (5)(b) must evaluate all the environmental impacts and risks arising directly or indirectly from: (a) all operations of the activity; and (b) potential emergency conditions, whether resulting from accident or any other reason.

Environmental impact and risk assessment for the Spartan Development has been undertaken consistent with the process described in Section 5 of the VI Hub Operations EP (EA-60-RI-10003).

5.1 Impact and Risk Assessment Terminology

Common terms applied during the impact and risk assessment process and used in this EP Addendum are defined in **Table 5-1**. For a more comprehensive listing of the terms and definitions used in environmental impact and risk assessment, refer to Environmental Hazard Identification and Assessment Procedure (EA-91-IG-00004_5).

Table 5-1: Impact and risk assessment terms

Name	Definition
Acceptability	Determined for both impacts and risks. Acceptability of events is in part determined by the consequence of the impact following management controls. Acceptability of unplanned events is in part determined from its risk ranking following management controls. For both impacts and risks, acceptability is also determined from a demonstration of the ALARP principle, consistency with Santos Policies, consistency with all applicable legislation and consideration of relevant stakeholder consultation when determining management controls.
Activity	Specific tasks and actions undertaken throughout the life cycle of oil and gas exploration, production and decommissioning.
ALARP	As Low As Reasonably Practicable. The term refers to reducing risk to a level that is As Low As Reasonably Practicable. In practice, this means showing through reasoned and supported arguments, that there are no other practicable options that could reasonably be adopted to reduce risks further.
Authorised Person	Person with authority to make the decision or take the action. Examples are Vessel Master, Field Superintendent, Supervisor, Person-in-charge, Company Authorised Representative, and Project Manager.
Control Measure	Means a system, an item of equipment, a person or a procedure, that is used as a basis for managing environmental impacts and risks[1].
DMIRS	Department of Mines, Industry Regulation and Safety.
Environment	Includes the natural and socio-economic values and sensitivities which will or may be affected by the activity. Is defined by NOPSEMA and DMIRS as: (a) ecosystems and their constituent parts, including people and communities (b) natural and physical resources (c) the qualities and characteristics of locations, places and areas (d) the heritage value of places (e) the social, economic and cultural features of the matters mentioned in paragraphs (a), (b), (c) and (d).
Environmental consequence	A consequence is the outcome of an event affecting objectives. Note 1 An event can be one or more occurrences and can have several cases. Note 2 An event can consist of something not happening. (Reference ISO 73:2009 Risk Vocabulary).
Environmental impact	Defined by NOPSEMA[1] as any change to the environment, whether adverse or beneficial, wholly or partly resulting from a planned or unplanned event[1.] Defined by DMIRS as any change to the environment, whether adverse or beneficial, that wholly or partly results from a petroleum activity of an operator.
ENVID	Environmental hazard identification workshop.

[1] Defined by the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009

Name	Definition
Environmental risk	Applies to unplanned events. Risk is a function of the likelihood of the unplanned event occurring and the consequence of the environmental impact that arises from that event.
Hazard	A situation with the potential to cause harm.
Grossly disproportionate	Where the sacrifice (cost and effort) of implementing a control measure to reduce impact or risk grossly exceeds the environmental benefit to be gained.
Impact assessment	The process of determining the consequence of an impact (in terms of the consequence to the environment) arising from a planned or unplanned event over a specified period of time.
Likelihood	The chance of an unplanned event occurring.
Non-routine planned event	An attribute of the planned activity that may occur or will occur infrequently during the planned activity. A non-routine planned event is intended to occur at the time.
Planned activity	A description of the activity to be undertaken, including the services, equipment, products, assets, personnel, timing, duration and location and aspect of the activity.
Planned event	An event arising from the activity which is done with intent (i.e., not an unplanned event) and has some level of environmental impact. A planned event could be routine (expected to occur consistently throughout the activity) or non-routine (may occur infrequently if at all). Air emissions, bilge water discharge and drill cuttings discharge would be examples of planned events.
Receptor	A feature of the environment that may have environmental, social and/or economic values.
Risk	The effect of uncertainty on objectives.
Risk assessment	The process of determining the likelihood of an unplanned event and the consequence of the impact (in terms of economic, human safety and health, or ecological effects) arising from the event over a specified period of time.
Routine planned event	An attribute of the planned activity that results in some level of environmental impact and will occur continuously or frequently through the duration of the planned activity.
SLT	Senior Leadership Team.
Unplanned event	An event that results in some level of environmental impact and may occur despite preventive safeguards and control measures being in place. An unplanned event is not intended to occur during the activity.

5.2 Summary of the Environmental Impact and Risk Assessment Approach

Santos operates under an overarching Risk Management Policy. The company Risk Procedure (SMS MS1 ST01) underpins the Risk Management Policy and is consistent with the requirements of AS/NZS ISO 31000:2018, Risk Management – Guidelines (ISO, 2018).

The key steps to risk management are illustrated in **Figure 5-1**. The forum used to undertake the assessment is the environmental hazard workshop, referred to as an ENVID, which is described in Section 4 of Santos' Offshore Division Environmental Hazard Identification and Assessment Guideline (EA-91-IG-00004_5).

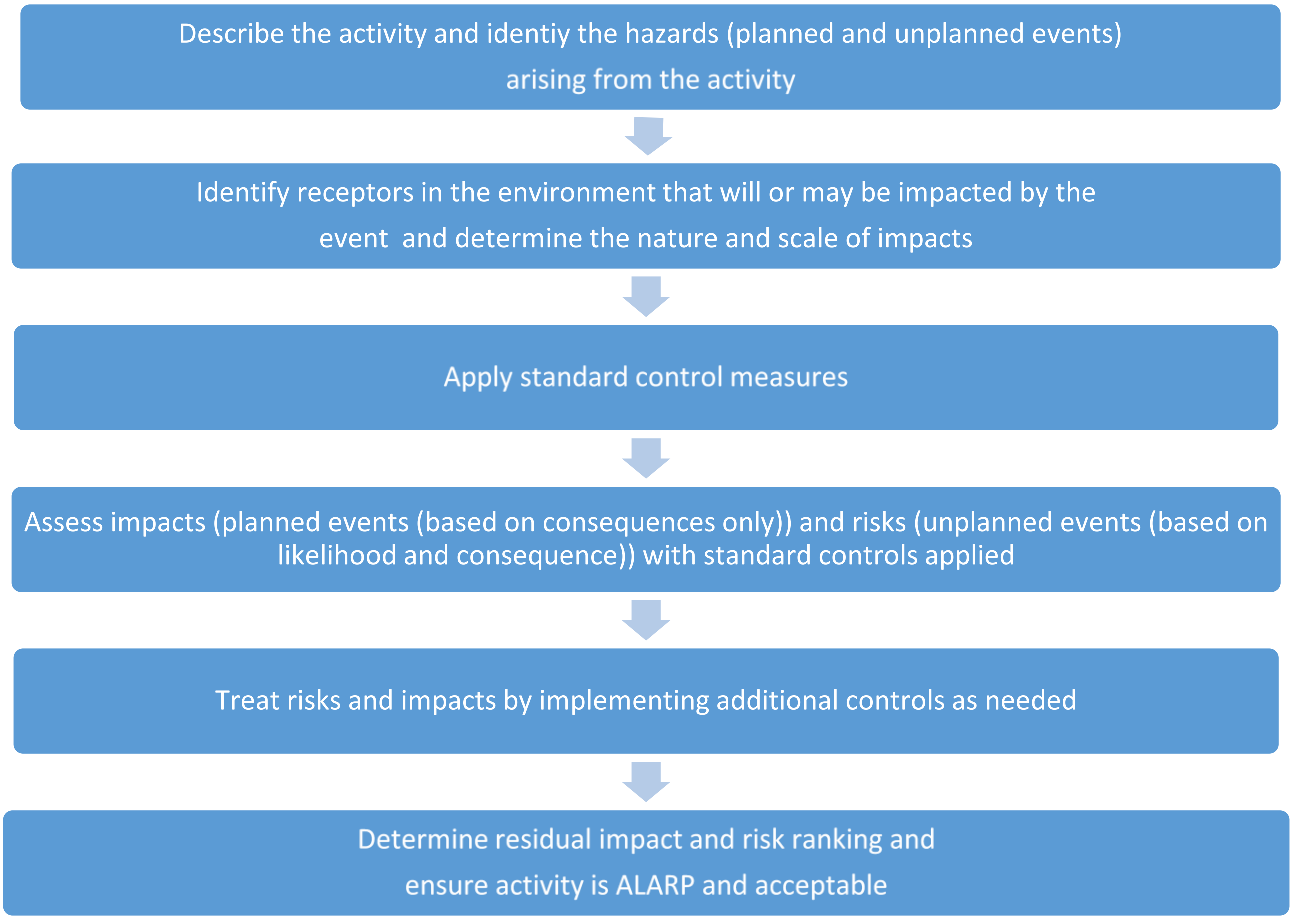

Figure 5-1 Environmental impact and risk assessment process

Santos' Environmental Hazard Identification and Assessment Guideline (EA-91-IG-00004) includes consideration of the key areas in an impact and risk assessment, being:

+ description of the activity (including location and timing);
+ description of the environment (potentially affected by both planned and unplanned activities);
+ identification of relevant persons;
+ identification of legal requirements ('legislative controls') that apply to the activity;
+ Santos' policy and SMS requirements;
+ principles of ecologically sustainable development (ESD); and
+ Santos' acceptable levels of impact and risk.

These factors are considered in environmental impact and risk assessment workshops in which environmental hazards are identified and assessed (ENVID workshop). The workshop involves participants from Santos' Health, Safety and Environment (HSE), Project and spill response departments and specialist environmental consultants.

5.2.1 Describe the activities and hazards (planned and unplanned events)

A description of the activity is required in order to determine the planned events that will take place and the credible unplanned events that may occur. The location, timing and scope of the activity must be described in order to determine the impacts from planned events, and the impacts and risks from unplanned events since these have a bearing upon the environment that may be affected (EMBA) by the activity.

The outcome of this assessment is detailed in the relevant sub-sections of **Sections 6** and **7**.

5.2.2 Identify receptors and determine nature and scale of impacts

A description of the environment (natural and socio-economic) within which hazards from the activity will, or may occur, is required. This constitutes a crucial stage of the risk assessment, as an understanding of the environment that will or may be affected is required to determine the type and consequence of impacts from the activity being assessed. The environment must be understood with respect to the spatial and temporal limits of the activity and key resources at risk that will or could be impacted by planned and unplanned events. Santos has developed a Values and Sensitivities of the Marine and Coastal Environment (EA-00-RI-10062, **Appendix C**) reference document which describes the existing environment that may be affected by Santos activities and is reviewed and updated on an annual basis.

Where the existing environment is being reviewed for regulatory approvals, a comparison shall be made against the Values and Sensitivities of the Marine and Coastal Environment (EA-00-RI-10062). A new protected matters search is required to ensure a thorough understanding of the existing environment to ensure all risks are assessed.

The extent of actual impacts from each planned activity or risks from each unplanned activity, are assessed using, where required, modelling (e.g., hydrocarbon spills) and scientific reports. The duration of the event is also described including the potential duration of any impacts should they occur. Receptors identified as potentially occurring within impacted area(s) are detailed in **Section 3** and **Appendix C**.

5.2.3 Cumulative impacts

Santos has assessed the cumulative impacts of the Spartan Development activities in relation to separate Spartan Development activities overlapping with each other (e.g. installation activities overlapping with drilling activities) and other relevant petroleum activities which could realistically result in overlapping space crowding (occurring at the same time) and space crowding (occurring at the same place). Only planned events (**Section 6**) have been considered with respect to cumulative impacts. Unplanned events are not intended to occur at any time during the Spartan Development activities.

Santos will continue to operate the VI Hub, including the John Brookes pipeline and WHP during the Spartan Development activities, however no IMR campaigns, operational campaigns or petroleum activities are planned to overlap with Spartan Development activities.

Additionally, this EP is for a single well and hence no concurrent drilling operations are planned under this EP. The activities within this Addendum are short-term and occur within a restricted spatial extent.

5.3 Describe the environmental performance outcomes and control measures

For each planned and unplanned event, a set of Environmental Performance Outcome(s), Control Measures, Environmental Performance Standards and Measurement Criteria are identified. The definitions of the performance outcomes, control measures, standards and measurement criteria must be consistent with the OPGGS(E)R 2009, and the NOPSEMA EP Content Requirements Guidance Note (NOPSEMA, 2019).

For any hazard, additional controls, must also be considered and either accepted for use or rejected based on whether the standard controls reduce impacts and risks to levels that are ALARP and acceptable (refer **Section 5.5** and **5.6**).

Controls are allocated in order of preference according to **Figure 5-2**.

For this EP Addendum, the control measures that will be implemented have been referenced based on the activity it relates to. Control measures to be implemented for drilling and completions have the naming convention ST-DC-CM-XXX, while control measures to be implemented for the subsea installation and pre-commissioning have the convention ST-IC-CM-XXX.

Control	Effectiveness	Example
Eliminate		*Removal of the risk.* Refueling of vessels at port eliminates the risks of an offshore refueling.
Substitute		*Change the risk for a lower one.* The use of low-toxicity chemicals that perform the same task as a more toxic additive.
Engineering		*Engineer out the risk.* The use of oil-in-water separator to minimise the volume of oil discharged.
Isolation		*Isolate people or the environment from the risk.* The use of bunding for containment of bulk liquid materials.
Administrative		*Provide instructions or training to people to lower the risk.* The use of Job Hazard Analysis to assess and minimise the environmental risks of an activity.
Protective		*Use of protective equipment.* Containment and recovery of spilt hydrocarbons.

Figure 5-2 Hierarchy of controls

5.4 Determine the impact consequence level and risk rankings (on the basis that all control measures have been implemented)

This step looks at the causal effect between the aspect/hazard and the identified receptor. Impact mechanisms and any thresholds for impacts are determined and described, using scientific literature and modelling where required. Impact thresholds for different critical life stages are also identified where relevant.

The consequence level of the impact is then determined for each planned and unplanned event using the Santos Environment Consequence Descriptors (**Appendix F**).

These detailed environmental consequence descriptions are based on the consequence of the impact to relevant receptors in the categories of:

- threatened/migratory/local fauna;
- physical environment/habitat;
- threatened ecological communities;
- protected areas; and
- socio-economic receptors.

This process determines a consequence level, based on set criteria for each receptor category, and takes into consideration the duration and extent of the impact, receptor recovery time and the effect of the impact at a population, ecosystem or industry level. The level of information required to complete the impact or risk assessment depends on the nature and scale of the impact or risk. This process determines a consequence level based on set criteria for each receptor category and takes into consideration the duration and extent of the impact, receptor recovery time and the effect of the impact at a population, ecosystem or industry level. Impacts to social and economic values are also considered based on existing knowledge and feedback from stakeholder consultation. As the result of historic consultation with stakeholders, the social and economic values in the region that are of interest are evident.

As planned events are expected to occur during the activity, the likelihood of their occurrence is not considered during the risk assessment, and only a consequence level is assigned (**Table 5-2**).

Table 5-2: Summary environmental consequence descriptors

Consequence Level	Consequence Level Description
I	**Negligible** – No impact or negligible impact
II	**Minor** – Detectable but insignificant change to local population, industry or ecosystem factors
III	**Moderate** – Significant impact to local population, industry or ecosystem factors
IV	**Major** – Major long-term effect on local population, industry or ecosystem factors
V	**Severe** – Complete loss of local population, industry or ecosystem factors AND/OR extensive regional impacts with slow recovery
VI	**Critical** – Irreversible impact to regional population, industry or ecosystem factors

For unplanned events, the consequence level of the impact is combined with the likelihood of the impact occurring (**Table 5-3**), to determine a residual risk ranking using the corporate Santos risk matrix (**Table 5-4**). For oil spill events, potential impacts to environmental receptors are assessed where they occur within the EMBA using results from modelling.

Table 5-3: Likelihood description

No.	Matrix	Description
f	Almost Certain	Occurs in almost all circumstances OR could occur within days to weeks
e	Likely	Occurs in most circumstances OR could occur within weeks to months
d	Occasional	Has occurred before in Santos OR could occur within months to years
c	Possible	Has occurred before in the industry OR could occur within the next few years
b	Unlikely	Has occurred elsewhere OR could occur within decades
a	Remote	Requires exceptional circumstances and is unlikely even in the long term

Table 5-4: Santos risk matrix

		Consequence					
		I	II	III	IV	V	VI
Likelihood	f	Low	Medium	High	Very High	Very High	Very High
	e	Low	Medium	High	High	Very High	Very High
	d	Low	Low	Medium	High	High	Very High
	c	Very Low	Low	Low	Medium	High	Very High
	b	Very Low	Very Low	Low	Low	Medium	High
	a	Very Low	Very Low	Very Low	Low	Medium	Medium

5.5 Evaluate if impacts and risks are as low as reasonably practicable

For planned and unplanned events, an ALARP assessment is undertaken to demonstrate that the standard control measures adopted reduce the impact (consequence level) or risk to ALARP. This process relies on demonstrating that further potential control measures would require a disproportionate level of cost/effort in order to reduce the level of impact or risk. If this cannot be demonstrated, then further control measures are adopted. The level of detail included within the ALARP assessment is based upon the nature and scale of the potential impact or risk. For example, more detail is required for a risk ranked as `Medium' compared to a risk ranked as `Low'.

5.6 Evaluate impact and risk acceptability

Santos considers an impact or risk associated with the proposed activity to be acceptable if the following criteria are met:

+ the consequence of a planned event is ranked as A or B; or a risk of impact from an unplanned event is ranked Low to Medium;
+ an assessment has been completed to determine whether further information or studies are required to support or validate the consequence assessment;

- assessment and management of risks has addressed the principles of ecologically sustainable development;
- that the acceptable levels of impact and risks have been informed by relevant species recovery plans, threat abatement plans and conservation advice can be demonstrated;
- performance standards are consistent with legal and regulatory requirements;
- performance standards are consistent with the Santos EHS Policy;
- performance standards are consistent with industry standards and best practice guidance (e.g., National Biofouling Management Guidance Guidelines for the Petroleum Production and Exploration Industry (Marine Pest Sectoral Committee, 2018));
- performance outcomes and standards are consistent with stakeholder expectations; and
- performance standards have been demonstrated to reduce the impact or risk to ALARP.

6 Planned Activities Risk and Impact Assessment

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment.
Environmental performance outcomes and standards 13(7) The environment plan must: (a) set environmental performance standards for the control measures identified under paragraph (5)(c); (b) set out the environmental performance outcomes against which the performance of the titleholder in protecting the environment is to be measured; and (c) include measurement criteria that the titleholder will use to determine whether each environmental performance outcome and environmental performance standard is being met.

An ENVID workshop (as described in **Section 5**) for planned activities was held in July 2021. This workshop identified eight potential sources of environmental impact associated with the planned activities for this activity. The consequence rankings resulting from the environmental assessments are summarised in **Table 6-1**. A comprehensive risk and impact assessment for each of the planned events, and subsequent control measures proposed by Santos to reduce the risk and impacts to ALARP and acceptable levels are details in the following subsections.

Table 6-1: Summary of the Consequence Level Rankings for Hazards Associated with Planned Events

EP Section	Hazard		Consequence Ranking
6.1	Noise emissions		II - Minor
6.2	Light emissions		I - Negligible
6.3	Atmospheric emissions		I - Negligible
6.4	Seabed and benthic habitat disturbance		II - Minor
6.5	Interaction with other marine users		I - Negligible
6.6	Operational discharges		II - Minor
6.7	Drilling and cement discharges		II - Minor
6.8	Planned chemical and hydrocarbon discharges – subsea installation and pre-commissioning		II - Minor
6.9	Contingency Spill Response Operations	Light emissions	I - Negligible
		Noise emissions	I - Negligible
		Atmospheric emissions	I - Negligible
		Operational discharges and waste	I - Negligible
		Physical presence and disturbance	II – Minor
		Chemical dispersant application	II – Minor
		Disruption to other users of marine and coastal areas and townships	II – Minor

6.1 Noise Emissions

6.1.1 Description of event

Event	Potential impacts from noise emissions may occur in the operational areas from the following sources: + ROV activities; + Installation vessel and support vessel activities (e.g., vessel engines, thrusters and other machinery); + MODU activities (e.g. drilling and machinery); and + helicopter activities (crew change requirements).
Extent	Impacts from all potential noise sources will be localised. This is on the following basis: + Noise from ROV operations will be limited to when ROVs are operating within the operational areas. + Noise from the installation vessel using main engines and bow thrusters to maintain position and the MODU undertaking drilling will become inaudible above background noise within approximately 1 km. + Noise from helicopters will be limited to when they are transiting over the operational areas. Cumulative effects from the activity and from other vessel based activities (e.g. commercial fishing) conducted in the vicinity are not expected, due to the short-term nature of the operations and the low sound levels generated by continuous noise sources.
Duration	Continuous and intermittent noise for the duration of the activity.

6.1.1.1 Noise generated by mobile offshore drilling unit (MODU)

The MODU will generate noise from the operation of on-board machinery, including diesel engines, mud pump, ventilation fans (and associated exhaust) and electrical generators, and also from the operation of the drill string and drill bit during operations. McCauley (1998) reported noise levels generated by a semi-submersible rig, during non-drilling periods the typical broadband level encountered was approximately 113 dB (rms) re 1 µPa@125 m with various tones from the machinery observable in the noise spectra. There was a significant variation in the broadband noise during non-drilling periods, attributed to the operation of specific types of machinery. During periods the broadband noise level increased to the order of 177 dB (rms) re 1 µPa@125 m. Studies undertaken in the Arctic on different MODU types (including semi-submersible and drill ships) indicate that noise levels dropped to 117 dB re 1 µPa within 1 km of the MODU and are much lower than those for large commercial vessels operating at normal speeds (Austin et al., 2018).

In general, jack-up MODUs transmit less noise underwater than a semi-submersible platform or a drill vessel due to a smaller surface area being in contact with the water column. Jack-up MODUs have been measured to produce noise between 0.005 and 1.2 kHz during drilling activity with a source level of 59 dB re 1 µPa m (Simmonds et al., 2004). A 2001 underwater acoustic survey (McCauley, 1998)Marine Acoustics, 2011) of a jack-up MODU operating in shallow waters (24.4 to 27.4 m water depth) reported non-continuous (less than one second) noise levels exceeding 120 dB re 1 µPa, were measured to a maximum range of 1.17 to 1.4 km from the MODU in a frequency band of 8.9 to 44.7 Hz. Underwater noise measured during this survey was at all times below 160 dB re 1 µPa.

6.1.1.2 Noise generated by vessels

For vessels, the noisiest anticipated activity is when the vessel uses thrusters to maintain its position. There is no applicable sound data available for a typical DP ISV; however, frequencies and sound levels are expected to be similar to those measured for a drilling support vessel. McCauley (1998) measured underwater sound pressure levels equivalent to approximately 182 dB re 1 µPa @ 1 m with a frequency range of 20 Hz to 10 kHz from a drilling support vessel holding station in the Timor Sea. The thruster noise dropped below 120 dB re 1 µPa within 3 to 4 km and was audible above ambient noise up to 20 km away (McCauley, 1998). This has been taken as the greatest noise-generating activity for assessment purposes, as other vessel activities will require the vessels to be idle or moving; e.g., flowline installation activities will typically require the vessel to be moving slowly at approximately four knots. McCauley (McCauley, 1998) measured underwater sound levels from the Pacific Ariki, a 64 m long support vessel with 8000 HP (6,000 kW) main engines during calm conditions in the Timor Sea in 110 m of water while transiting at 11 knots, and found the distance to 120 dB re 1 µPa to be approximately 1 km.

6.1.1.3 Noise generated by helicopters

Sound traveling from a source in the air (e.g., a helicopter) to a receiver underwater is affected by both in-air and underwater propagation processes, which are further complicated by processes occurring at the air seawater surface interface (e.g., wind and waves). The level of noise received underwater depends on source altitude and lateral distance, receiver depth, water depth, and other variables.

Helicopter engine noise is emitted at various frequencies however, the dominant tones are generally of a low frequency below 500 Hz (Richardson et al., 1995). Sound pressure in the water directly below a helicopter is greatest at the surface and diminishes with increasing receiver depth. Noise also reduces with increasing helicopter altitude, but the duration of audibility often increases with increasing altitude, with sound penetrating water at angles less than 13°. The noise from the flyover of a Bell 214 helicopter (stated to be a noisy model) has been recorded underwater (Richardson et al., 1995). The sound source was 162 dB re 1 µPa @ 1 m at its peak and had frequency of 155 Hz.

6.1.1.4 Noise generated from remotely operated vehicle operations

During the activities associated with the drilling and installation activities, notably inspections of the seabed prior to and/or after drilling or installation, and in the event of dropped objects, ROVs may be used. This will be undertaken from a vessel or MODU and the noise generated will typically be of considerably lower intensity than vessel noise.

As underwater sound levels are dependent on the primary (noisiest) sound source rather than being strictly additive, and since ROV operations will be undertaken from a vessel or MODU, they will make little contribution to the overall noise emissions associated with MODU and/or vessel activities, as described above and are not risk assessed further.

6.1.1.5 Noise generated by flaring during well testing

Noise from flaring is caused by high exit velocities of hydrocarbons through the flare. The noise from in-air flaring is typically reported in A-weighted units to assist with assessing potential effects on humans. For instance, Hantschk & Schorer (2008) reported an A-weighted sound power level (LwA) of108 dB (source level). The underwater noise from flaring has not been estimated, however the concepts of transmission are similar to those for helicopters, with sound penetrating the water at angles <13°, and experiencing loss during the transition between air and water. The underwater sound levels can be approximated to be lower than those for a helicopter, and therefore any potential effects less. This approximation is justified by contrasting flaring source level ((108 dBA) with that of a helicopter, an LwA around 139 dB during take-off or the final stages of approach (James and Zoontjens, 2012).

6.1.1.6 Single-Beam and Multi-Beam Echo Sounders, Side Scan Sonar

SBESs, MBESs and SSS are used to develop a high-resolution image of the seafloor and of objects on the seafloor such as the pipeline and subsea infrastructure. Sound pressure levels for SBESs and MBESs typically range from 210 to 245 dB re 1 µPa @ 1 m, and SSS typically range from 220 to 226 dB re 1 µPa @ 1 m (DECC, 2011).

A modelling study completed in 2013 (JASCO, 2013) indicated the maximum distances at which sound pressure levels were reduced to just above background level (120 dB re 1 µPa) from different equipment types. These were:

- MBES: Approximately 1 km from the sound source;
- SBES: Approximately 350 m from the sound source; and
- SSS: 1.5 km from the sound source.

6.1.1.7 Noise generated by positioning equipment

An LBL or USBL transponder may installed on the seabed for metrology and positioning. Transponders typically emit pulses of medium frequency sound, generally within the range 21 to 31 kHz. The estimated SPL would be 180 to 206 dB re 1 µPa at 1 m (Jiménez-Arranz et al., 2017). Transmissions are not continuous but consist of short ‘chirps’ with a duration that ranges from 3 to 40 milliseconds. Transponders will only be active when positioning is required.

6.1.2 Nature and scale of environmental impacts

Potential receptors: Threatened or migratory fauna (marine mammals, marine turtles, sharks, fish and rays).

Threatened/migratory fauna (marine mammals (particularly cetaceans), marine turtles, sharks, rays and fish. The operational areas and the 20 km buffer surrounding each of them overlap several BIAs. These are outlined in **Table 6-2**.

Table 6-2: Summary of the biologically important areas overlapping operational areas and a 20 km buffer

BIA				
Internesting BIA	**Migration BIA**	**Foraging BIA**	**Breeding BIA**	**Distribution**
+ Flatback turtle + Hawksbill turtle + Green turtle + Loggerhead turtle	+ Humpback whale	+ Whale shark + Wedge-tailed shearwater + Flatback turtle + Green turtle + Hawksbill turtle +	+ Wedge-tailed shearwater + Lesser-crested tern + Roseate tern + Fairy tern	+ Pygmy blue whale

The use of sound in the underwater environment is important for marine animals, particularly cetaceans, to navigate, communicate and forage effectively, along with turtles, sharks, rays and other fish, for a range of functions such as social interaction, foraging and orientation. Underwater noise may impact on marine fauna through:

+ attraction to the noise source;
+ increased stress levels;
+ disruption to underwater acoustic cues;
+ localised avoidance;
+ disturbance, leading to behavioural changes or displacement from areas;
+ masking or interference with other biologically important sounds such as communication or echolocation;
+ physical injury to hearing or other organs; and
+ indirectly by inducing behavioural and physiological changes in predator or prey species.

The nature and scale of impacts must be considered in the context of the ambient noise environment. Ambient underwater noise levels are dependent on location, and are often dominated by local wind noise, waves, biological noise and ship traffic. Wind speed and seabed conditions have a clear influence on the ambient noise level. Existing anthropogenic underwater noise sources in the region of the proposed activity include shipping, small vessel traffic, and petroleum-production activities. It is also common for petroleum activities such as drilling and seismic surveys to occur near the operational areas from time to time.

Marine fauna respond variably when exposed to underwater noise from anthropogenic sources, with effects dependent on a number of factors, including distance from the sound source, water depth and bathymetry, the animal's hearing sensitivity, type and duration of sound exposure and the animal's activity at time of exposure. Broadly, the effects of sound on marine fauna can be categorised as:

+ Acoustic masking – anthropogenic sounds may interfere with, or mask, biological signals, therefore reducing the communication and perceptual space of an individual. Auditory masking impacts may occur when there is a reduction in audibility for one sound (signal) caused by the presence of another sound (noise). For this to occur the noise must be loud enough and have a similar frequency to the signal and both signal and noise must occur at the same time.

- Behavioural response – behavioural impacts will depend on the audible frequency range of each potential receptor in relation to the frequency of the noise, as marine animals will only respond to acoustic signals they can detect, as well as the intensity of the noise. The intensity of behavioural responses of marine mammals to sound exposure ranges from subtle responses, which may be difficult to observe and have little implications for the affected animal, to obvious responses, such as avoidance or panic reactions. The context in which the sound is received by an animal affects the nature and extent of responses to a stimulus. The threshold for elicitation of behavioural responses depends on received sound level, as well as multiple contextual factors such as the activity state of animals exposed to different sounds, the nature and novelty of a sound, spatial relations between a sound source and receiving animals, and the gender, age, and reproductive status of the receiving animal.
- Physiological impacts – auditory threshold shift (temporary and permanent hearing loss) – marine fauna exposed to intense sound may experience a loss of hearing sensitivity, or even potentially mortal injury. Hearing loss may be in the form of a temporary threshold shift (TTS) from which an animal recovers within minutes or hours, or a permanent threshold shift (PTS) from which the animal does not recover.

Available threshold criteria associated with behavioural and physiological impacts for sensitive receptors have been derived from a number of sources ((NMFS, 2018); (NMFS, 2014); (Popper et al., 2014)). These criteria have been compared with measured and predicted sound levels for different sound sources to assess potential impacts.

6.1.2.1 Marine mammals

No known aggregation, resting, breeding or feeding areas for cetaceans lie in close proximity to the operational areas. However, cetaceans may travel through the area, the migration BIA for the humpback whale and the distribution BIA for the pygmy blue whale both overlap the operational areas. Additionally, conservation advice and management plans for humpback whales and blue whales list noise interference as a potential threat. Both these species are low-frequency cetaceans. Low (baleen whales) and mid-frequency (toothed whales except porpoises) cetaceans may frequent the operational areas.

To better reflect the auditory similarities between phylogenetically closely related species, but also significant differences between species groups among the marine mammals, Southall et al. (Southall et al., 2019) assigned the extant marine mammal species to functional hearing groups based on their hearing capabilities and sound production.

Exposure to impulsive noise may be more hazardous to hearing than continuous (non-impulsive) noise. For marine mammals, National Marine Fisheries Service (NMFS) issued a Technical Guidance document that provides acoustic thresholds for the onset of TTS and PTS in marine mammal hearing for all sound sources (NMFS 2018). Southall et al. (2019) published an updated set of criteria for onset of TTS and PTS in marine mammals. While the authors propose a new nomenclature and classification for the marine mammal functional hearing groups, the proposed thresholds and weighting functions for exposure to underwater sound do not differ in effect from those proposed by NMFS (2018). These thresholds that detail receptor noise impacts and behavioural response for continuous noise (MODU, support vessels) and impulsive noises are summarised in **Table 6-3** and **Table 6-4**. Dugong sensitivity range is between the low-frequency and mid-frequency cetaceans (NMFS, 2018), for the purposes of risk assessment dugongs are classed as 'low frequency' in accordance with the NMFS guidance.

Behavioural reactions to acoustic exposure are generally more variable, context-dependent, and less predictable than the effects of noise exposure on hearing or physiology. Hence, it is difficult to determine thresholds for behavioural response in individual cetaceans as the way they respond often varies (Nowacek et al., 2004, Gomez et al., 2016 and Southall et al. 2019) and is influenced by both biological and environmental factors such as age, sex and the activity at the time. Observed disturbance responses to anthropogenic sound in cetaceans include altered swimming direction; increased swimming speed including pronounced 'startle' reactions; changes to surfacing, breathing and diving patterns; avoidance of the sound source area and other behavioural changes

For non-impulsive noise, NMFS currently uses step function (all-or-none) threshold of 120 dB re 1 µPa SPL (unweighted) to assess and regulate noise-induced behavioural impacts for marine mammals (NOAA, 2019), whilst for impulsive noise, NMFS uses step function thresholds of 160 dB re 1 µPa SPL (unweighted) (NOAA, 2018, NOAA 2019). The behavioural disturbance threshold criteria applied summates the most recent scientific literature on the impacts of sound on marine mammal hearing so considered the most relevant to this activity.

Table 6-3: Continuous noise: acoustic effects of continuous noise on low-frequency cetaceans: unweighted sound pressure level and SEL_{24h} thresholds

Hearing Group	NOAA (2019)	NMFS (2018); Southall et al (2019)	
	Behaviour	PTS onset thresholds (received level)	TTS onset thresholds (received level)
	Sound Pressure 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 cetaceans and dugongs	120	199	179
High-frequency cetaceans	120	198	178

Table 6-4: Impulsive noise: unweighted sound pressure level, SEL_{24h} and PK thresholds for acoustic effects on marine mammals

Hearing Group	NOAA (2019)	NMFS (2018); Southall et al (2019)			
	Behaviour	PTS Onset Thresholds (Received Level)		TTS Onset Thresholds (Received Level)	
	SPL (L_p; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	PK (L_{pk}; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	PK (L_{pk}; dB re 1 µPa)
Low-frequency cetaceans and dugongs	160	183	219	168	213
Mid-frequency cetaceans	160	185	230	170	224

Potential impacts from vessels and MODU

Auditory masking impacts may occur when there is a reduction in audibility for one sound (signal) caused by the presence of another sound (noise). For this to occur the noise must be loud enough and have a similar frequency to the signal and both signal and noise must occur at the same time. Therefore, the closer the mammal is to the vessel, and the more overlap there is with their vocalisation frequencies, the higher the probability of masking. The potential for masking and communication impacts is therefore classified as high near the vessel (within tens of metres), moderate within hundreds to low thousands of metres (Clark et al., 2009).

There is a potential for auditory masking impacts to whales due to vessel noise; however, impacts are considered temporary and localised because the individual and the vessels will be almost constantly moving and therefore no single area will be impacted for any length of time.

The estimated distances to behavioural and physiological thresholds (as listed in **Table 6-3**) for marine mammals from vessels are provided in **Table 6-5**.

Table 6-5: Estimated distances to behavioural and physiological thresholds (as listed in Table 6-3) for marine mammals from vessels

Potential Marine Fauna Receptor	Estimated Distance	Justification
PTS		
Low-frequency cetaceans and dugongs	12 m	Based upon accumulation of unweighted SEL over 24 hours for a vessel with a source level of 166.3 dB re 1 µPa (SPL), and applying practical spreading loss
Mid-frequency cetaceans	Not predicted to occur	Not predicted to occur for vessels with a significantly greater power output (McPherson *et al.*, 2019)

TTS		
Low-frequency cetaceans and dugongs	266 m	Based upon accumulation of unweighted SEL over 24 hours for a vessel with a source level of 166.3 dB re 1 µPa (SPL), and applying practical spreading loss
Mid-frequency cetaceans	Not predicted to occur	Not predicted to occur for vessels with a significantly greater power output (McPherson *et al.*, 2019)
Behaviour		
Low-frequency cetaceans and dugongs	Within 1200 m	Considering a vessel with a source level of 166.3 dB re 1 µPa (SPL), and applying practical spreading loss (McPherson *et al.*, 2019)
Mid-frequency cetaceans		

In addition to levels where PTS and TSS impacts are observed there have been observations of marine mammals reacting to aircraft and other anthropogenic impacts, specifically:

+ Reactions of cetaceans to circling aircraft (fixed wing or helicopter) are sometimes conspicuous if the aircraft is below an altitude of 300 m, uncommon at 460 m and generally undetectable at 600 m (NMFS, 2001).
+ Baleen whales sometimes dive or turn away during overflights, but sensitivity seems to vary depending on the activity of the animals. The effects on cetaceans seem transient, and occasional overflights probably have no long-term consequences on cetaceans.
+ Observations by Richardson and Malme (1993) indicate that, for bowhead whales, most individuals are unlikely to react significantly to occasional single-pass low-flying helicopters transporting personnel and equipment at altitudes above 150 m.
+ Leatherwood et al. (1982) observed that minke whales responded to helicopters at an altitude of 230 m by changing course or slowly diving.

This is relevant to understanding the potential impacts of helicopter operations within the operational areas.

Potential impacts from positioning equipment, SBES, MBES and SSS

Transponders used for positioning and SDES, MBES and SSS used for surveys have the potential to cause some temporary behavioural disturbance to marine fauna, however noise levels are well below injury thresholds. Due to the short duration chirps, the temporary and intermittent use and the mid-frequencies used by positioning and survey equipment, the acoustic noise from the transponders and survey equipment is unlikely to have a substantive effect on the behavioural patterns of marine fauna.

The Operational Area overlaps with the foraging BIA for whale sharks, migration BIA for humpback whales, the distribution BIA for pygmy blue whales and the internesting BIAs for marine turtles (as described above). Given the short period during which transponders and survey equipment may be in use (intermittent over a period of about 3 months), individual animals may deviate slightly from their route but continue on their pathway. Notably, the Operational Area is surrounded by open water, with no restrictions (e.g. shallow waters, embayments) to an animal's ability to avoid these activities.

6.1.2.2 Marine Turtles

As described above, internesting BIAs for marine turtles overlaps the operational areas. However, the nearest nesting beach is approximately 24 km from the operational area, and the operational area is located in waters greater than 40 m deep. A study that investigated flatback turtle internesting behaviour found that the 30 m depth contour encompassed the vast majority of internesting activities (i.e., resting on the seabed) (Pendoley, 2017). Another study by Whittock et al. (2016) identified suitable internesting habitat for marine turtles to be between 0 and 16 m deep and within 5 to 10 km off the coastline. These studies demonstrate that, while marine turtles may be present in offshore waters during the internesting period, they are typically freely moving through these areas before they return to shallow waters to rest in the days leading up to nesting activity. Therefore, it is possible that individual marine turtles will traverse through the operational area during the peak internesting period.

The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017) highlights noise interference from anthropogenic activities as a threat to marine turtles. The plan refers to vessel noise and the operation of some oil and gas infrastructure as sources of chronic (continuous) noise in the marine environment, exposure to which may lead to avoidance of important turtle habitat.

Finneran et al. (2017) presented revised thresholds for sea turtle injury and hearing impairment (TTS and PTS). Their rationale is that sea turtles have best sensitivity at low frequencies and are known to have poor auditory sensitivity (Bartol & Ketten, 2006; Dow Piniak et al. 2012; Martin et al. 2012). Accordingly, TTS and PTS thresholds for turtles are likely more similar to those of fishes than to marine mammals (Popper et al. 2014).

Studies show that behavioural responses occur to received sound levels of approximately 166 dB re 1 µPa and that avoidance responses occur at around 175 dB re 1 µPa (McCauley et al., 2000). These levels overlap with the sound frequencies produced by vessels and the MODU. Based on the limited data regarding noise levels that illicit a behavioural response in turtles, the lower level of 166 dB re 1 µPa level drawn from National Science Foundation (NSF) (2011) is typically applied, both in Australia and by NMFS, as the threshold level at which behavioural disturbance could occur. The recommended criteria for impulsive and continuous sound sources are shown in **Table 6-6** and **Table 6-7**.

Table 6-6: Acoustic effects of continuous noise on sea turtles

Potential Marine Fauna Receptor	Popper et al. 2014		Finneran et al. (2017) Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µ$Pa^2 \cdot s$)	
	Masking	Behaviour	PTS onset threshold	TTS onset threshold
Marine Turtle	(N) High (I) High (F) Moderate	(N) High (I) Moderate (F) Low	220	200

Note: Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N) – tens of metres, intermediate (I) – hundreds of metres, and far (F) – thousands of metres.

Table 6-7: Acoustic effects of impulsive noise on sea turtles Unweighted SPL, SEL24h, and PK thresholds

NFS (2011)	Moein et al. (1995), McCauley et al. (2000b), (2000a)	Finneran et al. (2017)			
Behaviour		PTS onset threshold		TTS onset threshold	
SPL (L_p; dB re 1 µPa)		Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	PK (L_{pk}; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	PK (L_{pk}; dB re 1 µPa)
166	175	204	232	189	226

Potential impacts

Continuous noise sources are below PTS and TTS criteria for marine turtles.

Considering the open-ocean location of the operational area, only individual turtles may be affected as they transit the area, and impacts are not considered significant based on the following:

+ MODU noise emissions that are expected are below the thresholds for behavioural impacts, PTS and TTS;
+ vessel noise is expected to be below the thresholds for PTS and TTS given the typical size vessels used during the activity and the slow vessel speeds within the operational areas, the received levels may result in behavioural impacts, but for a limited duration and will not result in significant impacts; and helicopter and ROV noise will be intermittent during the activity, and below the thresholds for behavioural impacts, PTS and TTS; and
+ Helicopter noise will be intermittent during the activity, and below the thresholds for behavioural impacts, PTS and TTS.

6.1.2.3 Sea snakes

There is limited information about the effects of noise on sea snakes. A current research project investigating the impacts of seismic surveys found that hearing sensitivity of sea snakes is similar to species of fish without a swim bladder (discussed below). Therefore, it is considered that there is a moderate risk in the near and intermediate distances (which extends hundreds of metres) of behavioural impacts to sea snakes, with the impacts being limited to temporary avoidance of the area.

6.1.2.4 Sharks, rays and fish

The whale shark foraging BIA overlaps the operational area. All fish species can detect noise sources, although hearing ranges and sensitivities vary substantially between species (Dale et al., 2015). Sensitivity to sound pressure seems to be functionally correlated in fishes, to the presence and absence of gas-filled chambers in the sound transduction system. These enable fishes to detect sound pressure and extend their hearing abilities to lower sound levels and higher frequencies (Ladich & Popper, 2004; Braun & Grande, 2008). Based on their morphology, Popper et al. (2014) classified fishes into three groups, comprising fishes:

+ with swim bladders whose hearing does not involve the swim bladder or other gas volumes;
+ whose hearing does involve a swim bladder or other gas volume; and

+ without a swim bladder that can sink and settle on the substrate when inactive.

Thresholds for PTS and recoverable injury are between 207 dB PK and 213 dB PK (depending on the presence or absence of a swim bladder), and the threshold for TTS is 186 dB SELcum (Popper et al., 2014). Given there is no exposure criteria for sharks and rays, the same criteria are adopted, though typically sharks and rays do not possess a swim bladder.

Individual demersal fish may be impacted in the vicinity of the activity and tuna and billfish and other mobile pelagic species may transverse the operational area. However, the operational area is not known to be an important spawning or aggregation habitat for commercially caught targeted species. Therefore, no impacts to fish stocks are expected.

The criteria defined in Popper et al. (2014) for continuous (Table 6-8) and impulsive (Table 6-9) noise sources have been adopted.

Table 6-8: Continuous noise: criteria for noise exposure for fish (adapted from Popper et al., 2014)

Potential Marine Fauna Receptor	Mortality and Potentially 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
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

Note: Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N) – tens of metres, intermediate (I) – hundreds of metres, and far (F) – thousands of metres.

Table 6-9: Impulsive noise: criteria for noise exposure for fish (adapted from Popper et al., 2014)

Potential Marine Fauna Receptor	Mortality and Potential Mortal Injury	Impairment			Behaviour
		Recoverable Injury	TTS	Masking	
Fish: No swim bladder (particle motion detection)	> 219 dB SEL 24h or > 213 dB PK	> 216 dB SEL24 h or > 213 dB PK	> 186 dB SEL 24h	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: Swim bladder not involved in hearing (particle motion detection)	210 dB SEL24 h or > 207 dB PK	203 dB SEL24h or > 207 dB PK	> 186 dB SEL 24h	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: Swim bladder involved in hearing (primarily pressure detection)	207 dB SEL24 h or > 207 dB PK	203 dB SEL24h or > 207 dB PK	186 dB SEL24 h	(N) Low (I) Low (F) Moderate	(N) High (I) High (F) Moderate
Fish eggs and fish larvae	> 210 dB SEL 24h 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

Note: Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N) – tens of metres, intermediate (I) – hundreds of metres, and far (F) – thousands of metres.

Potential impacts from continuous noise

Based on criteria developed by Popper et al. (2014) for noise impacts on fish, MODU, vessel, helicopter and ROV noise has a low risk of resulting in mortality and a moderate risk of TTS impacts when fish are within tens of metres from the source. The most likely impacts to fish from noise will be behavioural responses. Popper et al. (2014) identified a moderate risk of behavioural impacts to fish in near (tens of metres) and intermediate distances (hundreds of metres) from the noise source. Masking could occur within thousands of metres under a worst case scenario of vessel operations; however, typically any effect will be limited to within hundreds of metres.

Whale sharks could potentially be impacted from operational noise if in the area, whale sharks would be expected to show avoidance to vessel noise, although they are likely to tolerate low level noise, because whale sharks have been observed swimming close to oil and gas platforms on the North West Shelf.

6.1.2.5 Invertebrates

Underwater noise emissions from the activity are not expected to cause a change in behaviour to benthic invertebrates.

Potential impacts from vessels and MODU

Benthic invertebrates are unlikely to be negatively impacted from noise generated from vessel operations, there is no convincing scientific evidence for any significant effects induced by non-impulsive noise in benthic invertebrates.

Plankton, including fish eggs and larvae, and pelagic invertebrates could drift into close proximity to high energy noise sources (for example, bow thrusters). However, any negative impacts that could occur would be restricted to within metres of the sound source. At such a localised extent, impacts would be negligible at an ecosystem or population level.

6.1.2.6 Protected and significant areas

The operational areas overlap the western portion of the Montebello AMP, Multiple Use Zone – IUCN Category VI (**Figure 3-5**). The values and sensitivities of the Montebello AMP include:

+ Foraging areas for migratory seabirds that are adjacent to important breeding areas;
+ areas used by vulnerable and migratory whale sharks for foraging;
+ foraging areas marine turtles which are adjacent to important nesting sites;
+ section of the north and south bound migratory pathway of the humpback whale;
+ shallow shelf environments with depths ranging from 15–150 m which provides protection for shelf and slope habitats, as well as pinnacle and terrace seafloor features;
+ seafloor habitats and communities of the Northwest Shelf Province provincial bioregions as well as the Pilbara (offshore) meso-scale bioregion; and
+ one KEF for the region is the ancient Coastline (a unique seafloor feature that provides areas of enhanced biological productivity).

Potential impacts to cetaceans, marine turtles, fish, sharks and rays, and benthic invertebrates are discussed above. The operational areas overlap the breeding and foraging BIA for the wedge-tailed shearwater. Seabirds and migratory shorebirds within the Operational Areas may avoid helicopters and flaring from the MODU during drilling. Given the expected low density of seabirds and migratory shorebirds within the Operational Area, the relative infrequency of helicopter flights and flaring, and lack of lasting effect of potential behavioural responses to helicopter and flaring noise, impacts are expected to be negligible.

Potential impacts to marine fauna within associated with the AMP is not expected to result in significant displacement from critical habitat. It is also unlikely to present a barrier to movement or disrupt migratory pathways or behaviour.

6.1.2.7 Summary

+ the noise emissions associated with the activity are not expected to have the intensity to cause physical injury;

- noise levels from the MODU, helicopters and vessels that may cause behavioural responses are expected to generally be confined to the operational areas and concentrated within a radius of a few hundred metres of the noise source, and as such cumulative impacts from concurrent project activities are not expected; and
- noise effects to fish may result in indirect impacts to fisheries through changes in fish behaviour. Any such impacts are expected to be restricted to within hundreds of metres of the MODU/vessels, as detailed above. With the majority of the noise emissions being of short duration and of limited extent, any impact on commercial or recreational fishing is expected to be minimal.

6.1.3 Environmental performance outcomes and control measures

The EPOs relating to this event include:

- No injury or mortality to EPBC Act 1999 and WA Biodiversity Conservation Act 2016 listed fauna during activities [ST-EPO-05].

The control measures considered for this event are outlined in **Table 6-10**, and the EPS and measurement criteria for the EPOs are described in **Table 8-2**.

Santos

Table 6-10: Control measure evaluation for noise emissions

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
ST-DC-CM-001 ST-IC-CM-001	Procedure for interacting with marine fauna	Reduces risk of physical and behavioural impacts to marine fauna from vessel, because if they are sighted, then the vessel can slow down or move away, and helicopters can increase distances from sighted fauna if required.	Operational costs to adhere to marine fauna interaction restrictions, such as vessel and helicopter speed and direction, are based on legislated requirements and must be adopted.	**Adopted** – Benefits in reducing impacts to marine fauna outweigh the costs incurred by Santos. Control drives compliance with EPBC Regulations (Part 8).
ST-DC-CM-015	Support vessel	Monitoring of surrounding marine environment to identify potential collision risks (and reducing harm) to cetaceans and other marine fauna.	No additional cost – industry practice.	**Adopted** – industry practice, benefits outweigh cost. Control drives compliance with the EPBC Regulations.
ST-DC-CM-044	MODU planned maintenance system (PMS)	Reduces noise emissions from the MODU because equipment is operating within its parameters.	Costs are standard for routine PMS.	**Adopted** – benefits in reducing noise impacts.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
ST-DC-CM-045 ST-IC-CM-002	Vessel PMS to maintain vessel DP, engines and machinery	Reduces noise emissions from the vessels because equipment is operating within its parameters.	Costs are standard for routine PMS.	**Adopted** – benefits in reducing noise impacts.
Additional Controls				
N/A	Undertake site specific acoustic modelling as per Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (2015))	The distance at which fauna could experience behavioural impacts can be predicted and compared to literary publications. Additional management controls can then be included if required to support an ALARP justification and reduce potential impacts to marine fauna.	Additional cost to contract consultant to develop a model and produce predicted noise outputs.	**Reject -** The cost associated with site specific modelling, outweighs any environmental benefit, and no further controls can be implemented to reduce vessel noise other than not undertaking the activity. Given the potential impacts are expected to be minor and limited to temporary and minor behavioural changes only, and noise levels from vessels will decay rapidly, site specific modelling will not provide additional information which would alter the current ALARP position.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
N/A	Heterodyne distributed vibration sensing (hDVS) technology	The hDVS can result in a reduction in time spent by the MODU on location undertaking VSP (and subsequent cost reduction), and reduction in the number of air-gun shots required for the activity, therefore decreasing the marine fauna exposure time to underwater noise.	This technology may be feasible for the well but availability cannot be guaranteed until the schedule is confirmed.	**Rejected** – VSP not being used for the Spartan drilling activities.
N/A	Dedicated Marine Mammal Observer (MMO) (as per EPBC Policy Statement 2.1 – Part B.1)	Improved ability to spot and identify marine fauna at risk of impact from vessel and survey noise.	Additional cost of contracting several specialist marine fauna observers while the risk to all listed marine fauna cannot be reduced due to variability in timing of environmentally sensitive periods and unpredictable presence of some species.	**Rejected** – Cost disproportionate to increase in environmental benefit and given that crew member will be observing for marine fauna during MODU and vessel activities.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
N/A	Develop a noise management plan as per approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (2015))	Potential reduction in impacts to marine fauna.	Additional cost to develop a noise management plan for a short duration activity (67 days total for drilling campaign and installation campaign combined) that is low risk to marine fauna.	**Rejected** – Although the activity does occur in a migratory pathway for protected cetacean species, the existing controls are considered best practice and sufficient to manage the impact and risk from MODU and vessel noise to ALARP. No seismic activity (e.g. VSP) will be conducted as part of the activity. Therefore, the cost associated with the development of a management plan outweighs the little or no benefit for a short duration activity which has a minor impact (e.g., potential temporary and minor behavioural changes).
N/A	Use of passive acoustic monitoring (PAM)	Improve detection of some sensitive receptors.	Costs of PAM operators. Operational costs of shut-downs potentially prolonging the activity.	**Rejected** – Cost disproportionate to increase in environmental benefit given the low level behavioural response expected. Limited ability of PAM to detect cetaceans would provide little benefit to the species expected to be present.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
N/A	Verification of noise levels	Allow implementation of adaptive management controls should impact be greater than expected.	Costs of deploying noise monitoring equipment and processing of data.	**Rejected** – Relatively short duration of the activity (approximately 67 days) would prevent noise verification being completed before the activity is finished. Cost disproportionate to increase in environmental benefit given the rapid reduction in noise levels from vessels and the low-level behavioural response expected.
N/A	Operational activities to avoid coinciding with sensitive periods such as the humpback whale migration period (June to November)	Reduce risk of impacts from noise emissions during environmentally sensitive periods for listed marine fauna.	High cost in moving or delaying activity schedule. The risk to all listed marine fauna cannot be reduced due to variability in timing of environmentally sensitive periods	**Rejected** –

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
				The operational areas overlap with the humpback whale migration BIA the distribution BIA for pygmy blue whales and foraging BIA for whale sharks and these species could also be present all year round. However, the potential impacts to cetaceans including pygmy blue whales that may be opportunistically foraging outside of known foraging BIAs and sharks are predicted to be low and if they occur would be well within 500 m of the vessel and equipment and with the controls in place to manage interaction with fauna within 500m of the vessel, the potential for impact is significantly reduced. The activity will not restrict the movement of whales or whale sharks within the area as the BIA and the area within which they are distributed in is widespread. Cost is disproportionate to increase in environmental benefit.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
N/A	Schedule activities to avoid coinciding with sensitive periods such as flatback turtle nesting, internesting and hatching (September to April)	Potential reduction in impact of noise to some sensitive receptors.	The timing of the activity is subject to MODU and ISV availability and weather windows, and therefore avoidance of activities for this 8 -month period given the low impact can result in the objectives of the drilling program being unable to be met. The risk to all listed marine fauna cannot be reduced due to variability in timing of environmentally sensitive periods	**Rejected** – The operational areas overlap with very small portions of internesting BIAs in place for marine turtles and hence marine turtles may be present all year round. However, the potential impacts to turtles if they occur would be well within 500m of the vessel and equipment (behavioural impacts within tens of metres of the vessel) and with the controls in place to manage interaction with fauna within 500 m of the vessel, the potential for impact is significantly reduced. The activity will not restrict the movement of turtles within the area as the BIAs and the area within which they are distributed in is widespread. Cost is disproportionate to increase in environmental benefit.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
	Anchoring	Reduction in the continuous noise emissions from the ISV could potentially reduce the impact of noise to some sensitive receptors.	Not feasible to anchor the ISV during installation and pre-commissioning because the vessel will be used for installing the subsea infrastructure requiring precise location using DP. Also, anchoring would result in additional impacts and risks to the seabed and existing infrastructure.	**Rejected –** Anchoring the ISV is not feasible for this activity.

6.1.4 Environmental impact assessment

Noise Emissions	
Receptor	**Consequence Level**
Noise from operations of vessels, MODU, VSP and equipment	
Threatened, migratory or local fauna	While the level of noise expected from temporary and intermittent operational activities has the potential to cause physical injury to marine fauna, most species that may transit through the area are expected to demonstrate avoidance behaviour if noise levels approach those that could cause pathological effects. Avoidance behaviour is likely to be localised within the area of the activity (due to small spatial extent of elevated noise) and temporary; i.e., for the duration of the activity only. Potential PTS to low-frequency marine mammals (for example, dugongs, humpback and blue whales) could occur within 12 m of the centre of the ISV or support vessel (considering a representative vessel) if the vessel and the marine mammal remained in the same place for 24 hours. However, as whales are always moving, the potential for this impact is extremely low. Behavioural impacts may be expected for marine mammals, e.g. humpback whales, from the vessels and equipment. The Blue Whale Conservation Management Plan (DoE, 2015b) recognises that aircraft noise and industrial noise (including drilling) can result in minor impact to blue whales, though also recognises that avoidance of these activities is typically shown.

	In the Recovery Plan for Marine Turtles in Australia, noise interference to marine turtles is separated depending on whether the exposure is short (acute) or long-term (chronic). Activities such as pile driving, seismic activity and some forms of dredging generate acute noise, and sources of chronic noise are identified as including shipping channels and the operation of some oil and gas infrastructure. The level of noise generated by this activity considered less than pile driving, seismic activity or dredging. Individuals may be encountered within the operational areas but are likely to be internesting adults due to the distance from the closest nesting beaches (approximately 24 km). As the area within which foraging and distribution of all turtle species is widespread, the minimal disturbance is not expected to significantly impact the critical habitat for turtles, or impact at a population level due to the nature and scale of the activity. It is possible that whale sharks could pass through the operational areas, as the whale shark foraging BIA overlaps. Whale sharks would be expected to show a behavioural response only, as it is unlikely that this species would swim within close range (within metres) of high energy sound sources (for example, bow thrusters). The slow working speed of vessels within the operational areas further reduces the risk of any negative impacts attributable to vessel noise. The Conservation Advice *Rhincodon typus* Whale Shark (TSSC, 2015a) identifies habitat disturbance as a risk. The expected noise levels and behavioural response are not considered to result in habitat disturbance, which is consistent with this advice. Seabirds are also unlikely to be directly affected by underwater noise generated during the activity. Due to the distance of the operational areas from any seabird nesting colonies, the potential for airborne noise from the activity to cause disturbance to seabirds is extremely low. Given the generally low level of noise expected from the MODU, vessels, helicopters and associated activities, and the relatively short duration of noise emissions, as well as the controls to manage interaction with marine fauna, cumulative impacts to marine fauna from noise emissions associated with concurrent project activities are not expected. Significant impacts to threatened or migratory species are not expected. Some temporary and localised behavioural response may result from the noise levels emitted, but these will not be at levels that could cause mortality or injury to marine fauna or cause a decrease in local population size or area of occupancy of species. The consequence level for fauna is considered to be II-Minor.
Physical environment or habitat	Not applicable – noise will not impact the physical environment itself, only the species mentioned above utilising it.
Threatened ecological communities	Not applicable – No threatened ecological communities identified in the area over which noise emissions are expected.
Protected areas	Noise emissions may impact the Montebello AMP given that the western extent of the AMP overlaps with the operational area. Protected marine fauna that are transient within the AMP may also traverse the operational areas. In the immediate vicinity of the MODU and vessels, any impacts are expected to be restricted to localised and temporary impacts to marine fauna as they transit

	through the area. With the controls in place to manage interaction with marine fauna, the potential impacts will be significantly reduced as fauna is unlikely to be within the vicinity of the MODU during the activities that could potentially impact on their behaviour, and physiological impacts are highly unlikely due to this, and the type of equipment used. Vessel based activities and oil and gas activities are permitted within the AMP and no controls are proposed within the North-west MPNMP to manage noise impacts that could be adopted for this type of activity occurring near to the AMP or to protect the transient fauna of the AMP. The overall impact was assessed as not having an adverse effect on the values and sensitivities that the protected areas have been established for, due to the limited duration and the nature of the proposed activities and the control measures proposed. The consequence level is considered to be II-Minor.
Socio-economic receptors	Noise levels are not expected to impact on socio-economic receptors due to their low activity level within the vicinity of the operational areas. Impacts to fish may result in indirect impacts to fisheries in the area given the potential for temporary avoidance behaviour. However, given the short duration of the activity, limited impacts from the noise levels emitted from the activity, the area available for the respective commercial fisheries and the area over which commercial species spawn, impacts to fisheries are considered negligible. There are no recreation zones within the area expected to be impacted by noise. The consequence level for socio-economic receptors is I – Negligible.
Overall worst-case consequence	II – Minor

6.1.5 Demonstration of as low as reasonably practicable

The use of the MODU and vessels is unavoidable if the operational activities are to proceed as required on a 24 hours a day basis. Equipment maintenance will keep the vessel noise levels to within normal operating limits, which will also aid in keeping noise emissions within the boundaries that have been risk assessed.

The vessel is also expected to produce similar noise emissions to other marine vessels that frequent or transit through the vicinity of the operational areas (oil and gas industry vessels). The vessel will adhere to the EPBC Regulations (Part 8) to ensure actions are undertaken to avoid marine mammals (and whale sharks) within 100 m of a vessel, and all crews will be inducted into these requirements. It is further expected that the vessel will typically emit sufficient noise for sensitive marine fauna to exhibit avoidance behaviour and move away from the activity to avoid physical impact zones.

The use of helicopters to transfer personnel to and from the MODU and ISV is necessary to allow operational activities to occur safely and effectively, with some personnel required to be rotated to and from other locations, and to provide for a rapid method of transferring to and from the MODU in the case of an emergency. A performance standard prohibiting helicopters from landing or taking-off in the presence of marine megafauna would introduce an unacceptable risk to human life.

Well test flaring done intermittently is an essential part of a safe well test program undertaken to evaluate the resource and prepare it for production.

Management controls are in place to reduce operating noise, including vessel and helicopter operational protocols, through adherence to the Santos' Protected Marine Fauna Interaction and

Sighting Procedure (EA-91-11-00003). This requires compliance with Part 8 of the Environment Protection and Biodiversity Conservation Regulations 2000 and includes controls to reduce the risk of disturbance to or collision with EPBC Act listed marine fauna. Santos has considered the actions prescribed in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017a) when developing these controls to minimise noise impacts on marine turtles.

Any behavioural impact caused by vessel and MODU activity noise is likely to be localised and temporary, with marine species expected to resume normal behavioural patterns in the open oceanic waters surrounding the operational areas in a short timeframe with no significant impact on their normal behaviour, including during sensitive periods such as migration, nesting or foraging.

Avoiding periods of higher sensitivity such as migration or nesting periods for whales and turtles (for example) is not considered feasible. The operational areas overlap with a number of BIAs for fauna: humpback and blue whale migration that occurs across the NWS from April to December, and nesting activities for marine turtle species from August to April/May, this leaves a very small window of opportunity within which to conduct activities. Given the low potential impacts to individual fauna, there is not expected to be an impact at population level or significant impacts on migratory or nesting behaviours.

Significant impacts are not expected on fauna, including cetaceans and turtles, and the assessed residual consequence for this impact is Minor (II) Additional control measures were considered but rejected since the associated cost or effort was grossly disproportionate to any benefit (see **Section 6.1.3**). Therefore, the impact from noise associated with the activities is ALARP.

6.1.6 Acceptability evaluation

Is the consequence ranked as I or II?	Yes – maximum consequence from noise emissions is II (Minor).
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are the risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian marine park zoning objectives)?	Yes –Management consistent with EPBC Regulations Part 8. Controls implemented will minimise the potential impacts from the activity to species identified in recovery plans and conservation advices as having the potential to be impacted by noise emissions. Relevant species recovery plans, conservation management plans and management actions (**Table 3-9**), including but not limited to the: + Recovery Plan for Marine Turtles in Australia (DoEE, 2017a); + Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (2015); + North-west Marine Parks Network Management Plan (2018); and + Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015d) + Blue Whale Conservation Management Plan 2015 to 2025 (DoE, 2015b); + Approved Conservation Advice for *Rhincodon typus* (whale shark) (2015).
Are risks and impacts consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – no concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The activities will be conducted over approximately 67 days (drilling and installation activities combined timeframe, dependent on weather delays and operational downtime) in remote offshore locations with a relatively low probability of encountering significant numbers of noise sensitive fauna. The activities that will generate noise are standard offshore industry practice and the potential impacts well documented. With the controls proposed and considering the relatively short duration and characteristics of noise types planned, the potential consequences of impacts to noise sensitive receptors in the area, including internesting green turtles are assessed to be Minor (II) and ALARP.

Recovery Plan for Marine Turtles

The Recovery Plan for Marine Turtles in Australia: 2017 to 2027 (Commonwealth of Australia 2017) highlights noise interference from anthropogenic activities as a threat to marine turtles. The plan refers to vessel noise and the operation of some oil and gas infrastructure as sources of chronic (continuous) noise in the marine environment, exposure of which may lead to avoidance of important turtle habitat.

It specifies the following priority action related to noise, for all marine turtle stock:

+ Manage anthropogenic activities to ensure marine turtles are not displaced from identified habitat critical to the survival.

Underwater noise emitted from MODUs consists of a combination of drilling operations and on-board machinery, and typically produces low intensity but continuous sound. Vessels will also generate underwater noise. Under normal operating conditions when the vessel is idling or moving between sites, vessel noise would be detectable over a short distance. Higher noise levels occur when the vessel is using the dynamic position system to hold station, such as during transfer operations. Overall, underwater noise levels generated during the activity are expected to be localised, and below the thresholds for PTS and TTS.

Transiting marine turtles are expected to occur within the operational areas during nesting and internesting periods. However, given the short duration of the activity and the proposed management measures, it is reasonable to conclude that noise emissions will not affect the conservation status of marine turtles or compromise the objectives of the marine turtle recovery plan and therefore impacts are acceptable.

Management plans and conservation advice for cetaceans

The operational areas intercept BIAs for humpback whales (migration) and blue whales (distribution) (**Figure 3-10**). The Conservation Management Plan for the Blue Whale (DoE, 2015b) discusses marine seismic surveys and associated risk management measures, including implementing practical measures outlined in Part A of EPBC Act Policy Statement 2.1. Conservation Advice for Humpback Whale (TSSC, 2015d) requires all seismic surveys to be undertaken in a manner consistent with the Part A of EPBC Act Policy Statement 2.1. Further, the advice states that Part B of the policy statement must be implemented for surveys being undertaken in or near a calving, resting, foraging area, or a confined migratory pathway. However, the operational areas are not within a humpback whale calving, resting, foraging area, or a confined migratory pathway and no seismic activity will occur.

Action A.2.3 of the Conservation Management Plan for the Blue Whale (DoE, 2015b) states that "Anthropogenic noise in biologically important areas will be managed such that any blue whale continues to utilise the area without injury, and is not displaced from a foraging area". Recent *Guidance on key terms within the Blue whale Conservation Management Plan* issued by DAWE (2021) provides guidance on what constitutes a foraging area, including opportunistic foraging areas outside of known foraging BIAs. This activity is consistent with the plan because:

+ the activity includes controls to manage anthropogenic noise include adaptive management in the event that whales are encountered by vessels and helicopters, therefore whales can continue to use the area without injury;
+ there will be no injury due to noise emissions to blue whales that may be encountered during the activity. As defined by the guidance on key terms in the CMP (DAWE, 2021), injury is considered to be either PTS or TTS from underwater noise. The received levels from MODU and vessels will decline rapidly from the source and be below thresholds for PTS and TTS within approximately 12 to 266 m of the source;

On this basis impacts are considered acceptable.

Summary

The controls proposed are consistent with relevant standards, including Part A of EPBC Act Policy Statement 2.1, EPBC Regulations Part 8 (Vessels and Aircraft), and aligned with the applicable management actions outlined in relevant Recovery Plans, conservation management plans and Approved Conservation Advice. No concerns from stakeholders (including fisheries) have been raised regarding noise emissions during the activity. Therefore, the Minor (II) impacts expected from noise emissions are considered environmentally acceptable.

6.2 Light Emissions

6.2.1 Description of event

Event	Potential impacts from light emissions may occur in the operational areas from: + safety and navigational lighting on the MODU; + safety and navigational lighting on vessels; + spot lighting used on an as-needed basis; e.g., equipment deployment and retrieval; and + light from flaring during well testing. Lighting will typically consist of bright white (i.e., metal halide, halogen, fluorescent) lights typical of lighting used in the offshore petroleum industry and not dissimilar to lighting used for other offshore activities in the region, including shipping and fishing.
Extent	Localised: Limited light 'spill' or 'glow' on surface waters surrounding the MODU and vessels. Impacts expected to remain within the operational areas. The amount of light produced from flaring during well testing is dependent on the characteristics of the reservoir and the flare flow rate. Flaring will be visible at distances of tens of kilometres.
Duration	Navigational and task lighting is required 24 hours a day for the duration of the activity. Flaring is an intermittent source of light emission which typically occurs for an average two to three days during well testing.

6.2.2 Nature and scale of environmental impacts

Potential receptors: Threatened, migratory or local fauna (marine mammals, marine turtles, sharks, rays, fish and seabirds).

Continuous lighting in the same location for an extended period of time may result in alterations to fauna behaviour, the specific impacts on different fauna groups is described below. The combinations of colour, intensity, closeness, direction and persistence of a light source are key factors in determining the magnitude of environmental impact (EPA, 2010). Disturbance may include:

+ seabirds may either be attracted by the light source itself or indirectly due to marine fauna prey (such as fish and invertebrates) attracted to light;
+ marine turtles and turtle hatchlings may be misoriented and disoriented by lights; and
+ fish and zooplankton may be directly or indirectly attracted to lights.

According to the National Light Pollution Guidelines for Wildlife, a 20 km threshold provides a precautionary limit based on observed effects of sky glow on marine turtle hatchlings demonstrated to occur at 15 to 18 km from the light source and fledgling seabirds grounded in response to artificial light 15 km away. The intensity and extent of light glow, and the potential to result in biological impact, will be dependent upon the light source itself, including the number, intensity, spectral output and position of individual lights at the source. The effect of light glow may occur at distances greater than 20 km for some species and under certain environmental conditions (Commonwealth of Australia, 2020).

Marine mammals

The humpback whale migration BIA and the pygmy blue whales distribution BIA overlaps the operational areas, with humpback whales likely to be present in the operational areas in increased numbers during migration windows. However, cetaceans and other marine mammals are not known to be significantly attracted to light sources at sea. Cetaceans predominantly use acoustic senses to monitor their environment rather than visual cues (Simmonds et al., 2004), therefore impacts are thought to be unlikely.

Marine turtles

Marine turtles are particularly sensitive to artificial lighting, which is known to disrupt breeding adult turtles, post-emergent hatchlings and hatchlings dispersing in nearshore waters (Limpus, 1971; Salmon & Wyneken, 1992; Limpus, 2007, 2008a, 2008b, 2009a, 2009b; Wilson et al . 2018). However, potential impacts to foraging turtles is limited to local attraction via a secondary response to effects of light on prey distribution (Kebodeaux, 1994). Marine turtles do not feed during the breeding season (Limpus et al., 2013), and light is not a cue to internesting behaviours. Therefore, potential impacts of artificial light to internesting turtles are not considered likely and are not discussed further.

The Recovery Plan for Marine Turtles in Australia: 2017-2027 (Commonwealth of Australia, 2017) highlights artificial light as a threat to marine turtles. Specifically, the plan indicates that artificial light may reduce the overall reproductive output of a stock, and therefore recovery of the species, by:

+ inhibiting nesting by females;
+ disrupting hatchling orientation and sea-finding behaviour; and
+ creating pools of light that attract swimming hatchlings and increase their risk of predation.

The most significant risk posed to marine turtles from artificial lighting is the potential disorientation of hatchlings following their emergence from nests by light spill on beaches, although breeding adult turtles can also be disoriented (Longcore and Rich, 2016, in EPA, 2010). This disruption can occur because hatchlings orient themselves to the lowest-elevation light horizon and away from high silhouettes when moving from the nest to the sea. When the direction of the lowest elevation light horizon is not clear, hatchlings move towards the brightest, lowest horizon (Limpus & Kamrowski, 2013).

Therefore, while onshore lights (landward side of dunes) are of particular concern, offshore bright lights also have the potential to attract hatchlings, which have been shown to orient towards light sources close to the horizon (Witherington & Martin, 2003). This generally would not pose a problem if hatchlings are attracted directly to the surf zone, for once in the surf zone, turtle hatchlings are believed to be less influenced by light and to navigate using sea-wave and magnetic cues (Witherington & Martin, 2003). However, hatchlings may also orient along the beach, depending on the location of the light source relative to the beach. This can lead to fatigue, increase the hatchlings exposure to predators, and reduce the success of hatching turtles entering the ocean. Once in the ocean, hatchlings are thought to remain close to the surface, orient by wave fronts and swim into deep offshore waters for several days to escape the more predator-filled shallow inshore waters. During this period, light spill from coastal port infrastructure and ships may ‘entrap’ hatchling swimming behaviour, reducing the success of their seaward dispersion and potentially increasing their exposure to predation via silhouetting (Salmon et al., 1992).

The operational areas overlap an internesting BIAs for marine turtles. The nearest nesting beach is located approximately 24 km from the operational area, at its closest point.

The National Light Pollution Guidelines states that a 20 km buffer (based on sky glow) to important habitat for turtles should be applied when considering possible impacts (DoEE, 2020). However, the demonstrated impacts on which this buffer is based were in response to light emissions associated with a liquified natural gas (LNG) plant. Although details around the individual light sources of the case study and the light sources on the vessels are unknown, it is expected that light emissions associated with the MODU and vessels will be notably lower compared to an LNG plant. Given the operational areas are located greater than 20 km away from the nearest turtle nesting beach, light emissions will not be visible and any impacts (including cumulative impacts) with respect to hatchling emergence are not expected). Experienced nesting females are unlikely to be disturbed by light, but first-time nesters may be disturbed by light when they are selecting their first nesting beach (Pendoley, 2014). Given that the closest nesting beach is greater than 20 km from the operational areas, nesting females should not be disorientated by light emissions. Furthermore, once in the water, turtle hatchlings orientate by wave fronts and do not appear to rely on visual cues (Pendoley, 2014), therefore light emissions are unlikely cause disorientation at that distance (i.e., greater than 20 km). Foraging turtles are adults and not considered as significantly impacted by lighting as hatchlings (refer below).

Impacts to turtles from operational activity lighting are expected to be restricted to localised attraction and temporary disorientation, but with no long-term, cumulative or residual impact due to the activity's short term nature (i.e., approximately 67 days depending on weather delays and operational downtime), and the unlikely presence of hatchlings due to the distance from the nearest shorelines. It is considered that the activity will not compromise the objectives as set out in the marine turtle recovery plan and impact of lighting associated with the activity to turtles is negligible.

Sharks, rays and fish

Fish at the surface of the water have the potential to be impacted by artificial light. Sharks and rays are not known to be significantly attracted to light sources at sea. However, they may be attracted to the fish that are attracted to the light. Therefore, disturbances to behaviour may occur.

The response of fish to light emissions varies according to species and habitat. Experiments using light traps have found that some fish and zooplankton species are attracted to light sources (Meekan et al., 2001), with traps drawing catches from up to 90 m away (Milicich et al., 1992). Lindquist et al. (2005) concluded from a study that artificial lighting associated with offshore oil and gas activities resulted in an increased abundance of clupeids (herring and sardines) and engraulids (anchovies). These species are known to be highly photopositive. The artificial light serves to focus their marine plankton prey and consequently leads to enhanced foraging success.

Overall, a short-term localised increase in fish activity is expected to occur as a result of lighting from the MODU and vessels, however, with negligible impacts to the local fish population.

Seabirds

Seabirds have been shown to be attracted to artificial light sources. Artificial light can disorient seabirds and potentially cause injury and/or death through collision with infrastructure. Birds may starve as a result of disruption to foraging, hampering their ability to prepare for breeding or migration. High mortality of seabirds occurs through grounding of fledglings as a result of attraction to lights and through interaction with vessels at sea (DoEE, 2020). Studies conducted between 1992 and 2002 in the North Sea confirmed that artificial light was the reason that birds were attracted to and accumulated around illuminated offshore infrastructure (Marquenie et al., 2008). Birds may either be attracted by the light source itself or indirectly as structures in deep water environments tend to attract marine life at all tropic levels, creating food sources and providing artificial shelter for seabirds (Surman, 2002). The light sources associated with the MODU and vessels may also provide enhanced capability for seabirds to forage at night.

The operational areas intercept a recognised BIA for the listed migratory wedge-tailed shearwater. There are no draft or adopted Recovery Plans for these species. The operational areas are located approximately 24 km from the nearest land mass (Barrow Island), that may provide seabird roosting or breeding habitat. As this is outside the 20 km buffer suggested by the National Light Pollution Guidelines, breeding behaviour is not expected to be interrupted, with individual seabird species expected to overfly the location.

The Spartan activities are anticipated to take approximately 67 days (dependent on weather delays and operational downtime). Consequently, light emissions from the MODU and/or vessels are unlikely to attract and/or affect the behaviour of large numbers of seabirds.

Protected and significant areas

The operational areas overlap a small portion of the western extent of the Montebello AMP and therefore light emissions may impact the values of the AMP, which includes (relevant to light emissions) breeding, foraging and resting habitat for seabirds, internesting and nesting habitat for marine turtles. As discussed above, impacts to internesting turtles are considered unlikely to be significant, and the operational areas are both 24 km from the nearest nesting beach on Barrow Island where, so turtle hatchlings are not considered vulnerable to light emissions from this location when orientating to find the ocean.

Migrating seabirds that may be roosting or nesting on the Montebello Islands may overfly the operational areas and could be attracted to the light on the vessels and MODU, but it is not considered likely that seabird behaviour would be significantly affected to the point of resulting in impacts at a population level.

6.2.3 Environmental performance outcomes and control measures

The EPO relating to this event is:

+ Reduce impacts to marine fauna from lighting on vessels and MODU through limiting lighting to that required by safety and navigational lighting requirements [ST-EPO-08].

The control measures for this activity are shown in Table 6-11 with EPS and measurement criteria for the EPOs described in Table 8-2.

Table 6-11: Control measure evaluation for light emissions

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
ST-DC-CM-039 ST-IC-CM-003	Lighting will be used as required for safe work conditions and navigational purposes	Light spill from unnecessary lighting reduced, even further lowering likelihood of impacts to the fauna from MODU and vessel lighting Lighting is assessed to only provide necessary lighting for safety and navigation during the activity. Reducing the potential for additional light pollution to the environment, thus reducing the potential impacts to fauna.	Additional costs associated with implementing control.	**Accepted** – Cost is considered acceptable for the benefit that may be realised from this control.
Additional Controls				
N/A	Manage the timing of the activity to avoid sensitive periods at the location (e.g., turtle nesting/ hatching)	Reduce risk of impacts from light emissions during environmentally sensitive periods for listed marine fauna (e.g., turtle nesting/hatching).	Although the operational areas overlap internesting BIAs for marine turtles, it is still approximately 24 km from the nearest nesting beach and in water depths where turtles are unlikely to	**Rejected** – Given the minimal risk of impacts to listed marine species (e.g., turtles) occurring due to lighting, the financial and environmental costs of extending the activity duration

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
			be internesting. Given that the closest nesting beach is greater than 20 km from the operational areas, nesting females should not be disorientated by light emissions. Furthermore, once in the water, turtle hatchlings orientate by wave fronts and do not appear to rely on visual cues, therefore light emissions are unlikely cause disorientation at that distance (i.e., greater than 20 km). Therefore, lighting from MODU and vessels, given the distance offshore and short term duration of the activity (67 days) is unlikely to cause impact to turtle nesting or hatching and therefore timing the activity to avoid this would not change the potential environmental impacts.	are deemed grossly disproportionate to negligible environmental benefits.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
N/A	Review lighting to a type (colour, intensity, frequency) that has less impact	Could reduce potential impacts of artificial light on certain fauna.	High cost to complete lighting change out on MODU and vessels in area of low sensitivity. Navigational lighting colours are stipulated by law.	**Rejected** – Cost outweighs the benefit. The operational area is approximately 24 km from the nearest turtle nesting beaches. Although the operational area overlaps with the internesting turtle BIAs, impacts are not expected on a population level or to impact on turtle habitat.
N/A	Limit or exclude night-time operations	Would eliminate potential impacts of artificial light during hours of darkness when light sources are more apparent and potential impacts are greatest.	Would double duration of activity, increase impacts or potential impacts in other areas, including increase in waste, air emissions, risk of vessel collision, etc. A minimal level of artificial lighting will still be required on-board the MODU and vessels on a 24-hour basis for safety reasons.	**Rejected** – Given the minimal risk of impacts to turtles occurring, the financial and environmental costs by requiring all works to be undertaken during daylight hours only are not considered appropriate given the extended duration of the activity that would occur.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
N/A	Use of dark, matte surfaces to reduce sky glow across all activities	Reduce potential for impacts on turtles from light emissions during hours of darkness when light sources are more apparent and potential impacts are greatest.	Additional cost to repaint vessel surfaces	**Rejected** – Given the distances from the nesting beaches the cost is considered disproportionate
N/A	Use of shrouding on external lights	Reduce potential for impacts on turtles from light emissions during hours of darkness when light sources are more apparent and potential impacts are greatest.	Cost associated with retro fitting external lighting with shrouding/shielding. Can only be done for lighting that does not impact on navigational requirements or safety.	**Rejected** - Operational areas are approximately 24 km from the nearest nesting beaches. Modelling of light spill pipelay and construction vessels indicates that light levels reduce to ambient levels within 11 km. Therefore, no environmental benefit would be obtained from installing shrouding.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
N/A	Implement light management actions recommended in the National Light Pollution Guidelines, including: + Switch off outdoor/deck lights when not in use + use available block-out blinds on portholes and windows not necessary for safety and/or navigation at night + manage and report seabird interactions	Would result in reduced light spill from internal lighting onto the sea surface, potentially reduce overall light emissions, and reduce the consequence of any seabird interactions.	Cost of maintaining records and to train staff. Potential re-engineering of vessel (lighting management systems and blackout blinds).	**Rejected** – Although the operational area is located within internesting BIAs for marine turtles, they are more than 24 km from the nearest nesting beaches, and therefore the management actions would not change the potential environmental impacts. 24 hour/day activities require a safe standard of lighting.
N/A	No flaring	Eliminates artificial light associated with flaring	There is no safe and feasible alternative to flaring to complete well testing. Flaring is an essential element for safe well testing.	**Rejected -** Not practical or feasible to eliminate flaring during well testing.

6.2.4 Environmental impact assessment

Receptor	Consequence Level
Light emissions	
Threatened, migratory or local fauna	Sensitive receptors that may be impacted by light emissions in the same location for an extended period of time include fish at the surface, marine turtles and seabirds. Light emissions may be visible to turtles transiting, foraging or internesting in surrounding areas, but they are unlikely to affect nesting or hatchling sea finding and dispersal activity. The National Light Pollution Guidelines for Wildlife states a 20 km threshold provides a precautionary limit based on observed effects of sky glow on marine turtle hatchlings demonstrated to occur at 15 to 18 km and fledgling seabirds grounded in response to artificial light 15 km away. The closest significant nesting area for turtles is Barrow Island (24 km away at the nearest point to the operational area). Therefore, night-time activity lighting from the activity is expected to have a negligible impact on breeding or hatchling turtles, given the distances from nearest beaches and cumulative impacts with respect to hatchling emergence are not expected. The operational area overlaps the breeding and foraging BIA for the wedge-tailed shearwater. However, the operational area is 24 km to Barrow Island that may provide seabird roosting or breeding habitat. Therefore, the location of the operational areas should not significantly impact foraging behaviour. Cetaceans and marine mammals are not known to be significantly attracted to light sources at sea therefore, disturbance to behaviour is unlikely. Indirect impacts on food sources or habitats also unlikely (see below). Fish, sharks and birds have been shown to be attracted to artificial light sources however, the activity is unlikely to lead to large-scale changes in species abundance or distribution. Impacts to transient fish, sharks and seabirds will therefore be limited to short-term behavioural effects with no decrease in local population size or area of occupancy of species, loss or disruption of critical habitat, or disruption to the breeding cycle. Due to management controls in place, and the distance from shorelines the artificial lighting associated with the activity is considered to have a negligible impact on fauna, including the breeding success of seabird and marine turtle populations.
Physical environment or habitat	Negligible – No impacts to physical environments and/or habitats from light emissions are expected.
Threatened ecological communities	Not applicable – No threatened ecological communities identified in the area over which light emissions are expected.
Protected areas	Negligible – The operational area overlaps with the Montebello AMP. The values and sensitivities of the AMP relevant to light emissions are breeding, foraging and resting habitat for seabirds, internesting and nesting habitat for marine turtles. The potential impacts to these marine fauna are considered to be negligible, as described above.
Socio-economic receptors	Negligible – Lighting is not expected to cause an impact to socio- economic receptors other than to act as a visual cue for avoidance of the area by other marine users for safety purposes.

Receptor	Consequence Level
Overall worst-case consequence	I – Negligible

6.2.5 Demonstration of as low as reasonably practicable

With the described controls, the consequence of artificial light on marine fauna and seabirds is considered to be negligible with insignificant impacts to ecological function. No population level impacts are expected, and the consequence is considered environmentally acceptable.

Artificial lighting is required 24 hours a day for operational and navigational safety during the activity. A minimum level of artificial lighting is required on a 24-hour basis to alert other marine users of the activity. There are also minimum light requirements that will be necessary to provide safe working conditions. To reduce lighting at night further would restrict the activity hours resulting in the activity taking approximately twice as long to complete. This would increase the period of time the operational areas would need to be avoided by other marine users and the amount of waste, discharges and emissions produced.

The increased risks/impacts with potentially larger scale consequences associated with reduced light levels are considered to present a cost that is grossly disproportionate to any environmental benefit. Given that lighting on the MODU and vessels will be consistent with industry standards and will result in negligible consequences, and that no reasonably practicable additional controls or alternatives were identified, it is considered that the environmental impacts of using 24-hour artificial lighting at an intensity to allow work to proceed safely are ALARP.

There is no safe and feasible alternative to flaring to complete the activity. Flaring can provide valuable information on the types of products the well can produce, the pressure and flow rates of fluids and other characteristics of the reservoir. Flaring procedures ensure that gases are disposed of in a controlled manner. It is not possible to divert the gas produced by well testing to production facilities, as the development well will be drilled prior to the required production infrastructure being installed. Flaring results in light emissions from the MODU for a short duration (two to three days per well test).

The operational area is located approximately 24 km from the nearest turtle nesting beaches at Barrow Island. Subsequently MODU and vessel light emissions will not be visible from the beaches.

The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017) specifies the following priority actions for the Pilbara genetic stock of flatback turtles the NWS genetic stock of green turtles and the Western Australian genetic stock of hawksbill turtles in relation to light pollution:

+ Artificial light within or adjacent to habitat critical to the survival of marine turtles will be managed such that marine turtles are not displaced from these habitats.

Although the operational area overlaps internesting BIAs for marine turtles, lighting from the planned activity is not expected to impact aggregating adults or internesting and nesting behaviour and therefore displacement will not occur and the habitat critical to survival of the species will only be affected for a short-term duration and not at levels that could result in impacts at a population level.

The activity will not compromise the objectives as set out in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017) or the National Light Pollution Guidelines for Wildlife (DoEE, 2020), as biologically important behaviours of nesting adults and emerging/dispersing hatchlings can continue given the distance from the nearest nesting beaches. The assessed residual consequence for this impact is negligible and cannot be reduced further. Additional control measures were considered but rejected since the associated cost or effort was grossly disproportionate to any benefit, as detailed in **Section 6.2.3**. Therefore, the use of 24-hour per day artificial lighting at an intensity to allow work to proceed safely is considered ALARP.

6.2.6 Acceptability evaluation

Is the consequence ranked as I or II?	Yes – maximum consequence from light emissions is I (Negligible).
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes – management consistent with International Convention of the *Safety of Life at Sea (SOLAS) 1974 and the Navigation Act 2012*. Consistent with relevant species recovery plans, conservation management plans and management actions set out in (**Table 3-9**), including but not limited to: + National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (DoEE, 2020) + Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017) + North-west Marine Parks Network Management Plan (Director of National Parks, 2018).
Are risks and impacts consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – no concerns raised
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP.

Lighting of the MODU and vessels is industry standard and required to meet relevant maritime and safety regulations. The potential consequences of the anthropogenic light sources in the operational areas are considered to be insignificant in nature and restricted to short-term behavioural impacts on individual fauna that may be present in the operational areas during the activity.

The operational area intercepts internesting BIAs for marine turtles. Significant impacts are not expected on fauna, including nesting turtles or hatchlings. No stakeholder concerns have been raised regarding lighting for the activity.

The Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017) specifies the following priority actions for the Pilbara genetic stock of flatback turtles, the NWS genetic stock of green turtles and the Western Australian stock of hawksbill turtles in relation to light pollution:

- Artificial light within or adjacent to habitat critical to the survival of marine turtles will be managed such that marine turtles are not displaced from these habitats.

Lighting from the planned activity is not expected to impact aggregating adults. Significant impacts are not expected on fauna, including nesting turtles or hatchlings and will not cause turtles to be displaced from these habitats. Noting that the guidelines are primarily in place for terrestrial light impacts rather than offshore lighting.

The potential consequence of light emissions on receptors is assessed as Negligible (I). With the control measures in place, including compliance with navigational safety legislation, no significant impacts are expected. Therefore, the impacts of light emissions to the receiving environment are ALARP and considered environmentally acceptable.

6.3 Atmospheric Emissions

Event	Potential impacts from atmospheric emissions may occur in the operational areas from the following sources: + combustion through flaring during well testing (oil and gas). Other gasses (CO_2 and H_2S) may also be produced from the reservoir. + operation of MODU and vessel engines, helicopters, generators, mobile and fixed plant and equipment. These emissions will include greenhouse gas (GHG) emissions, such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), and non-GHG emissions, such as sulphur oxides (SO_X) and nitrogen oxides (NO_X); + operation of incinerators on support vessels outside the 500 m exclusion zone around the MODU, and the ISV; + when transferring dry bulk products used for drilling (e.g., barite, bentonite, cement), tank venting is necessary to prevent tank overpressure. The vent air will contain minor quantities of product particles, which will suspend in the air or settle on the sea surface. + Although the MODU and vessels may use ozone-depleting substances (ODS), this will be in a closed rechargeable refrigeration system and there is no plan to release ODS to the atmosphere.
Extent	Localised: The quantities of gaseous and solid (powder) emissions are relatively small and will, under normal circumstances, quickly dissipate into the surrounding atmosphere. Atmospheric emissions from project activities are not expected to result in any cumulative impacts.
Duration	Intermittent for the duration of the activity.

6.3.1 Nature and scale of environmental impacts

Potential receptors: Physical environment (air quality).

Hydrocarbon combustion may result in a temporary, localised reduction of air quality in the environment immediately surrounding the discharge point during the activity. Non-GHG emissions, such as NO_X and SO_X, can lead to a reduction in local air quality. GHG emissions are recognised to also contribute to the greenhouse gas emissions loading globally. Similarly, flaring will reduce the air quality immediately surrounding the discharge point.

Ozone-depleting substances are used in closed refrigeration systems on board vessels. Ozone-depleting substances have the potential to contribute to ozone-layer depletion if accidentally released to the atmosphere. Ozone-depleting substances are not used, generated or discharged by vessel activity other than what is incidentally located and used in closed systems on board vessels. ODS will not be deliberately released during the course the activity. ODS air emissions would only occur in the event of damaged or faulty refrigeration equipment.

Tank venting is a necessary safety control, and any dust emissions will be negligible and limited to the immediate vicinity of the MODU and support vessels.

As the activity will occur in open-ocean offshore waters, the combustion of fuels, flaring of hydrocarbons and incineration in such remote locations will not impact on air quality in coastal towns, the nearest being Port Hedland. The quantities of gaseous emissions are relatively small and will quickly dissipate into the surrounding atmosphere. Air emissions will be similar to other vessels operating in the region for both petroleum and non-petroleum activities.

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6.3.2 Environmental performance outcomes and control measures

The EPOs relating to this event include:

+ No unplanned objects, emissions or discharges to sea or air [ST-EPO-04].
+ Reduce impacts to air and water quality from planned discharges and emissions from the activities [ST-EPO-06].

The control measures for this event are shown in Table 6-12, and the EPS and measurement criteria for the EPOs are described in Table 8-2.

Table 6-12: Control measure evaluation for atmospheric emissions

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
ST-DC-CM-011	Bulk solid transfer procedure – tank venting during bulk product (powder) transfer	Venting prevents over-pressure which would result in a potential release of bulk powders to the marine environment during filling	Health and safety requirement to prevent tank over-pressure.	**Adopted** – The health and safety requirement outweighs the negligible environmental impact.
ST-DC-CM-019 ST-IC-CM-004	Waste incineration	Reduces the potential for emissions or particulates by ensuring only permissible waste is incinerated as per International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI and Marine Order 97. No incineration within the MODU 500 m exclusion zone shall occur.	Personnel cost of maintaining waste records and training of staff.	**Adopted** – Negligible environmental impact outweighs the costs associated with transporting waste to shore for landfill.
ST-DC-CM-020 ST-IC-CM-005	Fuel oil quality	Reduces emissions through use of low-sulphur fuel in accordance with Marine Order 97.	Operational costs of refuelling.	**Adopted** – Environmental benefit outweighs cost and it is a legislated requirement.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
ST-DC-CM-021 ST-IC-CM-006	International Air pollution prevention certification	Reduces probability of potential impacts to air quality due to ozone-depleting substance emissions, high NO_X, SO_X and incineration emissions.	Personnel cost of ensuring vessel has current international air pollution prevention certificate during vessel contracting procedure and in pre-mobilisation audits or inspections.	**Adopted** – Benefit of ensuring vessel is compliant outweighs the minimal costs and it is a legislated requirement.
ST-DC-CM-022 ST-IC-CM-007	Ozone-depleting substance handling procedures	Reduces the potential for accidental release.	Cost associated with implementing procedures.	**Adopted –** Benefit of preventing accidental releases of ODS outweighs the minimal costs.
ST-DC-CM-044	MODU Planned Maintenance System (PMS)	Reduces atmospheric emissions from the MODU because equipment is operating within its parameters.	Costs are standard for routine PMS.	**Adopted** – benefits in reducing atmospheric emissions impacts outweigh the minimal costs.
ST-DC-CM-045 ST-IS-CM-002	Vessel PMS to maintain vessel DP, engines and machinery.	Reduces atmospheric emissions from the vessels because equipment is operating within its parameters.	Costs are standard for routine PMS.	**Adopted** – benefits in reducing atmospheric emissions impacts outweigh the minimal costs.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
ST-DC-CM-036	Well test procedures	Includes control measures that reduce the risk of poor quality incineration of hydrocarbons entering the atmosphere.	Cost associated with implementing procedures.	**Adopted –** Benefit of ensuring quality incineration outweighs the minimal costs.
Additional Controls				
N/A	No bulk product (powder) transfers	Reduces probability of potential impacts to air quality from unintentional release.	Bulk product is required to perform the activity and transfers of bulk product are required. Transfer activities are carried out in accordance with MODU owner's procedures to reduce the risk of an unintentional release.	**Rejected** – Not feasible.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
N/A	No incineration policy on vessels	Reduction in fuel consumption and air emissions through zero incineration.	Increase in health risk from storage of wastes. Limited space available to store waste, additional trips to shore would be required to transport waste. Increase in risk due to transfers (increased fuel usage, potential increase in collision risk, disposal on land).	**Rejected** – Health and safety risks outweigh the benefit given the offshore location. Cost associated with transporting waste to shore for landfill or incineration outweighs onboard incineration. Incineration on the vessels (outside the 500 m safety zone around the MODU) is a permitted maritime operation.
N/A	Removal of all ozone-depleting substance–containing equipment	Eliminates potential of ozone-depleting substance emissions occurring, impacting on air quality.	Lack of refrigeration systems on board the vessels would lead to unacceptable workplace conditions (i.e., air conditioning) and poor food hygiene standards, limiting the vessel's ability to undertake the activity therefore there is no practical solution to the use of refrigeration. It is noted that ozone-depleting substances are rarely found on vessels.	**Rejected** – Based on cost to replace all equipment and there is only a low potential for ozone-depleting substance releases.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
N/A	Use incinerators and engines with higher environmental efficiency	Improves air quality by more efficient burning or fuel combustion.	Significant cost in changing unknown vessel equipment.	**Rejected –** Cost grossly disproportionate to low environmental benefit (impact rated Negligible).
N/A	No flaring during well testing	Avoidance of flaring emissions and GHGs.	Introduces significant safety issues during well testing if the gas cannot be flared.	**Rejected –** Safety issues outweigh the environmental benefit for the short-term well testing.
N/A	No support vessels	Reduces the emissions and GHG associated with activity.	The MODU and ISV require support vessels for crew and supplies during a campaign and a vessel is also on standby to provide emergency services. Alternative transfer of supplies via helicopter is not feasible due to the size of containers being transferred.	**Rejected –** Support vessels are required to undertake the activity and no alternatives are considered feasible.

6.3.3 Environmental impact assessment

Receptor	Consequence Level
Atmospheric emissions	
Threatened, migratory or local fauna	Emissions are relatively small and will, under normal circumstances, quickly dissipate into the surrounding atmosphere. Short-term behavioural impacts to seabirds could be expected if they overfly the location and they may avoid the area. No decrease in local population size or area of occupancy of species, loss or disruption of critical habitat, disruption to the breeding cycle or introduction of disease. Therefore, any potential impacts are not expected to result in a decrease in local population size or disruption to the breeding cycle in either operational area. The consequence level for this receptor is assessed as Negligible (I).
Physical environment or habitat	The activity will occur in the open ocean and offshore waters, the combustion of fuels and venting will not impact on air quality in coastal towns. The quantities of gaseous emissions are relatively small and will, under normal circumstances, quickly dissipate into the surrounding atmosphere. The highly dispersive nature of local winds (i.e., strong and consistent) is expected to reduce potentially harmful or 'noticeable' gaseous concentrations within a short distance from the MODU or vessels. Cumulative impacts are not expected. The consequence level for this receptor is assessed as Negligible (I).
Threatened ecological communities	Not applicable – No threatened ecological communities present.
Protected areas	Gaseous emissions are relatively small, will quickly dissipate into the surrounding atmosphere, and are unlikely to impact the values and sensitivities for protected areas, including the Montebello AMP, given the offshore environment and rapid dissipation. The consequence level for this receptor is assessed as Negligible (I).
Socio-economic receptors	Gaseous emissions are relatively small, will quickly dissipate into the surrounding atmosphere, and are not considered to be a potential source of impact for socio-economic receptors. The consequence level for this receptor is assessed as Negligible (I).
Worst-case consequence level	I – Negligible

6.3.4 Demonstration of as low as reasonably practicable

Combustion of fossil fuels is essential to undertaking the activity to power the MODU, vessels, helicopters and equipment. Practical and reliable alternative fuel types and power sources for the MODU, vessels and helicopters have not been identified.

There is no safe and feasible alternative to flaring to complete well testing. Flaring is an essential element for safe well testing that results in atmospheric emissions. Bulk transfers are necessary to provide drilling materials and tank venting is a necessary safety control. There are no safe and feasible alternatives to venting to complete the activity.

Incineration on the support vessels will not occur within the 500 m safety exclusion zone around the MODU. Implementation of a zero incineration policy on the vessels would result in significant costs associated with the transport of waste to shore for disposal. Further transportation of the waste to shore would increase the environmental impacts and risks associated with the drilling activity through increased vessel movements and generate greater volumes of emissions associated with the vessel movements. Additional space would also be required to store waste (including refrigerated storage) which would require larger vessels to allow for the storage, resulting in higher emissions from engine combustion and to power additional refrigeration units. Since incineration is a permitted maritime operation in accordance with Marine Order 97 (reflecting MARPOL Annex VI requirements) it is considered ALARP.

Lack of refrigeration systems (i.e., air conditioning) on-board the MODU and vessels would lead to unacceptable workplace conditions and poor food hygiene standards, limiting the MODU and/or vessels' ability to undertake the activities, therefore there is no practical alternative to the use of refrigeration.

The assessed residual consequence for this impact is Negligible (I) and cannot be reduced further. Additional control measures were considered but rejected, since the associated cost or effort was grossly disproportionate to any benefit and the offshore open environment where the atmospheric emissions dissipate rapidly in the surrounding air which is not in close proximity to sensitive receptors, as detailed in **Section 0**. Therefore, it is considered that the impact of the activities conducted is ALARP.

6.3.5 Acceptability evaluation

Is the consequence ranked as I or II?	Yes – maximum consequence from atmospheric emissions is I (Negligible).
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes – pursuant to Marine Order 97 (Marine pollution prevention – air pollution), which gives effect under Australian law to MARPOL Annex VI. No plans identified atmospheric emissions like those described above as being a threat to marine fauna or habitats. The activity is compliant with requirements of the North-west Marine Parks Network Management Plan (2018).
Are risks and impacts consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – no concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

Atmospheric emissions from vessels are permissible under the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*, which is enacted in Australian waters by Marine Order 97 (Marine pollution prevention – air pollution) (which also reflects MARPOL Annex VI requirements). This is an internationally accepted standard that is used industry wide, and compliance with MARPOL standards is considered to be an appropriate management measure in this case.

The overall impacts to the atmosphere and sensitive receptors are expected to be I (Negligible) if the emissions management is adhered to, and impacts from emissions that are generated by the various operational activities are considered to be ALARP and environmentally acceptable.

6.4 Seabed and Benthic Habitat Disturbance

<table>
<tr><td>Event</td><td>Potential seabed disturbance may occur in the operational areas from the following sources:
+ positioning of the MODU (spud cans of MODU legs) at the well location;
+ installation of infrastructure on the seabed;
+ installation of support/stabilisation mattresses and grout bags;
+ placement of ROV baskets on the seabed;
+ placement of deployment frames on the seabed;
+ temporary wet storage of equipment/infrastructure.
+ During the activity, the MODU and ISV will not require anchoring, and there will be no anchoring or mooring of support vessels within the operational areas.
Note that seabed disturbance associated with drilling discharges is described in Section 6.7.</td></tr>
<tr><td>Extent</td><td><u>Drilling Activities</u>
Seabed disturbance in the operational area from the positioning of the MODU legs (spud cans) on the seafloor is conservatively estimated to be 260 m^2 per leg, equating to a footprint of 780 m^2. Should drilling difficulties arise and a re-spud is required, this area could double to 1,560 m^3.
<u>Installation Activities</u>
Seabed disturbance in the operational area from installation activities will include the following:
+ Installation of the flexible flowline (17 km in length, 10 inches in outer-diameter (8 inch internal diameter));
+ Installation of the EHU (17 km in length, 107 mm in diameter);
+ Installation of approximately 165 mattresses including (approximate numbers):
– 3 x umbilical pre-lay mattresses;
– 2 x JB GEP crossing mattresses;
– 42 x umbilical stabilisation mattresses;
– 84 x post-lay flowline stabilisation mattresses;
– 16 x dropped object protection mattresses at JB WHP;
– Each mattress has a footprint approximately 6 m x 3 m;
+ Contingency for the installation of 20 grout bags for stabilisation, with an approximate footprint of 1 m^2 each;
+ Placement of deployment frames on the seabed with a footprint of approximately 10 m x 3 m (30 m^2);
+ Potential wet storage of equipment on the seabed – equipment may be temporarily wet-stored in close proximity to its final deployment location;
+ The total approximate seabed disturbance from installation activities is expected to be approximately 9,200 $m^{2.}$
<u>ROV Activities</u>
The ROV may be used close to or on the seabed for subsea installation activities. The typical footprint for an ROV is approximately 2.5 m x 1.7 m. ROV workbaskets may also be temporarily placed on the seabed.</td></tr>
</table>

Duration	Seabed disturbance from the MODU spud cans, installation activities, the ROV and ROV work baskets will be temporary for the duration of the activity and limited to within the operational areas, with recovery within weeks to months following removal from the seabed within the area. Once installed, infrastructure will remain on the seabed for the life of the development.

6.4.1 Nature and scale of environmental impacts

Potential receptors: Physical environment (benthic habitats and fauna), threatened, migratory or local fauna (marine turtles), protected areas (Montebello AMP), commercial fisheries.

Operational activities may disturb seabed and benthic habitat through:

+ direct physical disturbance of an area of seabed habitat, including benthic fauna, of approximately 780 m^2 per well (planned) or 1,560 m2 per well, if re-spud is required;
+ indirect disturbance to benthic habitats and associated marine fauna by sedimentation;
+ increased turbidity of the near-seabed water column.

The potential impacts to the seabed and benthic habitats from drilling discharges are discussed in **Section 6.7**.

Physical environment

The positioning of the MODU, subsea installation activities and ROV activities associated with the activity will directly contact the seafloor and will inevitably result in localised impact to benthic habitat (and associated fauna) in the operational areas.

The majority of the operational area is likely to consist of soft sediment seabeds and sandy and muddy substrates, occasionally interspersed with hard substrates covered with sand veneers (DEWHA, 2008). Non-coral benthic invertebrates are likely to be the dominant community, albeit in low densities. Non-coral benthic invertebrates that occur in the operational area are likely to include sea cucumbers, urchins, crabs and polychaetes on soft substrate. Hard substrates are likely to contain sessile (fixed in one place) invertebrates, such as sponges and gorgonians (DEWHA, 2008). More diverse habitats are found on surrounding shoals, rather than on the soft sediment seabed.

The seafloor of this bioregion is strongly affected by cyclonic storms, and among the largest tidal energy observed anywhere in the world, which can resuspend sediments within the water column as well as move sediment across the seafloor.

The potential impacts of seabed disturbance caused by the planned activities are considered negligible due to the following:

+ Depressions on the seabed left by the MODU spud cans once the MODU has moved off site, and areas used for temporary wet-storage during installation activities are predicted to infill as a result of movement of sediments by water currents and by the deposition of detrital matter. Recovery and re-colonisation of soft sediment habitats happens in a short period of time and therefore any impacts would be short term and temporary in nature.
+ Deployment of the MODU spud cans and installation of subsea infrastructure may cause localised and temporary impacts to water quality from increased turbidity in the lower water column near the seabed. This may cause relatively small scale, permanent impacts to the physical seabed habitat and benthic communities as described above and in **Section 3.2.2**.

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+ No known sensitive seabed features (e.g., reefs, canyons, shipwrecks) or benthic primary producer habitat (e.g., significant areas of hard corals, seagrass, macroalgae or mangroves) are known to be present in the operational areas. The closest shoal or bank that may support hard substrate communities, including corals, is Penguin Bank, located more than 70 km away (**Section 3.2.2**). The nearest emergent reef or island that may support hard substrate communities including corals, is the Barrow Island, approximately 24 km away.
+ The overall footprint for disturbance for drilling activities is estimated to be no greater than 1,560 m^2 (allowing for a re-spud of the well, but will be more likely to be less than 780 m^2). The overall footprint for disturbance during installation activities is expected to be approximately 6,500 m^2. Seabed disturbance and may include benthic habitats and fauna assemblages. However, the benthic habitats and fauna assemblages that are expected to be impacted are considered widespread throughout the region (**Section 3.2.2**) and able to rapidly re-establish following physical disturbance. The scale of disturbance will be insignificant when compared to the vast areas of similar habitat throughout the NWS.
+ Marine turtles
+ BIAs for marine turtles occur within the operational areas, (internesting buffer) (**Table 3-8**). However, internesting activities typically occur within shallower waters than those in the operational areas (as discussed in **Section 6.1.2.2**) (Whittock et al., 2016; Pendoley, 2017). If a marine turtle was displaced from the area of seabed and benthic habitat disturbance, widespread internesting habitat is available in the immediate vicinity that marine turtles could continue to use within the identified BIAs. No loss or disruption of habitat critical to the survival of marine turtles or disruption to the breeding cycle of marine turtles is expected.
+ Protected and significant areas
+ Although a portion of the Montebello AMP is located within the operational area, the boundary of the AMP is approximately 380 m east of the well location at its closest point (**Figure 3-5**). Therefore, direct impacts from seabed disturbance will not occur within the AMP. Indirect impacts from reduction in water quality due to a localised and temporary increase in turbidity are possible, although are more likely to be confined to the immediate vicinity of the disturbance and thus indirect impacts are not expected to impact. the values and sensitivities of the AMP which include:
  – foraging areas for migratory seabirds that are adjacent to important breeding areas;
  – areas used by vulnerable and migratory whale sharks for foraging;
  – foraging areas marine turtles which are adjacent to important nesting sites;
  – section of the north and south bound migratory pathway of the humpback whale;
  – shallow shelf environments with depths ranging from 15–150 m which provides protection for shelf and slope habitats, as well as pinnacle and terrace seafloor features;
+ Socio-economic
+ Commercial fisheries in the operational area are not predicted to be significantly affected due to the temporary nature of the seabed disturbance and the size of the operational area compared to the total available fishing area. Potential impacts to benthic habitats and subsequently to associated fish species of commercial importance are likely to be localised with the impact to, and displacement of, fish insignificant at a population level.

+ Any temporary turbidity and sedimentation associated with the drilling and installation activities (including cumulative impacts from concurrent activities) is not considered likely to cause a significant environmental impact given the high background levels of natural sediment movement in the area, the minor disturbance caused by the activity and the short duration of the activity.

6.4.2 Environmental performance outcomes and control measures

The EPO relating to this event is:

+ Seabed disturbance is limited to planned activities and defined locations within the operational area [ST-EPO-07].

The control measures considered for this event are shown in **Table 6-13**, and the EPSs and measurement criteria for the EPOs are described in **Table 8-2**.

Table 6-13: Control measure evaluation for seabed and benthic habitat disturbance

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
ST-DC-CM-003	MODU move procedure	No accidental contact with the seabed and subsea infrastructure during the MODU move.	Personnel costs associated with ensuring procedures are in place and implemented during inspections.	Adopted – Benefits of ensuring procedures are followed and measures implemented outweigh the costs of personnel time.
ST-DC-CM-043	Recovery of all equipment deployed during drilling activities	Prevents ongoing impact to the seabed due to drilling equipment being left in situ	Minimal additional cost to recover equipment	Adopted – Helps to minimise impacts and extent of seabed disturbance.
ST-IC-CM-008	Pre- and post-installation seabed surveys	Confirms position of installed infrastructure, including no installation over sensitive benthic habitats or hard substrates.	Costs associated with ROV surveys pre and post installation of equipment/infrastructure.	Adopted - Environmental benefits outweigh the minimal additional cost.
ST-IC-CM-009	Installation procedures	Use of acoustic positioning devices (LBL/USBL) to position equipment/infrast	Minimal cost, standard installation practice.	Adopted - Environmental benefits outweigh the minimal additional cost.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		ructure within the planned footprint reduces disturbance to the seabed.		
ST-IC-CM-010	Wet-storage	Wet-storage of equipment in close proximity to final deployment location, and confirmed recovery of all wet-stored equipment reduces potential seabed disturbance.	Minimal cost, standard installation practice.	Adopted - Environmental benefits outweigh the minimal additional cost.
Additional Controls				
DC-CM-028	Anchoring	No planned anchoring of MODU and support vessels within operational areas reduces seabed disturbance area as no anchor or anchor chain drag/placement.	Additional fuel costs due to vessels moving or idling.	**Adopted** – MODU and support vessels do not require anchors. Benefits of ensuring procedure is followed and controls implemented, outweigh the costs of personnel time in implementation of control.
N/A	Use of MODU with dynamic positioning (DP) systems only (i.e., no spud cans)	Would reduce seabed disturbance as no contact of MODU with the seabed.	Not technically feasible to use a DP MODU as the water depth is too shallow.	**Rejected** – Not technically feasible to use a DP MODU for the well.
N/A	No installation of stabilisation materials (i.e. stabilisation mattresses)	Not using stabilisation, such a mattresses would reduce the area of seabed and benthic	Not considered as stabilisation materials are required to maintain the structural integrity of the	**Rejected** - Required to stabilise the infrastructure and introduces unacceptable risk to the safe

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		habitat disturbance.	subsea infrastructures, including dropped object protection on approach to the JB WHP.	operation of the subsea infrastructure.

6.4.3 Environmental impact assessment

Receptor	Consequence Level
Seabed disturbance	
Threatened, migratory or local fauna	No sensitive seabed features are known to occur in the operational area. The areas of seabed that will be impacted by the activity do not contain any significant or unique areas of benthic habitat. The benthic habitats within the operational area are broadly homogenous and comprised of two main types: soft sediment seabed and sandy and muddy substrates and no evidence of rock outcropping or coral reef development. The benthic habitat that exists in the operational area is also widespread across the northwest shelf and is expected to recover quickly from any direct disturbance. Marine invertebrates may inhabit soft sediments and can contribute to the diet of some fauna. Non-coral benthic invertebrates may be present in the operational areas including filter feeders such as sponges, soft corals, gorgonians, anemones and crinoids; however, there is not expected to be any significant areas of these. Furthermore, the area of soft sediment habitat that is potentially impacted is small compared to the amount of habitat available and therefore the disturbance is not expected to affect prey availability, or protected fauna species. Habitat modification is identified as a potential threat to a number of marine fauna species in relevant Recovery Plans and Conservation Advice (**Table 3-9**). However, the operational area has not been identified as a habitat that supports any protected species. Impacts will be temporary and the area potentially impacted is small compared to the size of the areas used by these species for foraging. Therefore, no long-term impacts to these species are expected. No decrease in local population size, area of occupancy of species, loss or disruption of critical habitat or disruption to the breeding cycle of any of these protected matters is expected. Given the potential for concurrent project activities (e.g. drilling and installation activities overlapping), there is potential for cumulative disturbance to the seabed, benthic communities, and marine fauna (from indirect impacts e.g. increased turbidity). Cumulative seabed disturbance would be limited to discrete locations including the well location and flowline installation operational area. Recovery from such cumulative impacts is expected to be relatively rapid, given the short-term nature of the impacts and expected re-colonisation from adjacent sediments. Cumulative indirect impacts such as increased turbidity are expected to be short-term, localised and temporary. Widespread internesting habitat for marine turtles is available in the immediate vicinity that marine turtles could continue to use within the identified BIAs. No loss or disruption of habitat critical to the survival of

Receptor	Consequence Level
	marine turtles or disruption to the breeding cycle of marine turtles is expected from cumulative impacts. Given the fact that the activity is proposed in a small area, the activity is short term and the nature of the existing environment is such that there is no benthic habitat providing significant environmental value to threatened or migratory species, the consequence level is considered to be Negligible (I).
Physical environment or habitat	The area of physical environment and habitat that will be impacted during the proposed activities is small compared to the area of similar habitat in the wider environment and is expected to re-establish following disturbance. As such, long-term or significant impacts to habitat values or ecosystem function are not expected. Impacts to the physical environment or habitat are assessed as Minor (II).
Threatened ecological communities	Not applicable – No threatened ecological communities are identified in the area where seabed disturbance could occur.
Protected areas	Although a portion of the operational area overlaps a very small portion of the Montebello AMP, no drilling or installation activities will occur in the AMP. The well location is located approximately 380 m west of the AMP boundary. The benthic habitats within the operational area that overlaps the AMP are well represented across the region and Northwest Shelf Province and are not known to support protected species. Whilst indirect impacts from a temporary decrease in water quality due to an increase in turbidity as a result of spud can deployment or flowline installation near the well location may occur, they would only be localised and temporary and are not expected to impact the values and sensitivities of the AMP. Given the discrete locations of impact and short-term duration, cumulative impacts are not expected. Impacts to the values and sensitivities of the AMP are assessed as Minor (II).
Socio-economic receptors	Disturbance of the seabed and benthic habitat within the operational area is highly unlikely to impact socio-economic receptors such as fishing and tourism. Any minor alteration or modification to habitats is not expected to impact commercial fisheries' target species based on the small size of disturbance relative to the available fishing grounds. No stakeholder concerns have been raised regarding socio-economic impacts.
Worst-case consequence level	II – Minor

6.4.4 Demonstration of as low as reasonably practicable

There are no reasonably practicable alternatives to the use of vessels and a jack-up MODU in order to undertake the activity. The use of a MODU with DP systems only, which would eliminate disturbance to the seabed from placement of spud cans, is not feasible for the activity as the water depth of the operational areas is too shallow. Other MODUs (such as semi-submersible MODUs) also require anchoring, which results in a greater area of seabed disturbance than that of a jack-up MODU.

Planned seabed disturbance associated with the activity will be limited to the placement of the MODU spud cans on the seabed when the rig is jacked up and the installation of subsea infrastructure within defined installation footprints. The disturbance will involve an area of benthic habitats (i.e., primarily soft sediments) that are widely represented at a regional scale within the northwest shelf province. Given the extremely small area (worst case area of disturbance approximately 10,760 m^2 including contingency for well re-spud) and temporary nature of disturbance from the MODU presence and subsea installation activities, the impacts are not considered to be significant, particularly given the open ocean environment and lack of sensitive features in the operational areas. The MODU move procedure, installation procedures, use of position equipment, designated wet storage areas and pre and post-installation surveys are designed to limit the extent of direct seabed disturbance. The MODU and ISV will not anchor and the support vessels will not require moorings or anchoring in the operational area, further reducing potential impacts to the benthic environment. Impacts will be localised to within the operational areas and benthic habitat would be expected to recolonise within weeks to months following completion of the activity.

Given the lack of sensitive receptors within the operational areas and the expected rapid recovery time, minor environmental impacts are expected.

All practicable control measures have been reviewed (**Section 6.4.3**) and those adopted are considered appropriate to manage the impacts such that the residual consequence is assessed to be minor and cannot be reduced further. The proposed management controls for seabed disturbance are in accordance with the Santos risk management criteria and are considered appropriate to manage the risk to ALARP.

6.4.5 Acceptability evaluation

Is the consequence ranked as I or II?	Yes – maximum consequence from seabed and benthic habitat disturbance is II (Minor).
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure which considers principles of environmentally sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	No recovery plans or conservation advice identified seabed disturbance like those described above as being a threat to marine fauna or habitats. The activity is consistent with the North-west Marine Parks Network Management Plan (Director of National Parks, 2018).
Are risks and impacts consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – no concerns raised
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The potential consequence of seabed disturbance on receptors is assessed as Minor (II). With the control measures in place, including compliance with industry standards and legislation, no significant impacts are expected. Therefore, the impacts of seabed disturbance to the receiving environment are ALARP and considered environmentally acceptable.

6.5 Interaction with Other Marine Users

6.5.1 Description of event

Event	Interaction with other marine users may occur as a result of, but not limited to: + MODU and ISV presence in the operational area; + support vessels presence in the operational area; + infrastructure on the seabed (within the well exclusion zone and the existing JB pipeline corridor and VI Hub Operations EP operational area). The presence of the activity could potentially temporarily inhibit marine user groups, tourism, commercial shipping, fishing and other oil and gas activities.
Extent	The operational area.
Duration	Temporary and intermittent interaction with vessels when transiting the operational areas.

6.5.2 Nature and scale of environmental impacts

Potential receptors: Socio-economic (commercial fishers, tourism, shipping traffic and other oil and gas activities).

Potential impacts to tourism and recreational fisheries include displacement from the area while the vessels are in the operational areas.

Socio-economic

There are three Commonwealth fisheries that overlap with the operational area and are actively fished (**Section 3.2.5**). An analysis of the current fishery closures, depth range of activity, historical fishing effort data, fishing methods and consultation feedback (refer to **Section 4**) has revealed that there is no potential for interaction with Commonwealth commercial fisheries. None of the Commonwealth fisheries identified in **Section 3.2.5** are known to be active in the operational area with the only fishery active in the area, the Western Tuna and Billfish Fishery, only having five active vessels since 2005.

There are two State commercial fisheries that overlap the operational area and may also be active within the area. The Pilbara Fish Interim Trawl Managed Fishery has a Closed Area and a Prohibited Area that overlap the operational area. As such, this fishery is unlikely to be active in the operational area. The Mackerel Managed Fishery also overlaps the operational area. Low level fishing effort from the Mackerel Managed Fishery has been recorded across the operational area in the last 10 years. Consultation with WAFIC suggests that there is likely to be no direct impact to fishing operations in the area. The licence holders in this fishery did not raise any concerns during recent stakeholder consultation for the Spartan Development activities. A number of other State commercial fisheries overlap the operational area, however, disruption to these fisheries is not expected given the typical water depths they operate in (shallower than the operational area) and the vast areas available to the fisheries.

There may be cumulative impacts to commercial fisheries from concurrent drilling and installation activities. However, given the low level of commercial fishing expected, any potential impacts to commercial fishing vessels in the operational area would be localised over the short duration of the activity with no lasting impact.

Due to the distance offshore it is unlikely recreational fishing and tourism activities will take place within the operational area. Recreational fishing and tourism is likely to occur within the Montebello

AMP, however activities are likely to be concentrated closer to shore and around significant features such as shallow water reefs, which are absent from the operational area.

The operational area is located wholly within Santos permit areas and are in close proximity to existing Santos infrastructure. As such, no impacts to other oil and gas operators are expected.

AMSA requires a high level of communication during the activities and inclusion of the activity on a notice to mariners, therefore reducing the likelihood of interaction with other sea users.

6.5.3 Environmental performance outcomes and control measures

The EPO relating to this hazard is:

+ Reduce impacts on other marine users through the provision of information to relevant stakeholders such that they are able to plan for their activities and avoid unexpected interference [ST-EPO-01].

The CMs for this activity are shown in Table 6-14. EPSs and measurement criteria for the EPOs are described in Table 8-2.

Table 6-14: Control measures evaluation for interaction with other marine users

Reference No	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
ST-DC-CM-039 ST-IC-CM-003	Lighting will be used as required for safe work conditions and navigational purposes	Ensures the MODU, ISV and support vessels are seen by other marine users. Reduces risk of environmental impact from vessel collisions due to ensuring maritime safety requirements are fulfilled. Marine Order Part 30: Prevention of Collisions, and with Marine Order Part 21: Safety of Navigation and Emergency Procedures requires vessels to have navigational equipment to avoid collisions.	Negligible costs of operating navigational equipment. Costs associated with vessel fit-out with navigational equipment.	**Adopted** – The safety benefits (and thus environmental benefits) outweigh the cost. Compliance with Marine Orders are a legislated requirement.
ST-DC-CM-040	Seafarer certification	Requires appropriately trained and competent personnel to navigate MODU and vessels to	Costs associated with personnel time in obtaining qualifications.	**Adopted** – Benefits considered to outweigh costs and is a

Reference No	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
ST-IC-CM-011		reduce interaction with other marine users.		legislated requirement.
ST-DC-CM-015	MODU support vessel	Minimises risk of collision through visual identification and avoidance of other vessels.	Negligible costs.	**Adopted** – Benefits considered to outweigh costs.
ST-DC-CM-023 ST-IC-CM-012	Santos stakeholder consultation strategy	Santos will notify all relevant stakeholders listed, or as revised, in **Section 4**, of relevant activity details prior to commencement, including activity timing, vessel movements, proposed cessation date and vessel details.	Costs associated with personnel time in preparing and distributing information and collating/addressing any feedback provided.	**Adopted** – Benefits considered to outweigh negligible costs to Santos.
ST-DC-CM-037 ST-IC-CM-013	No fishing from MODU, ISV or support vessels	Reduce potential impacts to fisheries in the vicinity of the activity.	Negligible costs.	**Adopted** – Benefits considered to outweigh negligible costs to Santos.
ST-DC-CM-014 ST-IC-CM-014	Maritime Notices	Ensures the presence of the MODU, ISV and activities is available on the AHO notifications to maritime users, reducing likelihood of interactions.	Negligible costs.	**Adopted** – Benefits considered to outweigh negligible costs to Santos.
ST-DC-CM-025 ST-IC-CM-015	MODU and ISV identification system	Reduces potential for interaction with other users during MODU moves and ISV activities.	Negligible costs, standard equipment on MODU and ISV.	**Adopted** – Benefits considered to outweigh negligible costs to Santos.
ST-DC-CM-038	Petroleum Safety Zone (PSZ) established	Reduces potential for collision or interference with	Negligible costs, standard industry practice	**Adopted** – Benefits considered to outweigh

Reference No	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
	around the MODU	other marine user activities		negligible costs to Santos
ST-IC-CM-016	Safety Exclusion Zone established around the ISV to reduce potential for collision or interference with other marine user activities	Requested Safety Exclusion Zone around the ISV prevents other vessels from getting too close and causing damage to equipment of either party.	No additional costs to Santos. Other marine users may be temporarily excluded from small areas.	**Adopted** – The exclusion of other marine users is temporary. Marine users will still be able to access the operational area. Normal navigation at sea process whereby shipping vessels avoid navigational risks. Hence, the safety benefits to all marine users outweighs any potential costs.
ST-IC-CM-017	Constant bridge watch on ISV	Reduces potential for collision or interference with other marine user activities	Negligible costs, standard industry practice	**Adopted** – Benefits considered to outweigh negligible costs to Santos
ST-IC-CM-018	ISV personnel inductions	Personnel aware of other users of the marine environment and control measures to minimise interactions. Reduces potential for collision or interference with other marine user activities	Negligible costs, standard industry practice	**Adopted – Benefits** considered to outweigh negligible costs to Santos
Additional control measures				
N/A	Eliminate the use of vessels and MODU	Would eliminate potential impacts to other marine users.	Not considered feasible as a MODU, ISV and support vessels are the only form of transport	**Rejected** – Not feasible.

Reference No	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
			that can undertake the activities.	
N/A	Manage the timing of the activity to avoid peak marine user periods (e.g., tourism and recreational fishing)	Would eliminate potential impacts to other marine users.	Not considered feasible as marine users could potentially be in the area all year round. The area that stakeholders are excluded from is small when compared to the area available to other marine users, and there is low fishing activity in the area as evidenced through consultation.	**Rejected** – Stakeholders in the area all year round.
N/A	Avoidance of other active marine users, where safe to do so	The ISV doesn't have the ability to avoid other vessels under own propulsion when on station for installation activities, in the unlikely event that interaction with marine user requires ISV to avoid other user. Note primary controls around stakeholder engagement and navigational lighting will suffice this control to not be implemented.	Additional costs as the ISV needs to be stationary and is not able to move from its position. If it has to move from it position this will delay installation.	**Rejected** - Not feasible as the ISV needs to be stationary. However, primary controls to avoid other marine users is thorough stakeholder engagement.
N/A	Support vessel in place/on standby during installation (ISV) activities	Identifies and communicates with approaching third-party vessels to ensure exclusion (safety) zone is observed, preventing potential interaction or interference.	Significant additional costs of contracting a dedicated support vessel.	**Rejected** – significant cost of a dedicated support vessel on standby for the duration of installation activities outweighs the negligible

Reference No	Control measure	Environmental benefit	Potential cost/issues	Evaluation
Standard control measures				
				environmental benefit.

6.5.4 Environmental impact assessment

Receptor	Consequence Level
Interaction with other marine users	
Threatened, migratory or local fauna	Not applicable – related to socio-economic receptors only.
Physical environment or habitat	
Threatened ecological communities	
Protected areas	The drilling operational area overlaps a very small portion of the Montebello AMP (**Figure 3-5)**. However, once in position the MODU will remain stationary, unless the unlikely event of a re-spud is required. No installation activities will occur in the AMP. Potential impacts to commercial fishing in the AMP are discussed below and are considered negligible. Potential impacts to tourism and recreational activities within the AMP are also considered negligible, due to the distance offshore, lack of seafloor features and water depth.
Socio-economic receptors	The impact of the MODU, ISV and support vessel operations on socio-economic receptors are considered to be Negligible (I) due to the fact that: + the MODU, ISV and subsea infrastructure will not be positioned within an AMSA defined shipping fairway; + vessels could be expected to divert around the operational area but this would be a temporary exclusion given the duration of the activity (approximately 67 days, depending on weather, equipment and operational issues); + tourism activities are not expected to occur in the operational area given the water depth, lack of seafloor features and distance from shore; + the operational area is not extensively fished – commercially, traditionally or recreationally. The presence of subsea infrastructure (well head, flexible flowline and associated equipment) is not expected to present a hazard to commercial fisherman, considering that no trawl fishing occurs within the operational areas. The Mackerel Managed Fishery is a line (trolling) fishery and is unlikely to target pelagic species near the seabed; + other operators may have vessels traversing the region that will need to avoid the operational area to access exploration and development sites, but the scale of exclusion area is small (500 m around the MODU and ISV) and duration of the activities (approximately 67 days expected);

Receptor	Consequence Level
	+ any cumulative impacts from concurrent activities would be localized with no lasting impacts; + additional controls to ensure communication of activity details and PSZ (MODU) or Safety Exclusion Zone (ISV) and communication with active fishermen are in place; + stakeholder consultation and a review of recent shipping data did not raise any concerns regarding disruptions to commercial shipping or other oil and gas operators; and + all installed subsea equipment will be marked on nautical charts
Overall worst-case consequence	I – Negligible

6.5.5 Demonstration of as low as reasonably practicable

There are no alternatives to the use of a MODU, ISV and support vessels to undertake the activity and a 500 m Petroleum Safety Zone (PSZ) around the MODU is required in accordance with the OPGGS Act. In addition, a 500 m Safety Exclusion Zone will established around the ISV.

To understand the potential impacts of the presence of the MODU, ISV and support vessels and exclusion zone Santos have consulted with relevant stakeholders. Throughout the duration of EP preparation, details of the activity have been communicated to relevant stakeholders as appropriate. In consultation, stakeholders are made aware of the proposed area from which other marine users may be excluded for the duration of the activity, and the potential schedule. During this consultation, no concerns were raised around the presence of the MODU, vessels and installed subsea infrastructure and the potential impacts to other marine users (**Section 4**). Through the commitment to continued engagement and notifications, no recreational fishing from the MODU or vessels, and updating notices to mariners (to ensure the PSZ is removed once the MODU leaves the area), Santos considers any potential concerns have been addressed. In addition, Santos inductions for the ISV will include a topic to reinforce the importance of marine communications regarding any potential interactions with active commercial fishing.

With the controls adopted, the assessed residual consequence for this impact is negligible and cannot be reduced further. Additional control measures were considered but rejected since the associated cost/effort was grossly disproportionate to any benefit as detailed above. Therefore, it is considered that the impact is ALARP.

6.5.6 Acceptability evaluation

Is the consequence ranked as I or II?	Yes – maximum interaction with other marine users consequence is I (Negligible).
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure which considers principles of environmentally sustainable development.

Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes – management consistent with SOLAS 1974 *and Navigation Act 2012*.
Are risks and impacts consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes **–** no concerns raised
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The presence of the MODU, ISV and support vessels is not expected to significantly affect other marine users, including commercial fishing operations or shipping traffic, given the:

+ small petroleum safety zone (500 m) around the MODU and ISV in relation to the wider areas for commercial fishing, shipping transit and navigation;
+ short duration of the activity (approximately 67 days, depending on weather, equipment and operational issues); and
+ outcomes of stakeholder engagement did not identify any concerns by relevant stakeholders.

A petroleum safety zone around the MODU and ISV is required under maritime legislation, and the controls proposed will ensure that other users are aware of its presence and readily able to navigate accordingly, such that potential impacts are ALARP and are considered to be environmentally acceptable.

6.6 Operational Discharges

6.6.1 Description of event

Event	Potential impacts may occur in the operational area from the following operational discharges: + sewage and grey water; + food wastes; + deck drainage; + cooling water; + bilge water; + brine; + ballast water; and + fire-fighting foam during routine testing. *Sewage and grey water* The volume of sewage, grey water and food waste is directly proportional to the number of persons on-board the MODU, ISV and support vessels. Up to 30 to 40 L of sewage/greywater will be generated per person per day. Treated sewage will be disposed in accordance with Marine Order 96 (Marine pollution prevention – sewage) requirements. *Food waste* Putrescible waste is estimated to consist of approximately 1 L of food waste per person per day. Putrescible waste will be disposed in accordance with Marine Order 95 (Marine pollution prevention – garbage) requirements. *Deck drainage* Drainage water on offshore facilities consists of rainwater and seawater spray and may potentially contain small residual quantities of oil, grease and detergents if present or used on the decks. However, controls are in place to prevent, contain and clean up such spills. Deck drainage from rainfall or washdown operations discharges directly to the marine environment. Assessment of the spillage of hydrocarbons and other environmentally hazardous liquids is discussed in **Sections 7.4** and **7.8**. *Vessel cooling water* Seawater may be used by some vessels as a heat exchange medium for the cooling of machinery engines. Seawater is drawn from the ocean and flows counter-current through closed-circuit heat exchangers, transferring heat from the vessel engines and machinery to the seawater. The seawater is then discharged to the ocean (i.e., it is a once-through system). Cooling water temperatures may vary depending on the vessel's engines' workload and activity. *Bilge water* While in the operational area, the MODU and vessels may discharge oily water after treatment to 15 ppm via a MARPOL-approved oily water filter system. Bilge water will be disposed in accordance with Marine Order 91 (Marine pollution prevention – oil, as appropriate to class) requirements. *Brine* Brine generated from the water supply systems on board the MODU and vessels will be discharged to the ocean at a salinity of approximately 10% higher than seawater. The volume of the discharge depends on the requirement for fresh (or potable) water and will vary between the MODU/vessels and the number of people on board.

	The effluent may contain scale inhibitors such as Alpacon that controls inorganic scale formation, such as the formation of calcium carbonate and magnesium hydroxide, in water-making plants. Other water purification chemicals such as chlorine may also be added to the potable water. Other water-making plant cleaning chemicals such as Ameroyal or Saf Acid may be used and discharged to sea after completion of the cleaning process. *Vessel ballast water* Ballast water could potentially be discharged to the marine environment from the MODU or vessel ballast tanks. *Fire Fighting Foam* During routine testing that could occur during the activity AFFF could be discharged from the foam tanks over each area covered by an AFFF firefighting system. It is unavoidable that some of this foam will be discharged to sea unless it is discharged within a closed bunding system.
Extent	The small volumes of non-hazardous discharges may cause localised nutrient enrichment, organic and particulate loading, toxic impacts to marine fauna, thermal impacts and increased salinity in waters around discharge points and in the direction of the prevailing current. The environment that may be affected by operational discharges will likely be contained within the operational areas and are predicted to be restricted to within approximately 100 m of the discharge point in the upper 5 m of the water column.
Duration	During the activity localised impacts to water quality may occur. However, water quality conditions will return to normal within minutes to hours of cessation of discharges.

6.6.2 Nature and scale of environmental impacts

Potential Receptors: Water quality, fish (pelagic) and sharks, marine mammals, marine turtles and, seabirds and protected areas (Montebello AMP).

Physical environment

The discharge of small volumes of non-hazardous wastes to the marine environment will result in a localised reduction in water quality. Discharges will be temporary (minutes to hours), localised and limited to surface waters (less than 5 m depth). The discharges are expected to be dispersed and diluted rapidly, with concentrations of wastes significantly dropping with distance from the discharge point. Changes to ambient water quality outside of the operational area are considered unlikely to occur.

Specifics of potential impacts to water quality from the discharge of non-hazardous wastes are as follows.

Eutrophication impacts from sewage, grey water and putrescible wastes

The discharges of food waste, treated sewage and grey water can result in localised increases in nutrient concentrations (e.g., ammonia, nitrite, nitrate and orthophosphate), organics (e.g., volatile and semi-volatile organic compounds, oil and grease, phenols and endocrine-disrupting compounds) and inorganics (e.g., hydrogen sulphide, metals and metalloids, surfactants, phthalates and residual chlorine). Increased biological oxygen demand on the receiving waters may promote localised elevated levels of phytoplankton due to nutrient inputs and bacteria activity due to organic carbon inputs. This could subsequently impact higher order predators.

However, dispersion and dilution of discharges is expected to be rapid, as the discharges are of low volume. The discharges are subject to biodegradation of organics through bacterial action, oxidation and evaporation, and the operational area is located in deep offshore waters dominated by high currents, resulting in short-term changes to surface water quality within the operational area.

In a study of sewage discharge in deep ocean waters, Friligos (1985) reported no appreciable differences in the inorganic nutrient levels between the outfall area and background concentrations suggesting rapid uptake of nutrients and/or rapid dispersion in the surrounding waters. Similar studies (Parnell, 2003) concluded similar results with rapid dispersion and dilution within hours of discharge.

It is possible that the discharge of sewage, grey water and putrescible wastes may reach the Montebello AMP, given the AMP is within the operational area, approximately 380 m from the well location. However, as described above, any impacts to water quality within the AMP are expected to be negligible and short-term. Significant impacts to the values and sensitivities of the AMP are not expected. The discharge of sewage, grey water and putrescible wastes is not expected to contact any offshore reefs, islands, shoals or banks.

Salinity increases

The desalination of seawater results in a discharge of brine with a slightly elevated salinity (around 10% higher than seawater). On discharge to the sea, the desalination brine, being of greater density than seawater, is expected to sink and disperse in the currents. On average, seawater has a salt concentration of 35,000 ppm. The volume of the discharge depends on the requirement for fresh (or potable) water and the number of people on board.

Most marine species are able to tolerate short-term fluctuations in salinity in the order of 20 to 30% (Walker and McComb, 1990), and it is expected that most pelagic species would be able to tolerate short-term exposure to the slight increase in salinity caused by the discharged brine.

Given the relatively low volume of discharge, low salinity increase and deep, open water surrounding the vessels, impact on water quality in the operational area is expected to be low.

It is possible that salinity increases may reach the Montebello AMP, given the AMP is within the operational area, approximately 380 m from the well location. However, as described above, any impacts from a temporary increase in salinity within the AMP are expected to be low and short-term. Significant impacts to the values and sensitivities of the AMP are not expected. The brine discharge is not expected to contact any offshore reefs, islands, shoals or banks.

Changes in temperature

Cooling water will be discharged at a temperature above ambient seawater temperature. Upon discharge it will be subjected to turbulent mixing and transfer of heat to the surrounding waters.

Temperature dispersion modelling shows that the water temperature of discharged water will decrease rapidly as the discharge mixes with the receiving waters, with discharged waters being less than 1°C above background levels within less than 100 m (horizontally) of the discharge point. Vertically, the discharge will be within background levels within 10 m (Woodside, 2011).

Cooling water discharge points vary for each vessel. However, they all adopt the same discharge design, which permits cooling water to be discharged above the water line to facilitate cooling and oxygenation of this wastewater stream before mixing with the surrounding marine environment.

Cooling water discharge to the marine environment could result in a localised and temporary increase in the ambient water temperature. This may cause alteration of the physiological processes (particularly enzyme-mediated processes) in marine biota. Given the relatively low volume of cooling water, the low temperature differential, and the deep, open water surrounding the vessels, impact on water quality is expected to be low and short term.

It is possible that cooling water discharge to the marine environment could result in a localised and temporary increase in the ambient water temperature within the Montebello AMP. However, as described above, any impacts from cooling water discharge within the AMP are expected to be low and short-term. Significant impacts to the values and sensitivities of the AMP are not expected. The cooling water discharge is not expected to contact any offshore reefs, islands, shoals or banks, or marine parks.

Contamination from releases of bilge water

Discharges of oily bilge water could result in a localised reduction in water quality with impacts on protected marine fauna and plankton. However, oily water discharged from the vessels will be treated to a concentration of less than 15 ppm before release, in accordance with the requirements of Marine Order 91 (Marine pollution prevention – oil), which will unlikely lead to any impacts to the receiving environment. The concentration and dosage within surface waters (including the Montebello AMP) is expected to be very low and toxic impacts to water quality and benthic habitats are expected to be negligible.

Toxicity

Discharges from vessel systems may include chemicals within sewage systems, greywater, desalination, firefighting systems and residues of those used for cleaning decks.

On discharge to the marine environment, the low volumes of these types of chemicals are expected to rapidly disperse in the offshore marine environment. Hence, any potential impacts would be confined to a localised area immediately surrounding the discharge.

There may be a localised and temporary (hours) reduction in water quality in the immediate vicinity of the release. Toxicity impacts to marine fauna, including within the Montebello AMP from the release of chemicals are unlikely to eventuate because:

+ strong ocean currents result in the discharge being further diluted upon release to the marine environment, so the duration of exposure of chemicals to fauna will be minimal;
+ deck cleaning products planned to be released to sea will meet the criteria for not being harmful to the marine environment according to MARPOL Annex V;
+ potential discharges will be intermittent and temporary within the operational area.

Given the intermittent, temporary and localised nature of discharges and impacts to water quality described above, any impacts will be localised and short-term with no lasting impacts and cumulative impacts to water quality within the Operational Area are not expected.

Threatened or migratory fauna

As discussed in the sections above, the discharge extent for all planned discharges is localised, and rapid dilution is predicted to occur within the offshore waters. Marine fauna within the operational area are likely to be transient. If contact does occur with any marine fauna, it will be for a short duration due to the rapid dispersion of the plume and the transient fauna movement, such that any exposure is likely not of sufficient duration to cause a toxic effect.

Given the nature of discharged chemicals, the small volumes that could be released to the marine environment and the nature of the marine environment within the vicinity of the operational area, the operational planned discharges are not predicted to have ecologically significant effects.

Discharges may cause changes to behaviour in marine fauna (avoidance or attraction). Fishes and oceanic seabirds may be attracted to the discharge of food scraps. However, such discharges would be isolated occurrences and not in any one location, so no prolonged influence on faunal behaviour is expected. Discharges of cooling water and brine may cause avoidance behaviour in marine fauna. Given the nature of the discharges (localised, rapid dilution, intermittent), any behavioural impacts are expected to be short term and low.

Given the localised extent and short-term duration of discharges from vessel discharges during concurrent activities, cumulative impacts or significant impacts to marine fauna are not expected.

Protected and significant areas

A portion the Montebello AMP (Multiple Use Zone – IUCN Category VI) is located within the operational area, approximately 380 m from the well location (**Figure 3-5**). The values and sensitivities of the AMP relevant to potential impacts from operational discharges include the following:

- foraging areas for migratory seabirds that are adjacent to important breeding areas;
- areas used by vulnerable and migratory whale sharks for foraging;
- foraging areas marine turtles which are adjacent to important nesting sites;
- section of the north and south bound migratory pathway of the humpback whale;
- shallow shelf environments with depths ranging from 15–150 m which provides protection for shelf and slope habitats, as well as pinnacle and terrace seafloor features.

Potential impacts to threatened and migratory fauna are discussed above and are considered to be short-term and low within the AMP. Impacts to seafloor and benthic habitats from operational discharges are not expected, given none of the discharges will occur near the seabed and rapid dilution is expected to occur in offshore marine waters. Therefore, significant impacts to the values and sensitivities of the Montebello AMP from operational discharges are not expected.

6.6.3 Environmental performance outcomes and control measures

The EPOs relating to this event include:

- No injury or mortality to EPBC Act 1999 and WA Biodiversity Conservation Act 2016 listed fauna during activities [ST-EPO-05].
- Reduce impacts to air and water quality from planned discharges and emissions from the activities [ST-EPO-06].

The control measures considered for this event are shown in **Table 6-15**, and EPS and measurement criteria for the EPOs are described in **Table 8-2**.

Table 6-15: Control measure evaluation for operational discharges

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
ST-DC-CM-004 ST-IC-CM-019	Waste (garbage) management procedure	Reduces probability of garbage being discharged to sea, reducing potential impacts to marine fauna. Stipulates putrescible waste disposal conditions and limitations. Provides compliance with Marine Order 95 (Marine pollution prevention – garbage).	Personnel cost of pre-mobilisation audits and inspections, and in reporting discharge levels.	**Adopted** – Benefits of ensuring MODU/vessel is compliant outweigh the minimal costs of personnel time and it is a legislated requirement.
ST-DC-CM-006 ST-IC-CM-020	Deck cleaning and product selection	Improves water quality discharge (reduced toxicity) to the marine environment. Those deck cleaning products planned to be released to sea meet the criteria for not being harmful to the marine environment according to MARPOL Annex V.	Personnel costs of implementing, potential additional cost and delays of chemical substitution.	**Adopted** – Benefits of ensuring MODU/ vessels are compliant and those deck cleaning products planned to be released to sea meet MARPOL criteria.
ST-DC-CM-008 ST-IC-CM-021	General chemical management procedures	Reduces potential for inappropriate discharge of chemicals at sea through appropriate handling	Personnel time associated with vessel inspection and implementation.	**Adopted** – Benefits of ensuring vessel is compliant outweigh the minimal costs of personnel time and it is a legislated requirement.
ST-DC-CM-007	Chemical selection procedure	Improves water quality discharge (reduced toxicity) to the marine	Personnel costs of implementing, potential additional cost	**Adopted** – Benefits of ensuring MODU/ vessels are

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
ST-IC-CM-022		environment e.g. from AFFF and potable water systems	and delays of chemical substitution.	compliant outweighs the cost.
ST-DC-CM-030 ST-IC-CM-023	Sewage treatment system	Reduces potential impacts of inappropriate discharge of sewage. Provides compliance with Marine Order 96 (Marine pollution prevention – sewage).	Personnel cost in ensuring vessel certificates are in place during MODU/ vessel contracting and in pre-mobilisation audits and inspections, and in reporting discharge levels.	**Adopted** – Benefits of ensuring MODU/vessel is compliant outweigh the minimal costs of personnel time and it is a legislated requirement.
ST-DC-CM-031 ST-IC-CM-024	Oily water treatment system	Reduces potential impacts of planned discharge of oily water to the environment. Provides compliance with Marine Order 91 (Marine pollution prevention – oil).	Time and personnel costs in maintaining oil record book.	**Adopted** – Benefits of ensuring MODU/vessel is compliant outweigh the minimal costs of personnel time and it is a legislated requirement.
Additional Controls				
N/A	Zero discharge of deck water	Would eliminate potential impacts of contaminants being discharged to sea.	Increased health and safety risks from wet deck not draining. Large amounts of water on a vessel's deck can also cause stability issues (free-surface effect). Storage space required for containment of drained liquids, increase in transfers to vessels resulting in increased	**Rejected** – Safety considerations outweigh the benefit given the small volumes of contaminants. Deck drainage is a permitted maritime practice and an important safety requirement.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
			potential impacts and risks. Increased transfers results in increased fuel usage, increased safety risks to personnel during transfer (e.g., crushing between skips), increase in crane movements.	
N/A	Zero discharge of bilge water	Would eliminate potential impacts of contaminants being discharged to sea from oily water.	Costs associated with containment and onshore disposal, space required for additional containment on MODU and vessels could create hazards for working on deck by limiting available space.	**Rejected** – Safety considerations regarding containment outweigh the environmental benefit given the small volumes of contaminants. Discharge of treated oily water to sea is permitted maritime practice.
N/A	Zero discharge of sewage	Would eliminate potential impacts of contaminants being discharged to sea from sewage.	Costs associated with containment and onshore disposal, space required for additional containment on MODU and vessels could create hazards for working on deck by limiting available space.	**Rejected** – Safety considerations regarding containment outweigh the environmental benefit given small volumes of contaminants. Discharge of treated sewage to sea is permitted maritime practice.
N/A	Discharge point for cooling water discharges, restricted to above sea level to allow it to cool further before	Reduce potential impacts associated with discharge of higher temperature water into the marine environment.	High costs associated with modifications to MODU and vessels. May not be feasible with some MODUs	**Rejected** – Cost outweighs the benefit given the low impact expected from planned discharges and

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
	mixing at sea surface		and ISVs. Reduction in temperature would be minimal compared to cost of altering the discharge height.	high potential impacts from risk transfer. Discharge of cooling water permitted maritime practice.
N/A	Zero discharge of cooling water	Would eliminate potential impacts of cooling water (elevated temperature) being discharged to sea.	Costs associated with containment and onshore disposal, space required for additional containment on MODU and vessels could create hazards for working on deck by limiting available space.	**Rejected** – Cost grossly disproportionate to environmental benefit. Limited benefit to be gained given low impact. Discharge of cooling water permitted maritime practice.
N/A	Restrict use of desalination plant	Would eliminate potential impacts from brine discharges by importing potable water.	Cost associated with transporting potable water. Health risks associated with limited supply of potable water.	**Rejected** – Cost grossly disproportionate to environmental benefit. Limited benefit to be gained given low impact. No detectable change in water quality expected. Water making and brine discharge permitted maritime practice.
N/A	Re-design desalination plant effluent discharge system	Limited benefit to be gained given desalination brine will be diluted.	High costs associated with modifications to MODU and vessels. May not be feasible with some MODUs and ISVs. Salinity difference would be minimal	**Rejected** – Cost grossly disproportionate to environmental benefit. Limited benefit to be gained given low impact. Minimal detectable change in water quality

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
			compared to significant cost of altering the desalination plant effluent discharge system.	expected. Water making and brine discharge permitted maritime practice.
N/A	Zero discharge of brine water	Would eliminate potential impacts from brine discharges by storing on-board for onshore disposal.	Cost associated with transporting waste brine water, space required for additional containment on MODU and vessels could create hazards for working on deck by limiting available space.	**Rejected** – Cost grossly disproportionate to environmental benefit. Limited benefit to be gained given low impact. No detectable change in water quality expected. Water making and brine discharge permitted maritime practice.
N/A	Do not test AFFF containing fire fighting equipment on MODU and vessels	Would eliminate the discharge of the small quantities of AFFF.	Increased safety risk due to potentially untested AFFF system. Inability to fight fire effectively.	**Rejected** – Safety considerations outweigh the environmental benefit given
N/A	Zero discharge of putrescible waste	Would eliminate potential impacts from putrescible waste discharges by storing on-board for onshore disposal.	Cost associated with transporting putrescible waste to shore, space required for additional containment on MODU and vessels could create hazards for working on deck by limiting available space. Health risks and costs associated with storage on-board and	**Rejected** – Cost grossly disproportionate to environmental benefit. Limited benefit to be gained given low impact. Health risks associated with managing putrescible waste in hot weather conditions, putrescible waste discharge is a permitted maritime practice.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
			transport/ disposal onshore.	
N/A	Scupper plugs continuously in place on vessels to prevent deck drainage.	Would eliminate potential impacts of contaminants being discharged to sea in rainwater.	Increased health and safety risks from wet deck not draining. Large amounts of water on a ISV's deck can also cause stability issues (free-surface effect)	**Rejected –** Cost outweighs the benefit given the low impact expected from planned discharges and high potential safety impacts.

6.6.4 Environmental impact assessment

Receptor	Consequence Level
Operational discharges	
Threatened, migratory or local fauna Physical environment or habitat Socio-economic receptors	Sensitive receptors that may be impacted include fish at surface, marine turtles and mammals, and seabirds. As the activity is located in an open oceanic environment where tides and currents would quickly dilute and disperse the planned discharges. Any effects on water quality are expected to be within the surface waters only and have no effect on seabed receptors. Impacts will be limited to short-term water quality impacts and temporary behavioural effects observed in fish, sharks and seabirds. Impacts to water quality will be experienced in the discharge mixing zone which will be 221ocalized and will occur only as long as the discharges occur (i.e., no sustained impacts), therefore recovery will be measured in hours to days. Consequently, only short-term behavioural impacts are expected with no decrease in local population size/area of occupancy of species/loss or disruption of habitat critical/ disruption to the breeding cycle/introduction of disease. No planned operational discharges will occur within areas known to be used by third-party operators or for tourism and recreation. Given the nature of the planned operational discharges, the small volumes that could be released to the marine environment, the high levels of dilution and the nature of the marine environment in the vicinity of the operational area, impacts to the physical environment and habitat are expected to be Negligible (I).
Threatened ecological communities	Not applicable – No threatened ecological communities identified in the area over which operational discharges are expected.
Protected areas	A portion the Montebello AMP (Multiple Use Zone – IUCN Category VI) is located within the operational area, approximately 380 m from the well location (**Figure 3-5**). As described above, given the nature of the planned operational discharges, the small volumes that could be released to the marine environment, the high levels of dilution and the nature of the marine environment in the vicinity of the

Receptor	Consequence Level
	operational area, impacts to the values and sensitivities of the Montebello AMP are expected to be Negligible (I).
Overall worst-case consequence	I – Negligible

6.6.5 Demonstration of as low as reasonably practicable

A MODU, ISV and support vessels are required to undertake the activity. The alternative to discharging these small amounts of liquid wastes to the marine environment is to store and transport the wastes to land, where they would be disposed of in line with industry best practice. However, this would result in an increase in environmental impacts through increased fuel consumption and increased atmospheric emissions, both by the vessel (or transport vessel) having to return to port a number of times to unload the wastes and by land transport to the nearest disposal facility. Increased energy consumption and atmospheric emissions would also result from the disposal (for example, incineration, treatment, etc) of the additional wastes. This method would also result in an increased risk of vessel to platform or vessel-to-vessel collision, which could lead to a marine diesel spill. Therefore, this option would be of no net environmental benefit and would increase the risk associated with the activity, so it has not been adopted. In some cases, the containment of discharges is difficult without significant modifications to vessels and the MODU (e.g. additional bunding or containment systems) presenting an increase in safety risk to personnel through the reduction in deck space, increased lifts and health hazards of storing wastes or other discharges.

The use of AFFF for emergency purposes requires routine testing of that foam fire-fighting system is critical for emergency response. Given the product will be assessed through the Drilling Fluid and Chemical Selection in Drilling Activities Procedure (EA-91-II-00007), potential impacts will be reduced.

To reduce the impacts and risks associated with discharging liquid wastes, these wastes will be treated in line with industry best practice. Discharge of sewage and other liquid wastes from vessels in Australian waters is permissible under the Protection of the Sea (Prevention of Pollution from Ships) Act 1983, which reflects requirements of MARPOL 73/78 Annexes IV, V and I and AMSA Marine Orders 95 and 96.

On-board treatment of most wastes and their subsequent discharge to the marine environment is considered to be the most environmentally sound method of disposal, considering that the waste streams will either be treated to a level unlikely to cause significant environmental harm or will be of a nature not considered to pose significant risk to the receiving environment. The proposed management controls for planned operational discharges are considered appropriate to manage the risk to ALARP. Additional control measures were considered but rejected since the associated cost or effort was grossly disproportionate to any benefit, as detailed in **Section 6.6.3**. Therefore, it is considered that the impact of operational discharges is ALARP.

6.6.6 Acceptability evaluation

Is the consequence ranked as I or II?	Yes – maximum planned operational discharge consequence is rated I (Negligible).
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.

Are risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure, which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes – IUCN principles and strategic objectives of nearby reserves (Montebello AMP and the MPNMP) are met. Consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 3-9**, including but not limited to: + Recovery Plan for Marine Turtles in Australia (2017) + North-west Marine Parks Network Management Plan 2018
Are risks and impacts consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – no concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

Release of non-hazardous discharges into the sea from vessels in Australian waters is permissible under the Protection of the Sea (Prevention of Pollution from Ships) Act 1983, which in Australian waters reflects MARPOL Annex I, IV, and V requirements respectively, and is enacted by:

+ Marine Order 91 (Marine pollution prevention – oil);
+ Marine Order 96 (Marine pollution prevention – sewage); and
+ Marine Order 95 (Marine pollution prevention – garbage).

The operational discharges are not expected to significantly impact the receiving environment, including the values and sensitivities of the Montebello AMP, with management controls proposed, including compliance with all MARPOL requirements. The MARPOL standard is considered to be the most appropriate standard given the nature and scale of the activities. These standards are internationally accepted and utilised industry wide. Therefore, compliance with the relevant and appropriate MARPOL requirements and standards is expected to reduce the potential for environmental impacts to a level which is considered environmentally acceptable.

Deteriorating water quality is identified as a potential threat to turtles in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017). However, with the management controls proposed, the operational discharges are not expected to significantly impact the receiving environment because they will be temporary and in a dispersive open-ocean environment. Therefore, the activities will be result in an acceptable level of impact, and therefore the activity is not inconsistent with identified Recovery Plans and conservation advice or the North-west Marine Parks Network Management Plan.

6.7 Drilling and Cement Discharges

6.7.1 Description of event

Event	Potential impacts from drilling and cement discharges may occur in the operational areas from: + drilled solids or cuttings; + drilling fluids; + lost circulation materials; + brines; + cement (set or unset); + hydraulic fluid; + other miscellaneous chemicals and additives such as tracer dyes and cement spacer; and + during well testing, formation water may be produced from the reservoir and would be discharged to sea. During the activity, the following estimated and approximate discharge volumes could be expected for the single well activity: + 350 m^3 of drill cuttings discharged to seabed (riserless surface hole section); + 150 m^3 of drill cuttings discharged at sea surface (remaining well sections); + 1,500 m^3 of water-based drilling fluids discharged at sea surface; + 3,000 m^3 of seawater/gel sweeps/mud discharged at seabed (riserless surface hole section); + 300 m^3 of brine; + approximately 30 m^3 of cement (wet) discharged to seabed; + less than 15 m^3 of cement (wet or set) discharged at sea surface (i.e., cement spacer, flushing tanks and lines); + 150 m^3 of cement (wet) discharged at sea surface or 260 m^3 at the seabed in the event of a cement job not meeting technical and safety standards; + 70 m^3 each of stock cement/barite/bentonite/brine at the end of the well in the event the stocks cannot be re-used/sold; + aqueous-based lost circulation material (LCM) may also be pumped downhole at times; + tracer dyes may also be used during cementing operations and for equipment leak detection; + approximately 2-5 L of hydraulic fluid per valve operation, required after installation of the XT. Cuttings discharge volumes are calculated based on the expected section sizes and lengths and include some contingency. The total volume of drilling fluid and cement is an estimate based on previous drilling and completion programs. There are many variables during drilling campaigns that could cause the abovementioned volumes to change, for example re-spud or side-tracking could be required and/or the interval length could change. Some of these variations could cause the estimated discharge volumes to increase or decrease, in particular the need for re-spud or side-track double the estimated volumes. Santos intends to keep unmixed bulk cement, barite, bentonite, and brine on-board the MODU at the end of the drilling program. In the event that this activity is the final well in

	the rig schedule, these substances will be disposed of according to the decision list in **Table 6-16**.
Extent	Drilling discharges with larger particle sizes such as large drill cuttings are expected to settle directly around the MODU, whereas discharges with finer particles such as drilling muds could be carried with prevailing currents before settling. The seabed area affected by drill cuttings is expected to extend up to 1 km from the source, with higher concentrations expected to be restricted to within 50 m of the well. The finer particles associated with bulk discharges of unused products if they can't be re-used or sold at the end of the campaign, may settle up to 2.9 km from the well. Turbidity from drilling-related discharges is expected to affect water quality for up to 3.4 km from the well location, albeit during a relatively short period of time. For further information, refer to the notes below. Any formation water produced during well testing would be discharged to the marine environment following water treatment. The volume of formation water is unknown at this stage, however, it is expected to be minimal given that the well will be perforated above the water leg and therefore, water is not expected to be produced. Additionally, the discharge will be limited to the duration of the well test. As this EP is for a single well, cumulative impacts from drilling discharges are not expected.
Duration	Intermittent for the duration of the activity.

Drilling operations

The activity will use WBM for all hole sections. Non-aqueous fluid (NAF) drilling fluids will not be used.

WBM will be discharged at the seabed for the riser-less top-hole sections of the well. Once the surface casing, high pressure (HP) riser and BOP are installed , thereby establishing a closed circulating system, the remainder of the well will be drilled with a weighted brine/shale-inhibited (e.g., Klashield or Veritherm) WBM. The WBM will be discharged from the MODU at sea surface either on cuttings (see below) or from surface storage tanks/mud pits when no longer required.

The water-based drilling fluid (WBM) will be comprised of water or brine (greater than 90% aqueous) as the major liquid phase. The remainder of the WBM will be made up of low toxicity drilling fluid solid additives (e.g., barite) and chemicals that are either completely inert or additives in such low concentrations they pose little or no risk to the environment.

As detailed in **Section 6.7.2**, the fluids and components of the drilling and completion fluids will be selected in accordance with the Santos Drilling Chemical Selection and Approval Process (EA-91-II-00007) to ensure that environmentally acceptable products are used or the risks can be demonstrated to be ALARP from the use of other chemicals.

Similar to WBM, drill cuttings generated from the top-hole sections will be discharged at the seabed. Drill cuttings from the deeper well sections will be recirculated to the MODU for processing over primary solids control equipment (SCE) and discharged at the sea surface.

Cement operations

Cement will be used to form permanent barriers and fix casings in place prior to drilling ahead with subsequent sections in the well. Cement in the annular space between casing and formation will form a seal to ensure the circulation system remains closed. Cement may also be used to seal a lost circulation zone and plug the wells from which a sidetrack may be drilled.

The majority of cement pumped remains downhole, but minor volumes may be discharged at the seabed (when cementing conductor or surface casing) or at surface (when flushing lines or tanks). Some cement may be mixed and dumped as part of cement unit commissioning prior to the start of a campaign if the cement unit/pump has not been used before or in a considerable period of time.

During cementing operations, surface cementing equipment and lines will need to be flushed, washed and cleaned with water to prevent hard setting. The residual cement and wash water will be discharged to sea after each cement job.

Tracer dyes may be used during cementing operations for detection purposes. While transferring dry bulk cement, minor solids will be vented to air to prevent tank over-pressuring.

Solids control equipment

The well will be drilled in sections or intervals (e.g., top hole, surface, intermediate and production). The top hole and surface sections will be drilled riserless, with all drilled solids (also called 'cuttings') and well returns discharged directly to sea.

The remaining well sections will be drilled with a closed-loop circulating system with all drilled solids and well returns managed via the MODU SCE. Drilled solids will typically be removed via shale shakers and centrifuges (as required) and discharged to sea surface. Drilling fluids will be re circulated downhole, stored for future if practicable, or discharged to sea surface if no longer required. Shale shakers are comprised of a series of vibrating shaker screens. The screens are sized so that valuable drilling fluid (i.e., liquid and fine solids) passes through ('underflow') and drilled cuttings/solids do not ('overflow'). The shaker screens will meet American Petroleum Institute (API) standard, providing a level of confidence that the screens will perform to a specific separation limit (e.g., particle size cut point, etc). The selected shaker screen cut points (API screen sizes) will be as small as possible, so the maximum drilled solids removal efficiency is achieved.

Centrifuges may be used to remove ultra-fine solids in the recovered drilling fluid (i.e., once surface hole section casing installed). The ultra-fine solids are detrimental to the drilling fluid properties due to increased surface area and reactivity. Centrifuges do not process all the well returns. Given the large volume, it is not practicable to centrifuge the entire drilling fluids system. Hence, a portion of the drilling fluid recovered from the shakers may be sent to the centrifuges where the higher G forces facilitate removal of finer particles.

Lost circulation material

Lost circulation can occur in any hole interval and varies in severity. Lost circulation occurs when the drilling fluid flows into natural geological fissures, fractures or caverns. In the surface interval, when drilling riserless, it is often not necessary to take any action to cure the losses as they often self-cure once sufficient cuttings have entered the loss zone.

For losses that have to be cured, there is a choice of options available. Conventional LCM additives such as granular and fibrous material are usually pumped into the loss zone in the first instance. When conventional LCM additives fail to plug the loss zones it may be necessary to pump speciality lost circulation additives, such as cement or cross-linked polymers to heal the loss zones. By design the LCM enters the loss zone thereby plugging it and allowing drilling operations to re-commence. Typically, the LCM additives remain in the subsurface loss zone and do not return to surface. On some occasions the lost circulation is cured before all the material pumped enters the loss zone. When this occurs, the lost circulation material remains in the wellbore until it is usually circulated back to the surface where it is discharged along with the cuttings.

Only aqueous drilling fluids will be used for the activity and therefore any LCM would also be aqueous.

Residual drilling fluid discharges

The conductor and surface hole sections will be drilled with seawater and pre-hydrated gel sweeps. These fluids will be mixed and blended on the MODU and stored in the surface mud storage tanks, or mud pits, until they are pumped downhole and discharged directly to the sea (top hole to seabed and surface hole from the conductor at sea level). Consumed volume will be replenished as required to reach interval total depth (TD). Once TD is reached, the well will be displaced to a brine and/or pre-hydrated water-based mud to aid wellbore stability. Excess sweeps and mud will be retained in the surface mud pit system, in the event that it is required to be pumped while running surface casing. Once the surface casing is run and cemented, surface residual volumes will be discharged, due to incompatibility with the subsequent fluid system, to marine environment. The fluid would be discharged at the sea surface via the master mud pit dump valve.

Once the surface casing string is installed, a WBM system will be maintained until well TD. This mud system will be mixed and blended on the MODU and stored in the surface mud storage tanks, or mud pits, until pumped downhole and recycled via the conductor to the MODU continuously, assuming there are no sub-surface loss zones.

Once TD is reached, and the well has been completed, residual drilling fluids will be discharged to sea via the master mud pit dump value, unless reusable at Santos' next drilling location.

Tank cleaning

At stages during the activity, tanks may need to be cleaned, including mud pits (i.e., tanks used to mix and hold brine, sweeps or WBM), cement mixing/holding tanks and bulk storage tanks. Cleaning may be required to remove or flush 'dead' or residual volumes of WBM, or settled inert solid material. The cement system will need to be flushed to prevent curing inside the cement unit and pipework after each cement job is completed. In most instances, tanks and pipework would be flushed with seawater or drill water and the diluted fluid discharged to sea surface.

Xmas tree control fluid discharges

A Xmas tree will be installed on the well once drilling is complete. The Xmas tree will be routinely checked by completing pressure and function testing. Some function testing will release control fluid (approximately 60 L) to the marine environment. The control fluids are subject to the Santos Drilling Chemical Selection and Approval Process (EA-91-II-00007) described in **Section 6.7.2**.

Formation water

Formation water may be produced from the reservoir during well flowback and discharged to sea. This will notionally take 2 to 3 days pending well and surface process conditions. The non-flammable completion fluids and produced water will be treated via a water treatment package to reduce the oil-in-water content to <30 mg/L before operational discharge. Other chemicals such as methanol and MEG may also be injected into the flow stream and either flared or discharged to sea. A steam exchange may be used during well testing operations. If so, the water that has been condensed from the steam used to heat the fluids via a steam exchanger in the well flowback package will also be discharged to sea. It is estimated that approximately 100 m^3 of heated water at a notional temperature of 60°C could be discharged to sea. The discharge rate would be notionally 2 to 3 m^3 per hour.

Well clean-up and suspension

At the end of drilling and evaluation activities, the well will be suspended in preparation for production as described in **Section 2.5.11**.

Bulk products

Unmixed bulk drilling fluid solid additives (barite and bentonite), dry cement and brine will be managed in accordance with the decision list in **Table 6-16**.

Table 6-16: Decision list for managing bulk powders[2] and brines remaining on the mobile offshore drilling unit at the end of the well exploration

Trigger	Fate of Stock	Reasoning
Well is not the last well in the MODU schedule and ongoing use of the product is anticipated.	**Retain stock** Stock will be retained on-board for use in the next well, or may be sent for temporary storage on a supply vessel. This option eliminates overboard disposal.	These products are expensive. Santos' preferred option is to use all stock in subsequent wells in the MODU schedule to minimise activity costs and reduce discharges.
Well is the last well in the MODU schedule and the next Operator is willing to buy the stock.	**Sell stock** Stock will be retained on-board or may be sent for temporary storage on a supply vessel for used by the next Operator. This option eliminates overboard disposal.	It may be possible for Santos and the next Operator using the MODU to transfer ownership of the unmixed stock. The implementation of this option is dependent on demand and commercial agreements.
Well is the last well in the MODU schedule and selling the stock to the next Operator is not an option.	**Minimise stock** Santos will have measures in place to reduce the stock requiring disposal at the end of the activity. This option requires some overboard disposal.	Stock minimisation measures will be put in place without compromising the minimum bulk stock required for well control or dealing with lost circulation.

[2] Bulk powders include any of the following: barite, bentonite and cement.

Trigger	Fate of Stock	Reasoning
Well is the last well in the MODU schedule, selling the stock to the next Operator is not an option but another Santos operated MODU is in proximity and can take on stock.	**Transfer stock to alternative MODU** This option eliminates overboard disposal.	Stock can be transported to an alternate MODU dependent on: whether MODU is capable of transferring dry bulk products back to support vessel whether Santos has another MODU operating in the region alternative MODU can use the product travel distance and cost associated with transporting the stock to the alternative MODU are not prohibiting alternate MODU has the capacity to take on additional stock.
All other disposal options have been exhausted.	**Overboard disposal of stock** Stock will be discharged as wet slurry.	Disposal volumes will be minimal due to stock minimisation. Under normal circumstances where the well is the last well in the program and the well drills to plan, the stock cement usually does not exceed 150 m^3. Barite and bentonite stocks are unlikely to exceed 80 m^3 each. A decision log will be prepared demonstrating that this disposal option is ALARP and acceptable.

6.7.2 Chemicals

A risk-based approach to select chemical products ranked under the Offshore Chemical Notification Scheme (OCNS) is applied for those chemicals used and discharged to the marine environment. This scheme lists and ranks all chemicals used in the exploration, exploitation, and associated offshore processing of petroleum on the United Kingdom Continental Shelf.

Chemicals are ranked according to their calculated Hazard Quotients by the Chemical Hazard Assessment and Risk Management (CHARM) mathematical model, which uses aquatic toxicity, biodegradation and bioaccumulation data. The Hazard Quotient is converted to a colour banding with Gold and Silver colour bands representing the least environmentally hazardous chemicals. Chemicals not amenable to the CHARM model (such as inorganic substances, hydraulic fluids or chemicals used only in pipelines) are assigned an OCNS grouping based on the worst-case ecotoxicity data with Group E and D representing the least hazard potential.

The Santos Drilling Fluids and Chemical Risk Assessment Procedure (EA-91-II-00008) accepts CHARM ranked Gold/Silver, or non-CHARM ranked E/D chemicals for use and discharge without a detailed environmental risk assessment. The same applies to chemicals that are on the OSPAR Pose Little or No Risk to the Environment (PLONOR) List. The PLONOR List, agreed upon by the OSPAR Convention (Convention for the Protection of the Marine Environment of the North-East Atlantic), contains a list of substances that will pose little or no risk to the environment in offshore waters. If chemicals are ranked lower than Gold, Silver, E or D (CHARM ranked purple, orange, blue or white, or non-CHARM A, B or C ranked chemicals) and no alternatives are available, a risk assessment is conducted providing technical justification for their use, and showing that their use and associated risk is acceptable and ALARP.

As described above, investigation of potential alternative chemicals are completed when chemicals are ranked lower than CHARM Gold, Silver, E or D (CHARM ranked purple, orange, blue or white, or non-CHARM A, B or C ranked chemicals). There is a preference for chemical options that are CHARM ranked Gold/Silver, or non-CHARM ranked E/D chemicals and/or chemical that have a low aquatic toxicity, are readily biodegradable and do not bioaccumulate (discussed below).

Any chemicals that may be discharged to the marine environment and not OCNS CHARM or non-CHARM ranked are risk assessed using the OCNS CHARM or non-CHARM models. The chemical is assigned a pseudo ranking based on the available aquatic toxicity, biodegradation and bioaccumulation data (discussed below) and assessed for environmental acceptability for discharge to the marine environment.

Ecotoxicity assessment

Table 6-17 and Table 6-18 act as guidance in assessing the ecotoxicity of chemicals during the investigation of potential alternatives. Table 6-17 is used by Cefas to group a chemical based on ecotoxicity results, 'A' representing highest toxicity/risk to environment and 'E' lowest. Table 6-18 shows classifications/categories of toxicity against aquatic toxicity results.

Table 6-17: Initial Offshore Chemical Notification Scheme grouping

Initial grouping	A	B	C	D	E
Result for aquatic-toxicity data (ppm)	<1	≥1-10	>10-100	>100-1,000	>1,000
Result for sediment-toxicity data (ppm)	<10	≥10-100	>100-1,000	>1,000-10,000	>10,000

Note: Aquatic toxicity refers to the Skeletonema costatum *EC_{50},* Acartia tonsa *LC_{50}, and* Scophthalmus maximus *(juvenile turbot) LC_{50} toxicity tests. Sediment toxicity refers to the* Corophium volutator *LC_{50} test.*
Source: Cefas Standard Procedure 2019, OCNS 011 NL Protocol PART 1: Core Elements

Table 6-18: Aquatic Species Toxicity Grouping

Category	Species	LC_{50} and EC_{50} criteria
Category Acute 1: Hazard statement – Very toxic to aquatic life	Fish	LC_{50} (96 hrs) of ≤1 mg/L
	Crustacea	EC_{50} (48 hrs) of ≤1 mg/L
	Algae/other aquatic plant species	ErC_{50} (72 or 96 hrs) of ≤1 mg/L
Category Acute 2: Hazard statement – Toxic to aquatic life	Fish	LC_{50} (96 hrs) of >1 mg/L to ≤10 mg/L
	Crustacea	EC_{50} (48 hrs) of >1 mg/L to ≤10 mg/L
	Algae/other aquatic plant species	ErC_{50} (72 or 96 hrs) of >1 mg/L to ≤10 mg/L
Category Acute 3: Hazard statement – Harmful to aquatic life	Fish	LC_{50} (96 hrs) of >10 mg/L to ≤100 mg/L
	Crustacea	EC_{50} (48 hrs) of >10 mg/L to ≤100 mg/L
	Algae/other aquatic plant species	ErC_{50} (72 or 96 hrs) of >10 mg/L to ≤100 mg/L

Source: United Nations (2019) Globally Harmonized System of Classification and Labelling of Chemicals (GHS), Eighth Revised Edition.

Biodegradation assessment

The biodegradation of chemicals is assessed using the Cefas biodegradation criteria, which aligns with the categorisation outlined in the United Nations GHS Annex 9 Guidance on Hazards to the Aquatic Environment (2019). The below is used as a guide during the investigation of potential chemical alternatives. Preference is to select readily biodegradable chemicals.

Cefas categorises biodegradation into the following groups:

+ readily biodegradable: results of greater than X% biodegradation in 28 days to an OSPAR harmonised offshore chemical notification format (HOCNF) accepted ready biodegradation protocol;
+ moderately biodegradable: results greater than 20% and less than X% to an OSPAR HOCNF accepted ready biodegradation protocol; and
+ poorly biodegradable: results from OSPAR HOCNF accepted ready biodegradation protocol

Where X is equal to:

+ 60% in 28 days in OECD 306, marine biodegradability of insoluble substances or any other acceptable marine protocols, or in the absence of valid results for such tests;
+ 60% in 28 days (OECD 301B, 301C, 301D, 301F, Freshwater biodegradability of insoluble substances), OR
+ 70% in 28 days (OECD 301A, 301E).

Bioaccumulation assessment

The bioaccumulation of chemicals is assessed using the Cefas bioaccumulation criteria, which aligns with the categorisation outlined in the United Nations GHS Annex 9 Guidance on Hazards to the Aquatic Environment (2019). Preference is to select non bioaccumulative chemicals.

The following guidance is used by Cefas:

- Non-bioaccumulative/non-bioaccumulating: Log Pow <3, or results from a bioaccumulation test (preferably using Mytilus edulis) demonstrates a satisfactory rate of uptake and depuration, and the molecular mass is ≥700.
- Bioaccumulative/Bioaccumulates: Log Pow ≥3, or results from a bioaccumulation test (preferably using Mytilus edulis) demonstrates an unsatisfactory rate of uptake and depuration, and the molecular mass is <700.

All operational chemicals will be selected in accordance with the Santos Drilling Fluids and Chemical Risk Assessment Procedure (EA-91-II-00008).

6.7.3 Nature and scale of environmental impacts

Potential receptors: physical environment (water quality, benthic habitat), threatened, migratory or local fauna, protected areas (Montebello AMP) and socio-economic receptors.

Dispersion modelling of drilling fluids, cuttings and end of campaign bulk discharges (if required)

To understand the fate of the drill cuttings, fluids and end of campaign bulk discharges of barite and bentonite (if they are required), RPS undertook a dispersion modelling study for the Spartan Development well drilling campaign (RPS, 2021a). Modelling was based on the inputs in **Table 6-19**. Thresholds used for the dispersion modelling are provided in **Table 6-20**. Results of the dispersion modelling are summarised in **Table 6-21**.

Table 6-19: Dispersion modelling key inputs

Input	Value
Volume of cuttings discharged (m^3)	Total: 460.0 Seafloor: 300 Surface: 160
Volume of drilling fluids solids discharged (m^3)	Total: 164.8 Seafloor: 92.2 Surface: 72.6
Volume of wet cement discharged (m^3)	Total: 50.0 Seafloor: 40.0 Surface: 10
Volume of barite discharged (m^3)	69.6
Volume of bentonite discharged (m^3)	32.6
Density of drill cuttings (kg/m^3)	2,660
Density of drilling fluids (WBM) (kg/m^3)	2,300
Density of cement (wet) (kg/m^3)	2,300
Density of barite and bentonite (kg/m^3)	2,300
Seafloor discharge duration (days)	4.0
Surface discharge duration (days)	2.9
Depth of seafloor discharges (m)	59
Depth of surface discharges (m)	1
Sea surface discharge pipe orientation	Vertically downwards
Sea surface discharge pipe diameter (inches)	14

Table 6-20: Dispersion modelling study thresholds

Parameter	Threshold	Justification
Water column concentration (TSS)	0.3 mg/L	Minimum detectable concentration. Represents the minimum measurable concentration of TSS in the water column. The detectable level is expected to be well below levels that result in a visible plume, which is generally 203 mg/L above background in regions with low TSS concentrations (RPS, 2021a).
	1.0 mg/L	Impact level threshold, representative of environmental and ecologically meaningful impacts (e.g. reduction in photosynthetically active radiation (PAR) in primary producers) (RPS, 2021a).
Bottom thickness	0.001 mm	See discussion below for sedimentation.
	3.0 mm	Impact level threshold, representative of environmental and ecologically meaningful impacts (e.g. minimum depositional thickness that may cause smothering impacts on benthic ecosystems) (RPS, 2021a).
Sedimentation	1.0 g/m^2	Minimum detectable concentration which equates to approximately 0.0001 mm bottom thickness. Represents the minimum measurable sedimentation mass per area. The detectable level is considered conservative and is expected to be far less than natural sedimentation rates (Ridd, 2015).
	10.0 $g/m^2/day$ (sedimentation rate)	Impact level threshold, representative of environmental and ecologically meaningful impacts (RPS, 2021a).

Table 6-21: Dispersion modelling results summary

Paramter	Threshold	Estimated maximum distance from discharge location to achieve 95th percentile outcomes
Water column concentration (TSS)	0.3 mg/L	8,710 m
	1.0 mg/L	3,404 m
Bottom thickness	0.001 mm	15,303 m
	3.0 mm	175 m
Bottom concentration	1.0 g/m^2	15,908 m
	10 g/m^2	4,033 m
Sedimentation rate	1.0 g/m^2	15,321 m
	10 g/m^2	2,862 m

When considering the results of the study, it is important to note that the maximum distances are a result of the drill cuttings, fluids and bulk discharges combined, and hence represent a conservative worst-case outcome. In reality, it is unlikely that all these products would be discharged at the same time.

In response to the prevailing currents, coarser sediments are predicted to typically settle out within short distances from the well. Finer sediments are forecast to disperse more widely, with the finest sediments contributing a lower proportion of material to the thicker deposits closer to the well. Deposits of finer sediments are consistently calculated to build up along the north-east/south-west tidal axis on either side of the source, indicating that tidal currents could have significant influence over movement of the finer particles, particularly in the case of the seafloor discharges. Ocean currents will also have a large influence on the net movement direction and distance travelled before settlement occurs, with finer particles distributed to both the north and south of the Spartan Development well.

No contact was predicted with shoals and banks from the combined seabed and surface discharges. Distribution of the drilling fluids and cuttings will be concentrated around the well location, with the smaller particulates carried further from the release location but settling as a very thin layer.

Water quality – turbidity

Drilling solids (i.e., cuttings), formation water, cement and solid additives (e.g., barite, bentonite) will be discharged during the activity. Discharges at the water surface or close to sea level will result in a reduction in water quality from an increase in turbidity.

Once discharged, large particles and flocculated solids form a plume that settles quickly on the seabed. Fine grained unflocculated clay-size particles and other soluble components form another plume in the water column that drifts with the prevailing currents away from the point source and is diluted rapidly in the receiving waters (Neff, 2005). Turbidity increases from discharges at the seabed will have less of an effect than discharges at the sea surface with little change in ambient light levels since light will already be limited at this depth.

Any increases in suspended solids and subsequent decreases in available oxygen surrounding the discharge location may result in a localised impact to organisms present in the water column. Impacts may include obstructions to respiratory processes and other physiological processes as well as behavioural changes due to a reduction in available oxygen or avoidance of the turbidity plume. The increased particle load in the water column could adversely affect respiratory efficiency of small fish species that become entrained in the turbidity plumes. However, large pelagic fish species and megafauna (such as sharks and rays, marine turtles and cetaceans) are unlikely to be affected as these mobile species would avoid the area or simply pass unaffected through turbid waters.

In well-mixed ocean waters, drilling fluids and cuttings are diluted by 100-fold within 10 m of the discharge and by 1000-fold after a transport time of about 10 minutes at a distance of about 100 m. Because of the rapid dilution of the drilling and cement discharges plume in the water column, impacts to water column fauna and flora (e.g., plankton, fish) is unlikely (Neff, 2005). Drilling discharge modelling (RPS, 2021a) conservatively predicted TSS at the low threshold of 0.3 mg/L may extend for up to 8.7 km from the well location for all drilling discharges combined. However, at this concentration there would be no visible plume. At the impact threshold of 1 mg/L, TSS may extend for up to 3.4 km from the well location, most likely along a north-east / south west vector under the influence of tidal currents.

Given the generally low concentration of TSS expected to occur away from the immediate discharge site (due to rapid dispersion) and the offshore oceanic location of the well location and the short period of intermittent discharges, the drilling discharge plume is not expected to have more than a localised potential area of ecological impact and it is not predicted to impact productivity of the water column. The impact on water quality from drilling discharges is expected to be low and short-term and is unlikely to have spatially or ecologically significant effects.

Water quality – toxicity

Cementing discharges (cement, cement slurry, additives and spacers, etc) and formation water have the potential to result in toxicity effects. Discharge of cement at the sea surface has not demonstrated significant harm to water column flora and fauna (Neff, 2005).

Components of WBM with potential toxicity to marine flora and fauna include metals associated with inorganic salt components, organic polymers and additional organic additives as well as barite/bentonite weighting agents. Metals present in drilling fluid generally resemble that of marine sediments, albeit with concentrations of some metals higher than clean marine sediments (Neff, 2005). Metals associated with WBM drill cuttings have been shown to have a low bioavailability as they tend to remain in a non-ionic form, remaining bound to other compounds, presenting a low toxicity risk to marine fauna (Neff, 2005). In general, the acute toxicity of WBM is low (Neff, 2005).

Toxic impacts from the oil content in formation water is expected to be very localised following treatment by filtration to less than 30 ppm. Any toxic effects that might potentially would likely be restricted to small organisms such as plankton, larvae and potentially small fish that become entrained in discharged water resulting in relatively high exposure periods. The period of which formation water may be discharged is short; i.e., nominally five days per well test target. Given the very short duration of each well test discharge, the depth of waters and the high degree of dispersal and dilution at the seabed at this depth, seabed loadings of contaminants are not predicted to reach levels of concern.

Bioaccumulation is the uptake and retention of xenobiotics (substances that are not natural components of the environment) by organisms from their environment. This process can have significant ecological consequences as pollutants move up the food chain to higher order species. Numerous studies have been carried out in the Gulf of Mexico to test and evaluate a range of biological, biochemical and chemical methodologies to detect and assess chronic sub-lethal biological impacts in the vicinity of long duration activities associated with oil and gas exploration and production. Contaminant concentrations at most locations studied were below levels thought to induce biological responses (Kennicutt et al., 1996). Therefore, discharges associated with this activity are not expected to have long-term effects due to bioaccumulation.

Smothering

The discharge of borehole materials during riserless drilling will occur at the well opening on the seafloor until the conductor is installed. During cementing activities, cement returns to the seabed at the well opening are associated with cementing the conductor and surface casing. Direct contact with these discharges is expected to smother any habitats, which may include soft sediment benthic invertebrates and sessile epifauna.

Smothering may also occur as the suspended solids from the drilling discharges released at the water's surface settle to the seabed. The depth of accumulated sediments will be greatest close to the well location where the heavier particles are deposited and decrease with increase in distance from the source point. Drilling discharge modelling (RPS, 2021a) predicted the maximum distance at the impact threshold of 3 mm thickness deposition for bottom thickness was 175 m from the well location. This is consistent with other studies in the region, summarised below. The modelling also predicted that sedimentation rate above impact threshold (10 g/m^2 per day) may extend for up to 2.9 km from the well location. However, bottom thickness is expected to be well below the impact threshold (3 mm) at these distances.

The effects of drilling discharges on the benthic environment are related to the total mass of drilling solids and drilling fluids discharged, the relative energy of the water column and benthic habitat at the discharge location (Neff, 2005). The effects of drilling fluids and cuttings piles on seabed communities are caused mainly by burial and low sediment oxygen concentrations caused by organic enrichment (Neff, 2005). With increasing thickness of drill cuttings, the number of taxa, abundance, biomass and diversity of macrofauna has been found to significantly reduce (Trannum et al., 2010).

Organic enrichment as a result of WBM drilling cuttings discharge increases bacterial activity. A mild enrichment often sees both an increase in the abundance and diversity of the benthic community in the area of discharge. As more organic enrichment occurs, the seafloor bacteria colonies consume more and more of the oxygen in the sediment, resulting in anoxic conditions. In a highly organic enriched area, the sediment can become anaerobic and both the abundance and diversity of species is much lower than normal (IOGP, 2021).

Recovery of benthic communities from burial and organic enrichment occurs by recruitment of new individuals from planktonic larvae and migration from adjacent undisturbed sediments. Ecological recovery usually begins shortly after completion of drilling and often is well advanced within a year. Hardened cement will provide a surface for colonisation by epifauna. Full recovery may be delayed until concentrations of biodegradable organic matter decrease through microbial biodegradation to the point where surface layers of sediment are oxygenated. Case studies on impacts of water-based muds and drilling discharges on soft sediment and benthic fauna are outlined below:

+ For Santos' East Spar development, the area of impact from water-based mud discharges was not more than 100 m from the drill site and short-lived (recovery in less than 18 months) (Sinclair Knight Merz, 1996, 1997; Kinhill, 1998).
+ Benthic monitoring at the Stag production platform (water depth approximately 45 m) indicated that drilling-induced impacts had less of an influence on infaunal assemblages through time than small spatial scale natural variability (Kinhill, 1998).
+ Benthic monitoring at the Santos Van Gogh 3 well location (water depth approximately 350 m) reported sediment deposition one month following drilling extended up to 180 m from the well location along the longest axis and 70 m along the shortest axis (Sea Serpent, 2008). Two months later, monitoring confirmed that the extent of deposition had decreased to a uniform distance of 55 m around the well with a total area reduction of approximately one third (Sea Serpent, 2008). The monitoring revealed that burrow-forming worms and crabs still persisted within the area of sediment deposition (Sea Serpent, 2008).

Given the localised extent, no impact to shoals, banks or shallow water habitats are expected.

Overall, impacts would likely be temporary, with rapid recolonisation of benthic infauna within the drilling discharges particle layer, given the low toxicity of the material. Epifauna is likely to recolonise within weeks to months.

Sediment quality

The top hole section of the well is drilled riser-less. Drill cuttings and unrecoverable WBM drilling fluids / additives from the top hole sections will be discharged at the seabed at the well location and typically result in a localised area of sediment deposition (cuttings pile) in close proximity to the well site.

A WBM drilling cuttings pile is effectively made up of:

+ a rock fraction (the cuttings);
+ WBM, including:
  - a weighting agent (API Barite); and
  - a liquid fraction (the liquid components of the drilling fluids)

Drill cuttings accumulation on seafloor sediments can cause changes in the physical properties and chemical composition of the seabed sediments. These include increased concentrations of organic material (described above), a change in the appearance of the sediment surface, increased sediment grain size and increase in concentrations of metals (relating to weighting agent use).

Barite is one of the main constituents used in WBM, and its use results in elevated levels of barium (Ba) in cuttings. Other chemicals of concern in cuttings, either because of their potential toxicity and/or abundance in WBM are arsenic (As), chromium (Cr), cadmium (Cd), copper (Cu), iron (Fe), lead (Pb), mercury (Hg), nickel (Ni) and zinc (Zn) (Breuer et al., 2004).

Dissolved barium and any heavy metal contaminants present in the barite may slowly leach out of an anoxic cuttings pile (Neff. et al., 2005). Breuer et al. (2008) has also observed that metals in cuttings, migrate either upward to the overlying water (Ba, Mn, and Fe), or diffuse downward (Cr, Cu and Pb) where they become incorporated into Fe monosulfides. The exposure of these Fe monosulfides to oxygen as a result of transport of oxygen into the cuttings via bioturbation or advection and/or pile resuspension may then lead to the release of the associated metals into the water column (Saulnier and Mucci, 2000; Huerta-Diaz et al., 1998).

In a stable cuttings pile with little physical disturbance or bioturbation, it is probable that the fraction of the total cuttings pile metals that is in the dissolved, bioavailable fraction remains low. It is probable that some dissolved metals diffuse into the overlying water column and escape from the pile as identified by Neff et al. (2005). However, this efflux is not sufficient to raise the concentration of metals above natural background levels to an ecologically significant extent (Hartley et al., 2003). There is no indication that the levels of trace metals in fish and shellfish collected close to offshore installations are significantly above natural background concentrations (Bakke et al., 2013).

Marine fauna that are exposed in the laboratory or field to cuttings in sediments do not bioaccumulate significant quantities of metals (Hartley et al., 2003). There is some evidence of a limited bioavailability of a few metals, such as Pb and Zn, which are present in cuttings piles, however doubt remains that metal bioaccumulation in marine fauna from cuttings piles is sufficient to cause harmful effects in marine fauna living on or near cuttings piles (OSPAR, 2019).

Barite selected for the drilling is manufactured in accordance with API Standards which have limitations on all contaminant concentrations.

Given the nature of the cuttings discharge, and the nature of the seabed the vicinity of the operational area, the impact from a reduction of sediment quality is expected result in a detectable but insignificant change to local population.

Cuttings pile legacy impacts

In the event of cuttings pile disturbance (e.g. future decommissioning results in disturbance), a proportion of a disturbed cuttings pile is likely to resettle on seabed sediment that has not been previously impacted by cuttings. The potential impact this has on benthic communities results from a combination of physical smothering, changes in sediment texture/grain size, oxygen depletion, organic enrichment and direct toxicity from drilling fluids and cuttings (impacts of which are described above). This can result in a decrease in both the abundance and diversity of benthic fauna (OSPAR, 2019). Resuspension of cuttings piles into the water column as a result of disturbance gives rise to the potential for exposure of marine fauna to contaminants in the cuttings (refer to discussion above).

Modelling of cuttings pile relocation (disturbance and re-deposition) has confirmed that potential impacts of metals are minimal and disturbance of cuttings drilled with WBM are not expected to result in any significant impact (OSPAR, 2019). Generally, impacts from disturbed cuttings drilled with WBM are expected to be minor and resemble the impacts from currently consented cuttings discharges, and any concern is more likely to focus on cuttings drilled with Non-aqueous Drilling Fluids (NADF) (OSPAR, 2019).

Threatened or migratory fauna

As discussed in the sections above, the discharge extent for the drilling and cement discharges is localised and temporary. Marine fauna within the operational area are likely to be transient. If contact does occur with any marine fauna, it will be for a short duration due to the rapid dispersion of the plume and the transient fauna movement, such that exposure time may not be of sufficient duration to cause a toxic effect. Given the nature of the marine environment within the vicinity of the operational area, the drilling and cement discharges are not predicted to have ecologically significant effects.

Habitat modification is identified as a potential threat to a number of marine fauna species in relevant recovery plans and conservation advices (**Table 3-9**). Disturbance of the seabed is not anticipated to significantly affect mobile marine fauna, such as marine mammals, marine reptiles, fish, sharks and rays, given the sparse benthic and epi-benthic communities expected in the operational areas. Impacts to benthic fauna are discussed above. These are localised and while a decrease in local population size may occur, no loss or disruption of habitat critical to the survival of a species or disruption to the breeding cycle of any of these protected matters is expected.

Fish, sharks and rays may also forage in the soft sediments for marine invertebrates. However, given the small scale of the activity and the regionally availability of habitat, seabed and benthic habitat disturbance from drilling and cement discharges is not expected to affect these species.

BIAs for marine turtles occur within the operational areas, (internesting buffer) (**Table 3-8**). However, internesting activities typically occur within shallower waters than those in the operational areas (as discussed in **Section 6.1.2.2**) (Whittock et al., 2016; Pendoley, 2017). If a marine turtle was displaced from the area of seabed and benthic habitat disturbance, widespread internesting habitat is available in the immediate vicinity that marine turtles could continue to use within the identified BIAs.

<u>Protected and significant areas</u>

The operational area overlaps a very small portion of the Montebello AMP, with the boundary of the AMP located approximately 380 m west of the well location (**Figure 3-5**).

The values and sensitivities of the AMP that could potentially be impacted by drilling discharges are:

+ foraging areas for migratory seabirds that are adjacent to important breeding areas;

- areas used by vulnerable and migratory whale sharks for foraging;
- foraging areas marine turtles which are adjacent to important nesting sites;
- section of the north and south bound migratory pathway of the humpback whale;
- shallow shelf environments with depths ranging from 15–150 m which provides protection for shelf and slope habitats, as well as pinnacle and terrace seafloor features;
- seafloor habitats and communities of the Northwest Shelf Province provincial bioregions as well as the Pilbara (offshore) meso-scale bioregion;
- one KEF for the region is the ancient coastline (a unique seafloor feature that provides areas of enhanced biological productivity); and
- commercial tourism, commercial fishing, mining and recreation are important socio-economic values for the park; and
- two historic shipwrecks are located within the MAP, the Trial (wrecked in 1622) and the Tanami (date unknown).

The Montebello AMP has been zoned Multiple Use Zone (IUCN category VI) - managed to allow ecologically sustainable use while conserving ecosystems, habitats and native species. The zone allows for a range of sustainable uses, including commercial fishing and mining where they are consistent with park values (Director of National Parks, 2018). The North-west Marine Parks Network Management Plan (NWMPMP) identifies habitat modification as one of the pressures on the North-west Marine Park Network, in particular:

For example, benthic communities are vulnerable to the discharge of sediments which can result in localised smothering of benthic biota and or reduction in the quality and quantity of light received at the seabed (Director of National Parks, 2018).

Although the discharge modelling indicates the potential for impacts inside the AMP from drilling discharges, impacts to threatened and migratory fauna that use the AMP are expected to be minor. As discussed above, the discharge extent for the drilling and cement discharges is localised and temporary. If contact does occur with any marine fauna, it will be for a short duration due to the rapid dispersion of the plume and the transient fauna movement, such that exposure time may not be of sufficient duration to cause a toxic effect.

Habitat modification from smothering is not expected to significantly impact foraging habitats, internesting habitats or other seafloor habitats and communities within the AMP. Further, the benthic habitats of the AMP that may be affected are well represented across the region and Northwest Shelf Province. The depth of accumulated sediments will be greatest close to the well location where the heavier particles are deposited and decrease with increase in distance from the source point. Drilling discharge modelling (RPS, 2021a) predicted the maximum distance at the impact threshold of 3 mm thickness deposition for bottom thickness was 175 m from the well location. This is consistent with other studies in the region, summarised above. The modelling also predicted that sedimentation rate above impact threshold (10 g/m^2 per day) may extend for up to 2.9 km from the well location. However, bottom thickness is expected to be well below the impact threshold (3 mm) at these distances. Any impacts from smothering impacts would likely be temporary, with rapid recolonisation of benthic infauna within the drilling discharges particle layer, given the low toxicity of the material. Epifauna is likely to recolonise within weeks to months. Impacts to sediment quality area also expected to be limited to a small area of the AMP, and are expected result in a detectable but insignificant change to local population. Direct and indirect impacts form water quality impacts from TSS may occur.

At the impact threshold of 1 mg/L, TSS may extend for up to 3.4 km from the well location, most likely along a north-east / south west vector under the influence of tidal currents. However, given the lack of sensitive primary producer habitat in these deeper, offshore waters of the AMP, no significant direct or indirect impacts are expected.

As discussed above, internesting habitat for marine turtles is likely to be closer to nesting beaches (nearest nesting beach approximately 24 km away), and therefore significant impacts to internesting habitat for marine turtles is not expected. No sensitive or significant benthic habitats within the AMP are expected to be impacted by drilling discharges.

Impacts to commercial fishing are likely to be negligible, with important commercial species unlikely to be affected by drilling discharges due to the temporary nature of the discharges, rapid dilution of the plume and lack of significant seabed features in the area. Impacts to tourism and recreation are unlikely, given these activities occur in shallower water, closer to shore and distant from the potential area of impact from drilling discharges.

The shipwrecks of the Trial and Tanami are located more than 40 km from the well location and will not be impacted by drilling discharges. The Ancient coastline KEF is located more than 16 km away from the operational area and will not be impacted by drilling discharges.

Overall, the drilling discharges will not significantly impact the values and sensitives of the Montebello AMP and no sensitive or significant benthic communities within the AMP are expected to be impacted by drilling discharges.

6.7.4 Environmental performance outcomes and control measures

The EPOs relating to this event include:

+ No injury or mortality to EPBC Act 1999 and WA Biodiversity Conservation Act 2016 listed fauna during activities [ST-EPO-05].
+ Reduce impacts to air and water quality from planned discharges and emissions from the activities [ST-EPO-06].

The control measures considered for this activity are shown in **Table 6-22** and EPSs and measurement criteria for the EPOs are described in **Table 8-2**.

Table 6-22: Control measure evaluation for drilling and cement discharges

Control Measure Reference No	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Control Measures				
ST-DC-CM-007	Chemical selection procedure	Aids in the process of chemical management that reduces the impact of drilling discharges to sea. Only environmentally acceptable	Cost associated with implementation of procedure. Range of chemicals reduced with potentially higher costs for alternative products.	**Adopted** – Environmental benefit of using lower toxicity chemicals outweigh procedural implementation costs.

Control Measure Reference No	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		products are used.		
ST-DC-CM-032	Cuttings management system	Reduces the concentration of drilling mud on cuttings prior to discharge while drilling with a closed circulating system, thereby reducing the total volume of mud lost to sea.	High cost associated with implementing procedure.	**Adopted** – Benefits of implementing procedure and measures implemented outweigh costs.
ST-DC-CM-033	Inventory control procedure	Restricts the type and volume of drilling discharges, and includes a decision-making framework for managing left-over bulk products (refer to **Table 6-16**).	High cost associated with implementing procedure.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh costs.
ST-DC-CM-047	Quality control limits for Barite	Contaminant limit concentrations in barite: Mercury (Hg) – 1 mg/kg dry weight in stock barite Cadmium (Cd) – 3 mg/kg dry weight in stock barite Puts a limit on the contaminants within the barite, therefore reducing sediment contamination as a result of cuttings	Low cost associated with ensuring the barite selected by the drilling contractor meets the contaminant limits.	**Adopted** – Environmental benefit of using a barite with lower contaminant concentrations outweigh the implementation costs.

Control Measure Reference No	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		discharge or any future cuttings disturbance.		
ST-DC-CM-034	Oil content measurement procedure	Accounts for potential for oil contamination from reservoir.	Cost associated with implementing procedure.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh costs.
ST-DC-CM-035	Lost-circulation material procedures	Reduces hydrocarbon based lost-circulation material that may be released to the environment.	Cost associated with implementing procedure.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh costs.
ST-DC-CM-036	Well test procedures	Ensures well testing fluids are appropriately managed and that oil-water content in formation water, if produced, is below 30 ppm.	Cost associated with implementation of procedure.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh costs.
Additional Control Measures				
N/A	Early establishment of closed circulating system	Establishes a closed circulating mud system, hence provides an opportunity to re-use drilling fluids, thereby reducing environmental discharges. Does not reduce the volume of drilled cuttings discharged to sea.	Cost associated with change to well design.	**Rejected** – A conductor reduces risk to well design by protecting the inner casings from the ocean.

Control Measure Reference No	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
N/A	Riserless mud recovery (RMR)	RMR system returns top-hole cuttings/WBM from the riserless section of the well to the MODU and provides an opportunity to recover and re-use the WBM drilling fluids. Recovery of the WBM drilling fluids reduces the fluids on the cuttings prior to disposal to the marine environment and subsequent impacts. As discussed in **Section 6.7.3**, drilling fluids on cuttings increase the toxic effects to marine fauna and reduce the sediment quality over the area in which they are discharged. However as discussed in **Section 6.7.3,** in general, the acute toxicity of WBM is low (Neff, 2005) and the impact from reduced sediment quality is anticipated to be detectable but insignificant to local population.	High costs associated with modifications to wellhead, HP riser system and MODU and rental of service equipment. Also, service equipment is large and there may not be room available of the Jack-up MODU.	**Rejected** – Costs grossly disproportionate to environmental benefit.

Control Measure Reference No	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		Disposal of cuttings using RMR from the MODU occurs below the water surface, instead of directly to seabed. Discharging from the MODU rather than at the seabed reduces the consequence of environmental impacts from smothering of surrounding benthic fauna and impact to sediment quality (refer to **Section 6.7.3**), due to a greater spread of cuttings on the seafloor. However, discharging the cuttings from the MODU results in a localised reduction in water quality from increased turbidity and water toxicity (refer to **Section 6.7.3**).		
N/A	Cuttings reinjection	Would minimise/ eliminate overall discharges to sea, reducing potential impacts to marine environment.	Significant cost to drill injection well and manage the re-injection process. Additional discharges while drilling the injection well.	**Rejected** – Not justifiable for a single production well.

Control Measure Reference No	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
N/A	Extended cuttings dump chute to below sea surface	Releases drilled solids (cuttings) deeper in the water column, thereby potentially reducing spatial extent and turbidity plume.	Significant cost associated with engineering, fabricating and/or installing chute. Potential delays if chute becomes blocked. Higher operational risk. Increased depth of concentrated cuttings deposition may inhibit infauna recovery at seabed.	**Rejected** – Chute does not reduce volume of cuttings discharged. Chute system introduces higher costs and operational risk. Given the low environmental impact of the cuttings discharged (due to the chemicals selected) and the short duration of discharge in an area that is not identified as significant habitat for marine fauna, the additional cost is considered disproportionate to the environmental benefit.
N/A	Skip and ship to shore of drilling/ cement waste and bulk product.	Would eliminate discharges to sea, reducing potential impacts to marine environment.	Storage space required for containment of waste, increase in transfers to vessels resulting in increased potential impacts and risks. Increased transfers results in increased fuel usage, increased safety risks to personnel during transfer (e.g., crushing between skips), increase in	**Rejected** – Cost outweighs the benefit given the low impact expected from drilling and cement discharges and increase in safety risks and additional costs.

Control Measure Reference No	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
			crane movements, high cost to transport and dispose onshore.	
N/A	Amend well design to reduce the volume of cuttings discharged to sea through reduction in diameter of the well to 6" hole in the primary target and reducing the casing string above the target to 7".	Would reduce discharges to sea thereby reducing potential impacts to the seabed and water quality and marine fauna	8-1/2" hole through the reservoir is required in order to produce the reservoir volume to make the development economic.	**Rejected** – Not feasible.

6.7.5 Environmental impact assessment

Receptor	Consequence Level
Drilling and Cement Discharges	
Threatened, migratory or local fauna	No sensitive seabed features are known to occur within either operational area or in the area predicted to be contacted (directly or indirectly) by drilling discharges (up to approximately 15 km north-east / south-west of the well location (RPS, 2021a)). The areas of seabed that will be impacted by the activity do not contain any significant or unique areas of benthic habitat. The benthic habitats within the operational areas and the area predicted to be contacted by drilling discharges are broadly homogenous and comprised of two main types: silt/sand sediment and low relief hard substrate habitats (such as rubble and stones) and no evidence of rock outcropping or coral reef development. Marine invertebrates may inhabit soft sediments and can contribute to the diet of some fauna. Non-coral benthic invertebrates may be present in the operational areas and surrounds, including filter feeders such as sponges, soft corals, gorgonians, anemones and crinoids. However, there is not expected to be any significant areas of these. Furthermore, the area of soft sediment habitat that is potentially impacted is small compared to the amount of habitat available and therefore the disturbance is not expected to affect prey availability, or protected fauna species. Habitat modification is identified as a potential threat to a number of marine fauna species in relevant Recovery Plans and Conservation Advice (**Table 3-9**). However, the operational areas have not been identified as a habitat that supports any

	protected species. Impacts will be temporary and the area potentially impacted is small compared to the size of the areas used by these species for foraging. Therefore, no long-term impacts to these species are expected. No decrease in local population size, area of occupancy of species, loss or disruption of critical habitat or disruption to the breeding cycle of any of these protected matters is expected. Marine invertebrates may inhabit soft sediments and can contribute to the diet of some fauna. The area of soft sediment habitat that is potentially impacted is small compared to the amount of habitat available. Therefore, the disturbance is not expected to affect prey availability, and protected fauna species, significantly. Recovery of benthic communities from burial and organic enrichment occurs by recruitment of new colonists from planktonic larvae and immigration from adjacent undisturbed sediments. Ecological recovery usually begins shortly after the end of drilling and often is well advanced within a year. Full recovery may be delayed until concentrations of biodegradable organic matter decrease through microbial biodegradation to the point where surface layers of sediment are oxygenated. Mobile marine species are expected either to avoid turbid stretches of water or pass through with no significant impacts. The toxicity of WBM, formation water and cement is considered low and the potential for bioaccumulation of any toxic compounds is negligible. As with all chemicals selected for use in drilling operations by Santos, the chemicals chosen for the activity will be either CHARM rated Gold or Silver (or E or D OCNS) or risk assessed through the Chemical Risk Assessment process as being environmentally-acceptable, reducing the likelihood of any impacts. The increased particle load in the water column could adversely affect respiratory efficiency of fish, although most visual orientated fish species would likely avoid the affected area. The operational areas and surrounds are in a high-energy, well mixed open water environment and significant discharge plumes are not expected to occur outside of the areas directly adjacent to the operational areas. Given the potential for concurrent project activities (e.g. drilling and installation activities overlapping), there is potential for cumulative disturbance to the seabed, benthic communities, and marine fauna (from indirect impacts e.g. increased turbidity). Cumulative seabed disturbance would be limited to the well location and flowline installation operational area, given the highly localised nature of other seabed distubances, vessel dicahrges and installation discharges. Recovery from such cumulative impacts is expected to be relatively rapid, given the short-term nature of the impacts and expected re-colonisation from adjacent sediments. Cumulative indirect impacts such as increased turbidity are expected to be short-term, localised and temporary. Overall, the consequence to marine fauna from any of the drilling discharges is considered Minor (II) given the low toxicity of the drilling and cement discharges and there are no significant impacts expected to threatened and migratory fauna.
Physical environment or habitat	Local minor changes to soft sediment habitat will result from cuttings and associated drilling mud deposition near the MODU. Effects to benthic infauna communities from sedimentation and reduction in sediment quality resulting from drilling discharges have been determined to most likely be a result of a change in sediment texture as opposed to any toxicological effects, with increased clays and larger particles altering the habitat suitability for some species.

	Given the low toxicity of the materials to be discharged and the relatively small area predicted to be significantly smothered or have a reduction in sediment quality, overall impacts are considered to be minor to this habitat type and due to the loss of epifauna and infauna expected through smothering and release of drilling and cement discharges. The impacts are considered recoverable within weeks to months. For cement discharges, geomorphology of the habitat would be altered, with cement hardening over time and blanketing the existing habitat. Although impacts on the form of the seabed and sediment quality in the immediate vicinity of the MODU will be longer term, the impacts are low in magnitude owing to the small area that would be affected. Impact is anticipated to be detectable but insignificant to local population. Overall, the consequence to the physical environment/habitat from any of the drilling discharges is considered Minor (II).
Threatened ecological communities	Not applicable – No threatened ecological communities are identified in the area where discharge effects could occur.
Protected areas	Although the discharge modelling indicates the potential for impacts inside the Montebello AMP from drilling discharges, impacts to threatened and migratory fauna that use the AMP are expected to be minor, as discussed above. Habitat modification from smothering is not expected to significantly impact foraging habitats, internesting habitats or other seafloor habitats and communities within the AMP. The benthic habitats of the AMP that may be affected are well represented across the region and Northwest Shelf Province. The depth of accumulated sediments will be greatest close to the well location where the heavier particles are deposited and decrease with increase in distance from the source point. Drilling discharge modelling (RPS, 2021a) predicted the maximum distance at the impact threshold of 3 mm thickness deposition for bottom thickness was 175 m from the well location. The modelling also predicted that sedimentation rate above impact threshold (10 g/m^2 per day) may extend for up to 2.9 km from the well location. However, bottom thickness is expected to be well below the impact threshold (3 mm) at these distances. As discussed above, any impacts from smothering impacts would likely be temporary, with rapid recolonisation of benthic infauna within the drilling discharges particle layer, given the low toxicity of the material. Impacts to sediment quality area also expected to be limited to a small area of the AMP, and are expected result in a detectable but insignificant change to local population. As discussed above, internesting habitat for marine turtles is likely to be closer to nesting beaches (nearest nesting beach approximately 24 km away), and therefore significant impacts to internesting habitat for marine turtles is not expected. No sensitive or significant benthic habitats within the AMP are expected to be impacted by drilling discharges. Direct and indirect impacts form water quality impacts from TSS may occur. At the impact threshold of 1 mg/L, TSS may extend for up to 3.4 km from the well location, most likely along a north-east / south west vector under the influence of tidal currents. However, given the lack of sensitive primary producer habitat in these deeper, offshore waters of the AMP, no significant direct or indirect impacts are expected. Impacts to commercial fishing are likely to be negligible, with important commercial species unlikely to be affected by drilling discharges due to the temporary nature of the discharges, rapid dilution of the plume and lack of

	significant seabed features in the area. Impacts to tourism and recreation are unlikely, given these activities occur in shallower water, closer to shore and distant from the potential area of impact from drilling discharges. The shipwrecks of the Trial and Tanami are located more than 40 km from the well location and will not be impacted by drilling discharges. Overall, the drilling discharges will not significantly impact the values and sensitives of the Montebello AMP and no sensitive or significant benthic communities within the AMP are expected to be impacted by drilling discharges.
Socio-economic receptors	Impacts to commercial fishing are likely to be negligible, with important commercial species unlikely to be affected by drilling discharges due to the temporary nature of the discharges, rapid dilution of the plume and lack of significant seabed features in the area. Impacts to tourism and recreation are unlikely, given these activities occur in shallower water, closer to shore and distant from the potential area of impact from drilling discharges. No stakeholder concerns were raised regarding this event.
Overall worst-case consequence level	II – Minor

6.7.6 Demonstration of as low as reasonably practicable

Drilling and cementing is a requirement of the activity and the resultant fluid and solid by-products cannot be eliminated or avoided. With the control measures adopted to minimise the environmental impact of drilling discharges, the consequence was assessed as Minor (II). In particular, the application of Santos' Drilling Fluid and Chemical Selection in Drilling Activities Procedure (EA-91-II-00007), so that only environmentally acceptable products are used, ensures the impacts to the environment will not be significant.

Santos uses a risk-based approach to selecting chemical products ranked under the OCNS as described in **Section 6.7.2**.

Santos' Drilling Fluid and Chemical Selection in Drilling Activities Procedure (EA-91-II-00007) requires that chemicals for use and discharge are CHARM rated Gold or Silver, or non-CHARM rated E or D. Any chemicals which are not OCNS CHARM or non-CHARM-able rated are risk assessed through the procedure (EA 91 II 00007) to provide for a product that is environmentally acceptable for discharge to the marine environment.

If the activity is the last on the MODU schedule there will be discharges of bulk products prior to moving off location (barite, bentonite and cement). Alternatives to this will be considered first (refer **Table 6-16**); however, bulk discharges may be the most appropriate and cost-effective alternative. The discharge of drilling fluids, cement and other chemicals to the marine environment is seen as the most viable management method for this waste stream. In addition, control measures have been adopted to reduce the impact of the waste stream to the marine environment (including the Montebello AMP) to a minor consequence, including processing the return fluids and on board the MODU prior to disposal, mixing chemicals to further dilute them (e.g., as a slurry) prior to discharge and selecting chemicals using the chemical selection procedure.

The high cost associated with any of the additional management controls that were rejected would impact the financial viability of the activity. For this reason, they were assessed as being 'grossly disproportionate to environmental benefit'. The commitment to not discharge any residual drilling fluids at all during the drilling program was rejected because of the high alternative disposal costs and the low potential for environmental impact in the operational area and surrounding environment.

Oily water from well testing

Well testing will occur over 2-3 days. Hydrocarbons (oil and gas) and potentially formation water will be produced from the reservoir. Oil and gas hydrocarbons will be flared (combusted) using burners to alleviate the need to store produced hydrocarbons on board the drill rig, while providing a means of discharging hydrocarbons without contamination of surrounding waters (refer **Section 6.3**– Atmospheric emissions). If any formation water is produced, it will be discharged to the marine environment following processing. A heat exchanger/heater may be used during well testing and heated water (fresh water or seawater) will be discharged to sea, if required. It is estimated that approximately 100 m^3 of heated water at a notional temperature of 60°C could be discharged to sea. The discharge rate would be notionally 2 to 3 m^3 per hour.

MARPOL Annex I (Regulation 15 and 39) is not appropriate to use for maximum oil in water concentrations for produced formation water (PFW), as it applies to the discharge of oil from machinery spaces on ships (defines the discharge requirement of the oil in water content to not exceed 15 ppm). MARPOL Annex I (Regulation 56) states for fixed/floating platforms (which includes MODUs) that only the discharge of machinery space drainage and contaminated ballast should be subject to MARPOL 73/78, and that discharges including production water discharge, are not subject to these regulations. The volumes of bilge water and machinery space drainage water that are discharged routinely from MODUs are small intermittent volumes (typically 5 m3 for similar duration activity). These discharges are usually contained in holding tanks prior to treatment and processed through the oily water system more than once (if required) to meet the MARPOL Annex I 15 ppm discharge requirement.

The well test equipment including the treatment system to remove oil is a separate system to the MODU's MARPOL-compliant oily water treatment system. The volume of water that may need to be treated during well testing is usually approximately 55 m^3 discharged over a two to three day period. The additional volume of oil introduced to the marine environment comparing an oil in water (OIW) concentration of 30 ppm rather than 15 ppm would be small. The estimated total oil volume at 30 ppm concentration and 15 ppm concentration for 55 m^3 of discharge would be less than two litres and less than one litre respectively.

To meet an OIW discharge of 15 ppm, a specialised water treatment tank (to enable re-treatment and storage of the water to reach 15 ppm) would need to be mobilised to the MODU before the well test. The tank would consume valuable open deck space desirable for safe working conditions, including crew egress. The additional cost to hire the tank, as well as additional filtration cartridges, is estimated at greater than $50,000 AUD.

Monitoring of PFW discharge at the Stag platform (previously operated by Santos) shows that the discharge of PFW does not significantly affect water quality. At a distance of more than 50 m from the Stag discharge point, the PFW could not be differentiated from background conditions in the marine environment. The hydrocarbon and metal concentrations were also below all ANZECC/ARMCANZ 95% species protection guidelines. These results indicate that there is no significant impact from the release of PFW at the Stag facility. Given the water depth in the operational areas is generally much deeper and the total treated water discharge for the short duration well tests (two to three days) is less than 2% of the daily discharge at Stag, it is reasonable to conclude that discharging water with oil at less than 30 ppm will not have a significant environmental impact and the risk to the environment negligible.

Where possible, produced water will be burned with the flared hydrocarbon produced during well testing, eliminating the discharge of produced water to the marine environment.

Given the lack of sensitive receptors in the operational area and surrounding environment, Santos considers that there is negligible environmental benefit to reduce the OIW content of the PFW further (i.e., to less than 15 ppm, less than one litre of oil for the well test) prior to PFW discharge from well testing. Given the potential reduction of oil discharge to the marine environment of less than one litre, for an additional cost greater than $50,000 AUD Santos considers this cost to be disproportionate given the negligible environment consequence, therefore the OIW concentration of 30 ppm is ALARP for potential discharge volumes associated with the activity.

With the control and management measures adopted, the assessed residual consequence for this impact is Minor (II). Additional control measures were considered but rejected since the associated cost or effort was grossly disproportionate to any benefit, as detailed in **Section 6.7.4**. Therefore, it is considered that the impact from drilling and cement discharges is ALARP.

6.7.7 Acceptability evaluation

Is the consequence ranked as I or II?	Yes – maximum consequence from drilling and cement discharges is Minor (II).
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes –IUCN principles and strategic objectives of the Montebello AMP are met. Consistent with relevant species recovery plans, conservation management plans and management actions set out in Table 3-9, including but not limited to: + Recovery Plan for Marine Turtles in Australia (2017) + North-west Marine Parks Network Management Plan 2018
Are risks and impacts consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – no concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The use of drilling fluids and solid additives, and the generation of drilling discharges, is an unavoidable part of the drilling program. It is accepted industry practice to discharge cuttings to sea, along with any associated water-based drilling fluids. Water quality and benthic impacts will be highly localised and largely concentrated immediately around the surface hole location and MODU. The operational areas are not located close to any sensitive nearshore habitats.

The drilling activity will only use WBM drilling fluids which are either completely inert or have additives in such low concentrations they pose little or no risk to the environment. The application of the chemical selection procedure for drilling and cementing chemicals is an important control measure for reducing the toxicity of drilling discharges to the marine environment. In accordance with the procedure, CHARM-rated Gold/Silver and non-CHARM grouped E/D chemicals managed under the OCNS, or PLONOR substances listed by OSPAR, or chemicals risk assessed by Santos and deemed environmentally acceptable, will be selected for the drilling program.

Drilling discharges are not expected to result in significant impacts to the values and sensitivities of the Montebello AMP (as described in **Sections 6.7.3** and 6.7.5) and are not considered inconsistent with the North-west Marine Park Network Management Plan.

With control measures in place to minimise the environmental impact of drilling discharges, the consequence was assessed as Minor (II) and ALARP. The managed discharges will not reduce the habitat values of the area potentially affected as described in relevant Recovery Plans, Approved Conservation Advice or North-west Marine Park Network Management Plan, or be inconsistent with the strategies of these documents. No concerns have been raised regarding this event by stakeholders. Therefore, the minor impacts expected from proposed drilling discharges are considered to be environmentally acceptable.

6.8 Planned chemical and hydraulic fluid discharges – subsea installation and pre-commissioning

6.8.1 Description of event

Event	The following subsea installation and pre-commissioning activities will result in the discharge of chemicals and hydraulic fluids to the marine environment: + leak testing; + umbilical tie in; + valve operations; + flowline end deployment ; + pressure cap removal; and + ROV operations + Leak testing Leak testing of the flexible flowline may result in a discharge of approximately 20 m^3 to the marine environment. Treated seawater will contain a biocide (Hydrosure 0-3670R at a concentration of 500 ppm) and a fluorescent dye. Umbilical tie-in The umbilical cores will be pressurised with 80/20 MEG/Water and hydraulic fluid prior to loadout and installation. During connection of the umbilical cobra-head to the Xmas tree, a small amount of hydraulic fluid) and MEG/water may be released to the environment (approximately 10 L). Valve operations Once the subsea system is fully installed and leak tested, the valves on the XT shall be functioned in a pre-determined sequence to demonstrate operability. During the valve operations (closing) hydraulic fluid shall be released from the SCM vent line due to the open loop system design. Approximately 2-5L of hydraulic fluid is released per valve, resulting in a total of approximately 25L released during cold commissioning. Flowline deployment When the flowline end is laid down from the ISV at the xmas tree, there will be a small release of treated seawater of approximately 2 m^3. Treated seawater will contain a biocide (Hydrosure 0-3670R at a concentration of 500 ppm) and a fluorescent dye. During the removal of pull-heads on the end of each flowline section, a release of approximately 0.5 m3 of treated seawater will be released for each section (total of approximately 3 m3 for the entire flowline). Pressure cap removal When the xmas tree pressure cap is removed, there will be small release of approximately 10 L preservation fluid (MEG) or hydraulic control fluid. Prior to tie in a chemical stick will be inserted into the connection containing oxygen scavenger, biocide and dye. ROV operations ROV operations may result in small releases of hydraulic fluid of approximately 1 L during hot stab operations.
Extent	Chemicals and hydraulic fluids may be discharged to the marine environment from the surface or close to the seabed. Discharges will be small in volume and dissipate quickly in the open ocean marine environment.

	Temporary localised decline in water quality in the immediate vicinity of the discharge; and toxicity to marine fauna.
Duration	Various chemical and hydraulic discharges will occur intermittently for the duration of the activity, and will last for minutes to several hours over the course of the activity.

6.8.2 Nature and scale of environmental impact

Potential Receptors: Water quality, fish (pelagic) and sharks, marine mammals, marine turtles, seabirds, protected areas (Montebello AMP) and socio-economic.

The potential environmental impacts from planned chemical and hydrocarbon discharges include:

+ temporary localised decline in water quality in the immediate vicinity of the discharge; and
+ toxicity to marine fauna.

Hydraulic fluids

Hydraulic fluids are used extensively in the petroleum industry in subsea production systems. Hydraulic fluids are either petroleum or water-based blends with additives. The main properties required of a hydraulic control fluid are low viscosity, low compressibility, corrosion protection, resistance to microbiological attack, and compatibility with seawater. The potential impacts of hydraulic fluid discharges near the seabed are a localised reduction in water quality and potential toxicity to benthic marine fauna associated with bare sediments or attracted/attached to subsea infrastructure (e.g. fish, infauna and sessile filter feeding organisms). Due to the small volumes (approximately 10 L per release) it is likely that any impacts to benthic fauna and water quality will be highly localised, if occurring at all.

Hydraulic fluids behave similarly to MDO when discharged in the marine environment (information on MDO is provided in **Section 7.6**). Hydraulic fluids are medium oils of light to moderate viscosity and have a relatively rapid spreading rate and, like MDO, will dissipate quickly, particularly in high sea states.

Treated seawater and MEG

Treated seawater will contain a biocide, likely to be Hydrosure O-3670R or similar, a common biocide used in the offshore oil and gas industry. Although biocides typically contain a substance (quaternary ammonium chloride) which is known to be very toxic to aquatic organisms, the concentration is typically very low less than 30%) within the biocide itself as a whole. MEG has low toxicity, is readily biodegradable and is rated as posing little or no risk to the environment (PLONOR) and E (non-CHARM) in the OCNS rankings. Therefore, it is likely that any impacts to benthic fauna and water quality will be highly localised, if occurring at all.

Toxicity

On discharge to the marine environment, the low volumes of these types of chemicals and residual hydrocarbons are expected to rapidly disperse in the offshore marine environment. Hence, any potential impacts would be confined to a localised area immediately surrounding the discharge.

There may be a localised and temporary (hours) reduction in water quality in the immediate vicinity of the release. Toxicity impacts to marine fauna from the release of chemicals are unlikely to eventuate because:

- the chemicals will have been risk assessed for their suitability for discharge using Operations Chemical Selection Evaluation and Approval Procedure (EA-91-II-10001);
- the low sensitivity of the receiving environment;
- relatively small volumes of discharges;
- strong ocean currents mean that the discharge will become further diluted upon discharge, so the duration of exposure of chemicals to fauna will be minimal; and
- potential discharges will be localised, intermittent and temporary within the operational areas.

Threatened or migratory fauna

As discussed in the sections above, the discharge extent for all planned discharges of chemicals and hydrocarbons is localised, and rapid dilution is predicted to occur within the offshore waters. Marine fauna within the operational area are likely to be transient. If contact does occur with any marine fauna, it will be for a short duration due to the rapid dispersion of the plume and the transient fauna movement, such that any exposure is likely not of sufficient duration to cause a toxic effect.

Given the nature of discharged chemicals and hydrocarbons, the small volumes that could be released to the marine environment and the nature of the marine environment within the vicinity of the operational area, the planned discharges are not predicted to have ecologically significant effects. Discharges of chemicals and hydrocarbons may cause avoidance behaviour in marine fauna. Given the nature of the discharges (localised, rapid dilution, intermittent), any behavioural impacts are expected to be short term and minimal.

Protected Areas

The operational area overlaps a very small portion of the Montebello AMP, with the AMP boundary located approximately 380 m from the well location at its closest point (**Figure 3-5**). No equipment is being installed within the AMP. During subsea installation and pre-commissioning activities, there may be small releases of chemicals and hydraulic fluid at the well location. As discussed above, the potential impacts form hydraulic fluid, treated seawater and MEG discharges to benthic habitats and threatened and migratory fauna are expected to be highly localised, short-term and temporary. Therefore, there will be no significant impacts to the values and sensitivities of the AMP as a result of chemical and hydraulic fluid discharges.

6.8.3 Environmental performance outcomes and control measures

EPOs relating to this event include:

- Reduce impacts to air and water quality from planned discharges and emissions from operational activities [ST-EPO-06].

The Control Measures considered for this Activity are shown in **Table 6-23**; Environmental Performance Standards and Measurement Criteria for the EPOs are described in **Table 8-2**.

Table 6-23: Control measures evaluation for planned chemical and hydraulic fluid discharges

CM Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Control Measures				
ST-IC-CM-022	Chemical selection procedure	Ensures that planned discharges to sea meet the criteria for not being harmful to the marine environment according to MARPOL Annex V; or Gold/Silver/D or E rated through OCNS; or have a completed Santos ecotoxicological risk assessment so that only environmentally acceptable products are used.	Personnel time associated with chemical selection, approval and procurement as per chemical selection procedure.	**Adopted** – benefits outweigh minor costs.
ST-IC-CM-025	Equipment pressure tested	All new subsea infrastructure will undergo factory acceptance testing (FAT) to ensure strength (minimising the offshore testing required to only a system leak test). Reduces the volume of chemicals released to the marine environment.	Minimal cost, standard practice.	**Adopted –** the environmental benefit outweighs the additional minimal cost.
ST-IC-CM-026	Chemical dosage and volume	Monitoring chemical dosage and volume reduces the potential for impacts.	Minimal cost, standard practice	**Adopted** – the environmental benefit outweighs the additional minimal cost.
ST-IC-CM-027	ROV inspections during leak testing	ROV inspection during leak test to identify leakage and trigger activity stop reduces the	Minimal cost, standard practice.	**Adopted** – the environmental benefit outweighs the

CM Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		potential for impacts.		additional minimal cost.
ST-IC-CM-028	Flowline dewatering	Flowline will only be dewatered back to the VI onshore facility, eliminating any marine discharges from dewatering the flowline.	Minimal cost, standard practice.	**Adopted** – the environmental benefit outweighs the additional minimal cost.
Additional Control Measures				
N/A	Reduce, capture or eliminate use of chemicals and hydraulic fluid	Would eliminate or reduce the chemical and hydraulic fluid discharge to the marine environment.	Chemicals are assessed to ensure the discharge is environmentally acceptable in accordance with Operations Chemical Selection Evaluation and Approval Procedure (EA-91-II-10001). Excessive use of chemicals is restricted. Eliminating the use of chemicals and hydraulic fluid would cause safety and process issues.	**Rejected** – Safety and process considerations outweigh the environmental benefit given small volumes and low toxicity of the discharges.
N/A	Do not conduct flooding and leak testing activities	Would eliminate any potential impacts from flooding and leak testing activities but increases likelihood of loss of integrity during operation and potentially greater environmental impacts	Potential loss of production due to loss of integrity, possibly leading to a larger environmental impact.	**Rejected -** Cost outweighs the benefit given the low impact expected from planned chemical and hydraulic fluid discharges.

6.8.4 Environmental impact assessment

Receptor	Consequence Level
Operational Discharges	

Receptor	Consequence Level
Threatened, migratory or local fauna Physical environment or habitat	Planned chemical and hydraulic fluid discharges have the potential to cause a localised decrease in water quality alteration to marine fauna behaviour. Sensitive receptors that may be impacted include fish at surface, marine turtles and mammals and seabirds. Any effects on water quality are expected to be highly localised and have little to no effect on seabed receptors. Given the distance from shorelines and that the activity will be for a limited duration, impacts will be limited to short-term water quality impacts and temporary avoidance behaviour in fish, marine mammals, sharks and seabirds. Impacts to water quality will be experienced in the discharge mixing zone which will be localised and will occur only as long as the discharges occur (i.e., no sustained impacts), therefore recovery will be measured in hours to days. Consequently, only short-term behavioural impacts are expected with no decrease in local population size, area of occupancy of species, loss or disruption of habitat critical. disruption to the breeding cycle and introduction of disease. Given the minor volumes and localised, short term and minor impacts predicted to water quality and marine fauna, cumulative impacts affecting marine fauna from the discharge of subsea installation fluids including MEG, hydraulic fluid and treated seawater are considered unlikely. Given the nature of the planned chemical and hydrocarbon discharges, the small volumes that could be released to the marine environment, the high levels of dilution and the nature of the marine environment in the vicinity of the operational area, impacts to the physical environment and habitat are expected to be II (Minor).
Socio-economic receptors	Negligible - planned chemical and hydrocarbon discharges are not expected to impact fishery resources (demersal fish species) and are unlikely to result in changes in distribution and abundance of fish species outside the operational area. No stakeholder concerns have been raised regarding this event.
Threatened ecological communities	Not applicable – No threatened ecological communities identified in the area over which planned chemical or hydrocarbon discharges are expected.
Protected areas	Minor - Impacts to water quality will be experienced in the discharge mixing zone which will be localised and will occur only as long as the discharges occur (i.e., no sustained impacts), therefore recovery will be measured in hours to days. Impacts to benthic habitats within the AMP are not expected. Significant impacts to the values and sensitivities of the AMP are not expected.
Overall worst-case consequence	II – Minor

6.8.5 Demonstration of as low as reasonably practicable

The use of chemicals to conduct testing on subsea infrastructure is a standard technique that is considered critical in determining the presence of leaks and infrastructure integrity. Alternatives to the use of MEG and treated seawater include freshwater. The use of freshwater in the subsea system can result in hydrate formation and introduce integrity risks, therefore it is not considered feasible. The use of treated seawater is also an industry standard and uses chemicals that have been appropriately risk assessed under the Operations Chemical Selection Evaluation and Approval Procedure (EA-91-II-10001). The controls in place to manage the volume of treated seawater and chemicals used during subsea activities manages the volumes released to the ocean to ALARP. The assessed residual consequence for this impact is minor and cannot be reduced further.

Additional control measures were considered but rejected since the associated cost / effort was grossly disproportionate to any benefit. It is considered therefore that the impact is ALARP.

6.8.6 Acceptability evaluation

Is the consequence ranked as I (Negligible) or II (Minor)	Yes – maximum consequence from planned chemical and hydrocarbon discharges is II (Minor).
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development (ESD)?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure, which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes – Management consistent with management and recovery plans and the North-west Marine Park Network Management Plan.
Are risks and impacts consistent with Santos' Environmental, Health and Safety Policy?	Yes – aligns with Santos' Environmental, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – no concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The use of chemicals and hydraulic fluids is unavoidable as they are required to safely complete the activities. However, water quality and benthic impacts will be highly localised to the immediate vicinity of the discharge. The operational areas are not located nearby to any sensitive habitat. Significant impacts to the values and sensitivities of the Montebello AMP are not expected.

The application of the chemical selection procedure is an important control for reducing the toxicity of any chemicals that may be discharged during the activities. In accordance with the procedure, CHARM-rated Gold/Silver and non-CHARM grouped E/D chemicals managed under the OCNS, or PLONOR substances listed by OSPAR, or chemicals risk assessed by Santos and deemed environmentally-acceptable, will be selected.

With control measures in place to minimise the environmental impact of chemical and hydraulic fluid discharges, the consequence was assessed as Minor (II) and ALARP. The managed discharges will not reduce the habitat values of the area potentially affected as described in relevant Recovery Plans, Approved Conservation Advice and the North-west Marine Park Network Management Plan, or be inconsistent with the strategies of these documents. No concerns have been raised regarding this event by stakeholders. Therefore, the minor impacts expected from the proposed discharges are considered to be environmentally acceptable.

6.9 Spill Response Operations

6.9.1 Description of event

Event	In the event of a hydrocarbon spill, response strategies will be implemented where possible to reduce environmental impacts to ALARP. The selection of strategies will be undertaken through the net environmental benefit analysis (NEBA) process and evaluation of response strategies outlined in this EP Addendum and the OPEP. Spill response will be under the direction of the relevant Controlling Agency, as defined in Section 3 of the OPEP, which may be Santos, another agency or both. In all instances, Santos will undertake a 'first-strike' spill response and will act as the Controlling Agency until the designated Controlling Agency assumes control. The response strategies considered to be appropriate for the worst-case oil spill scenarios identified for the activity are provided in Section 5.7 of the OPEP and comprise: + source control; + monitor and evaluate; + mechanical dispersion; + offshore containment and recovery; + shoreline protection and deflection; + shoreline clean-up; + oiled wildlife response; + scientific monitoring; and + waste management. While response strategies are intended to reduce the environmental consequences of a hydrocarbon spill, poorly planned and coordinated response activities can result in a lack of or inadequate information being available upon which poor decisions can be made, exacerbating or causing further environmental harm. An inadequate level of training and guidance during the implementation of spill response strategies can also result in environmental harm over and above that already caused by the spill. It should be noted that subsea dispersant injection is maintained as a secondary spill response strategy only to reduce VOC's at the release site for safety of personnel (refer OPEP for further detail). The greatest potential for impacts additional to those described for routine operations is from shoreline clean-up and oiled wildlife response operations where coastal and shoreline habitat damage and fauna disturbance may occur.
Extent	Extent of spill. Spill response could occur anywhere within the MEVA for the worst-case spill scenarios. Some strategies will be concentrated in the vicinity of sensitive receptors in coastal waters and along shorelines.
Duration	The spill response effort as a whole will exceed the duration of the worst-case spill, due to persistence of the oil in the environment and the requirement to remove this oil and/or monitor impacts and recovery to sensitive receptors. The OPEP provides further detail on the duration of specific response strategies.

6.9.2 Nature and scale of environmental impacts

Light emissions	
Spill response activities will involve the use of vessels, which are required, at a minimum, to display navigational lighting. Vessels may operate in close proximity to shoreline areas during spill response activities. Spill response activities will also involve onshore operations, including the use of vehicles and temporary camps, which may require lighting.	
Potential receptors:	Fauna (including threatened, migratory or local fauna) Protected areas
Lighting may cause behavioural changes to fish, mammals, birds and marine turtles that can have a heightened consequence during key lifecycle activities, such as turtle nesting and hatching. Turtles and birds, which includes threatened and migratory fauna (**Table 3-7**), have been identified as key fauna susceptible to lighting impacts. **Section 6.2** provides further detail on the nature of impacts to fish, birds and marine turtles. Spill response activities that require lighting may take place in protected areas important to turtles and birds, such as shoreline locations of the Montebello Islands, Barrow Island, the Muiron Islands, and Ningaloo area, which are seasonally important for turtles and include BIAs and critical habitats. This could result in indirect impacts on the values of the protected areas. During nesting and hatching season (primarily over summer months), lighting may cause behavioural impacts to turtles, including aborted nesting attempts and disorientation of newly hatched turtles, which may increase the hatchling mortality rate. Spill response activities may also occur on shorelines used by nesting and feeding birds, including seabirds and shorebirds. Lighting can cause disorientation in flying birds, disrupt nesting and breeding behaviours and impact on the ability of birds to forage. Disturbance to feeding migratory shorebirds may reduce their ability to replenish energy reserves and alter the timing and success of migratory flights. Lighting impacts to fauna are not considered to have the potential to impact supported industries such as tourism.	
Acoustic disturbance	
Spill response activities will involve the use of aircraft and vessels, which will generate noise both offshore and in proximity to sensitive receptors in coastal areas. Spill response activities will also involve the use of equipment on coastal areas during clean-up of shorelines (e.g., pumps and vehicles), for accessing shoreline areas (e.g., vehicles) and for supporting temporary camps (e.g., diesel generators).	
Potential receptors:	Fauna (including threatened, migratory or local fauna) Protected areas Socio-economic receptors
Underwater noise from the use of vessels may impact marine fauna, such as fish (including commercial species), marine reptiles and marine mammals, in the worst instance causing physical injury to hearing organs but more likely causing short-term behavioural changes; e.g., temporary avoidance of the area, which may impact key lifecycle processes (e.g., spawning, breeding, calving). Underwater noise can also mask communication or echolocation used by cetaceans. **Section 6.1** provides further detail on these impacts from vessels and helicopters. Cetaceans have been identified as the key concern for vessel noise within the MEVA. The humpback migration and resting BIA and the pygmy blue whale migration, foraging and distribution BIAs are all within the MEVA.	

Spill response activities using vessels have the potential to impact fauna in protected areas, which may impact on the conservation values of the protected areas. This includes the Montebello AMP and Ningaloo. Noise and vibration from terrestrial activities on shorelines has the potential to cause behavioural disturbance to coastal fauna, including protected seabirds and turtles. Shoreline activities involving the use of noise-generating equipment may take place in important nesting areas for turtles and roosting and feeding areas for shorebirds. As a consequence of impacts to fauna (including shorebirds, marine mammals, fish and sharks), noise has the potential to impact supported industries such as tourism and commercial fishing and recreational values of marine parks.
Atmospheric emissions
The use of fuels to power vessel engines, generators and mobile equipment used during spill response activities will result in emissions of greenhouse gases, such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), along with non-GHGs such as sulphur oxides (SO_X) and nitrogen oxides (NO_x). Emissions will result in a localised decrease in air quality.

Potential receptors:	Fauna (including threatened, migratory or local fauna) Physical environment or habitat (air quality) Socio-economic receptors

Atmospheric emissions from spill response equipment will be localised, and the use of mobile equipment, vessels and vehicles is not considered to create emissions on a scale where noticeable impacts would be predicted. Emissions may occur in protected areas and/or areas where tourism is important; however, the scale of the impact relative to potential oil spill impacts is not considered great.
Operational discharges and waste
Operational discharges include those routine discharges from vessels used during spill response, which may include: + deck drainage; + putrescible waste and sewage; + cooling water from operation of engines; + bilge water; + ballast water; and + brine discharge. + In addition, there are specific spill response discharges and waste creation that may occur, including: – cleaning of oily equipment, vessels and vehicles; – flushing water for the cleaning of shoreline habitats; – sewage and putrescible and municipal waste at camp areas; and – creation, storage, transport and disposal of oily waste and contaminated organics.

Potential receptors:	Fauna (including threatened, migratory or local fauna) Physical environment or habitat Protected areas Socio-economic receptors

Operational discharges from vessels may create a localised and temporary reduction in marine water quality. Effects include nutrient enrichment, toxicity, turbidity, and temperature and salinity increases, as detailed in **Section 6.6**. Vessel discharges may occur in shallower coastal waters during spill response activities than that described in **Section 6.6**. Discharge could potentially occur adjacent to marine

habitats, such as corals, seagrass and macroalgae, and in protected areas (i.e., receptors anywhere within the MEVA), which support a more diverse faunal community; however, discharges are still expected to be localised and temporary. Cleaning of oil-contaminated equipment, vehicles and vessels has the potential to spread oil from contaminated areas to areas not impacted by a spill, potentially spreading the impact area and moving oil into a more sensitive environment. Flushing of oil from shoreline habitats is a clean-up technique designed to remove oil from the receptor that has been oiled and remobilise it back into the marine environment. It results in further dispersion of the oil. The process of flushing has the potential to physically damage shoreline receptors such as mangroves and rocky shoreline communities, increase levels of erosion, and create an additional and potentially higher level of impact than if the habitat was left to bioremediate. Sewage and putrescible and municipal waste will be generated from onshore activities at temporary camps, which may include toilet and washing facilities. These wastes have the potential to attract fauna, impact habitats, flora and fauna, and reduce the aesthetic value of the environment, which may be within protected areas. Disturbance may also impact cultural values of an area. The creation, storage, transport and disposal of oily waste and contaminated organics has the potential to spread impacts of oil to areas, habitats and fauna not previously contaminated. Sewage and putrescible and municipal waste generated onshore will be stored and disposed of at approved locations.	
Physical presence and disturbance	
The movement and operation of vessels, vehicles, personnel and equipment, the undertaking of clean-up activities, and the set-up of temporary camp areas during spill response activities have the potential to disturb the physical environment and marine and coastal habitats and fauna, which may occur within protected areas. Disturbance may also impact cultural values of an area. Vessel movement and transportation could potentially introduce to nearshore areas invasive marine species attached as biofouling, while vehicle and equipment movement could spread non-indigenous flora and fauna. Oiled wildlife response activities may involve deliberate disturbance (hazing), capture, handling, cleaning, rehabilitation, transportation and release of wildlife, which could lead to additional impacts to wildlife.	
Potential receptors:	Fauna (including threatened, migratory and local fauna) Physical environment or habitat Protected areas Socio-economic receptors
The use of vessels may disturb benthic habitats in coastal waters, including corals, seagrass, macroalgae and mangroves. Impacts to habitats from vessels include damage through the deployment of anchors, chains and nearshore booms and from grounding. Vessel use in shallow coastal waters also increases the chance of contact with or physical disturbance of marine megafauna such as turtles and dugongs. Booms create a physical barrier on the surface waters that has the potential to injure or entangle passing marine fauna that are either surface breathing or feeding. Vehicles, equipment, personnel and cleaning activities during shoreline response activities have the potential to damage coastal habitats, such as dune vegetation, mangroves and habitats important to threatened and migratory fauna, including nests of turtles and birds and bird roosting and feeding areas. Shoreline clean-up may involve the physical removal of substrates that could cause impact to habitats and coastal hydrodynamics and alter erosion or accretion rates. The presence of camp areas, although relatively short term, may disrupt normal behaviour of coastal species, such as shorebirds and turtles, and could potentially interfere with nesting and feeding behaviours. Oiled wildlife response may include the hazing, capture, handling, cleaning, rehabilitation, transportation, cleaning and release of wildlife susceptible to oiling, such as birds and marine turtles.	

While oiled wildlife response is aimed at having a net benefit, poor responses can potentially create additional stress and exacerbate impacts from oiling, interfere with lifecycle processes, hamper recovery and, in the worst instance, increase levels of mortality. Impacts and risks from invasive marine species are described in **Section 7.2** and are not described further in this section. Impacts from invasive terrestrial species are similar in that the invasive species (e.g., weeds) can outcompete local species and interfere with ecosystem processes. Non-native species may be transported attached to equipment, vehicles and clothing. Such an introduction would be especially detrimental to wilderness areas or protected terrestrial reserves, which may have a relatively undisturbed flora and fauna community. The disturbance to marine and coastal natural habitat, as well as the potential for disruption to culturally sensitive areas, may occur in specially protected areas and may have flow on impacts to socio-economic values and industry (e.g., tourism, fisheries).
Disruption to other users of marine and coastal areas and townships:
Spill response activities may involve the use of vessels, equipment and vehicles and the establishment of temporary camps in areas used by the general public or industry. The mobilisation of spill response personnel into an affected area may also place increased demands on local accommodation and other businesses.
Potential receptors: — Socio-economic receptors
The use of vessels in the nearshore and offshore environment and the undertaking of spill response activities at shoreline locations may exclude the general public and industry use of the affected environment. As well as impacting leisure activities of the general public, this may impact on revenue with respect to industries such as tourism and commercial fishing. The mobilisation of personnel to small communities has the potential to affect the local community through demands on local accommodation and business, reducing the availability of services to members of the public.

6.9.3 Environmental performance and control measures

The control measures considered for this activity are shown in **Table 6-24**. However, EPOs, EPSs and measurement criteria for these spill response control measures are provided within the relevant strategy sections of the OPEP.

Table 6-24: Control measure evaluation for spill response operations

Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Competent Incident Management Team (IMT) and oil spill responder personnel	Ensures that spill response strategy selection and operational activities consider the potential for additional environmental impacts.	Personnel and operational costs associated with maintaining competent IMT team and responder personnel.	**Adopted –** Considered a standard spill response control.

Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Use of competent vessel crew and personnel	Reduces potential for environmental impacts from vessel usage.	Personnel and operational costs associated with maintaining contracts with competent vessel crew and personnel.	**Adopted –** Considered a standard spill response control.
Spill response activities selected on basis of a NEBA	Provides a systematic and repeatable process for evaluating strategies with net least environmental impact.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard spill response control.
Noise and atmospheric emissions			
Vessels and aircraft compliant with Santos' Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003)	Reduces potential for behavioural disturbance to cetaceans.	No cost/issue associated with this control measure.	**Adopted –** Ensures compliance with Part 8 of the EPBC Regulations 2000, which is considered a standard spill response control (regulatory requirement).
International Air Pollution Prevention Certificate	Reduces level of air quality impacts.	Personnel and operational costs associated with maintaining Air Pollution Certificate.	**Adopted –** Considered a standard spill response control (regulatory requirement).
Operational discharges and waste			
Vessels meet applicable sewage disposal requirements	Reduces potential for water quality impacts.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard spill response control (regulatory requirement).
Vessel meet applicable requirements for oily water (bilge) discharges	Reduces potential for water quality impacts.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard spill response control (regulatory requirement).

Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Ballast Water Management Plan	Improve quality of water discharged to marine environment to ALARP. Reduce risk of introduced marine species.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard spill response control (regulatory requirement).
Compliance with controlled waste, unauthorised discharge and landfill regulations	Ensures correct handling and disposal of oily wastes.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard spill response control (regulatory requirement).
Physical presence and disturbance			
Vessels and aircraft compliant with Santos' Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003)	Reduces potential for behavioural disturbance to cetaceans.	No cost/issue associated with this control measure.	**Adopted –** Ensures compliance with Part 8 of the EPBC Regulations 2000, which is considered a standard spill response control (regulatory requirement).
Use of shallow draft vessels for shoreline and nearshore operations	Reduce seabed and shoreline disturbance.	Operational costs associated with operating shallow draft vessels for shoreline and nearshore operations.	**Adopted –** Considered a standard control.
Oil Spill Response Team Leader assesses and selects vehicles appropriate to shoreline conditions	Reduce coastal habitat and fauna disturbance.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control.
Conduct shoreline, nearshore habitat, bathymetry assessment	Reduce shoreline habitat disturbance.	Operational costs associated with conducting shoreline nearshore habitat assessment.	**Adopted –** Considered a standard control.

Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Establish demarcation zones for vehicle and personnel movement considering sensitive vegetation, bird nesting and roosting areas and turtle nesting habitat	Reduce coastal habitat and fauna disturbance.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control.
Operational restriction of vehicle and personnel movement to limit erosion and compaction	Reduce coastal habitat erosion and compaction.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control.
Prioritise use of existing roads and tracks	Reduce coastal habitat and fauna disturbance.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control.
Select temporary base camps in consultation with DoT and DBCA	Reduce coastal habitat and fauna disturbance.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control to be adopted by the relevant Control Agency.
Soil profile assessment prior to earthworks	Reduce habitat disruption and erosion.	Operational costs associated with soil profile assessment.	**Adopted –** Considered a standard control.
Pre-cleaning and inspection of equipment (quarantine)	Prevent introduction of invasive species.	Operational costs associated with response plan.	**Adopted –** Considered a standard control.
Use of Heritage Advisor if spill response activities overlap with potential areas of cultural significance	Reduce disturbance to culturally significant sites.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control to be adopted by the relevant Control Agency.
Adhere to WA Oiled Wildlife Response Plan and Pilbara Regional Oiled Wildlife Response Plan	Oiled wildlife hazing, capture, handling and rehabilitation meet minimum standards as outlined within the WA Oiled Wildlife Response Plan.	Operational costs associated with response plan.	**Adopted –** Considered a standard control to be adopted by the relevant Control Agency.

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Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Chemical dispersant application			
Chemical Dispersant Plan	Additional impacts from dispersant application are reduced to ALARP.	No cost/issue associated with this control measure.	**Adopted –** A standard control adopted by industry.
Disruption to other users of marine and coastal areas and townships			
Stakeholder consultation	Promotes awareness and reduces potential impacts from response to socio-economic activities.	Minimal cost in relation to overall effort/costs in managing incident.	**Adopted –** Considered a standard control for incident management.
Utility resource assessment and support to be conducted if activity is of significant size in comparison to the size of the coastal community	Reduces potential impact due to higher utility demands causing disruptions to local community.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control.
Accommodation assessment	Reduces strain on accommodation.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control.
Transport Management Plan	Reduces potential for traffic disruptions.	No cost/issue associated with this control measure.	**Adopted –** Considered a standard control for large scale deployment in highly populated areas.

6.9.4 Environmental impact assessment

Receptor	Consequence Level
Spill Response Operations – Light Emissions	
Threatened, migratory or local fauna Physical environment or habitat Threatened ecological communities Protected areas Socio-economic receptors	The receptors considered most sensitive to lighting from vessel and shoreline operations are seabirds, shorebirds and marine turtles, particularly over summer months with respect to marine turtles where emerging hatchlings are sensitive to light spill onto beaches. Following restrictions on night-time operations by spill response vessels, which will demobilise to mooring areas offshore with safety lighting only, impacts from vessels are considered to be Negligible (I). Temporary camps will be positioned at the direction of DoT or DBCA and control measures on lighting colour and direction will be followed, therefore, the consequence of shoreline lighting is considered Negligible (I). These species are likely to be values of the protected area they occur in (e.g., Montebello Islands, Barrow island, Ningaloo, etc), and the impact to the protected area from light is also considered Negligible (I). As a consequence of impacts to fauna, lighting has the potential to impact supported industries, such as tourism; however, as impacts to fauna are considered negligible, any indirect impacts on tourism will also be Negligible (I).
Overall worst-case consequence level	I – Negligible
Spill Response Operations – Acoustic Disturbance	
Threatened, migratory or local fauna Physical environment or habitat Threatened ecological communities Protected areas Socio-economic receptors	The receptors considered most sensitive to vessel noise disturbance is the humpback whale during migration season, when these whales come close to the Montebello Islands and Barrow Island during their peak migration (July to October), as well as populations of marine turtles, whale sharks and pygmy blue whales. However, following the adoption of control measures to limit close interaction with protected fauna (i.e., Protected Marine Fauna Interaction and Sighting Procedure (EA-91-II-00003)), a temporary behavioural disturbance is expected only with a consequence of Negligible (I). With respect to noise from onshore operations (mobile equipment and vehicles), nesting, roosting or feeding birds are considered to be the most sensitive to noise, in particular shorebirds that may be aggregating at Montebello Islands, Barrow Island, the Muiron Islands, Lowendal Islands, and the Ningaloo coast. The equipment used is not considered to have excessive sound levels and, following direction by DoT and DBCA on the location of temporary camp areas, the consequence to birds from noise is expected to be Negligible (I). Shorebirds may be official values of the protected area they occur in, and the impact to the protected area from noise is also considered Negligible (I).
Overall worst-case consequence level	I – Negligible
Spill Response Operations – Atmospheric Emissions	
Threatened, migratory or local fauna	Atmospheric emissions from spill response equipment will be localised, and impacts to even the most sensitive fauna, such as birds, are expected to be Negligible (I). Because of the emissions will be localised and low level, impacts to

Receptor	Consequence Level
Physical environment or habitat	protected area values, physical environment and socio-economic receptors are predicted to be Negligible (I).
Threatened ecological communities	
Protected areas	
Socio-economic receptors	
Overall worst-case consequence level	I – Negligible
Spill Response Operations – Operational Discharges and Waste	
Threatened, migratory or local fauna	Operational discharges from vessels may create a localised and temporary reduction in marine water quality, which has the potential to impact shallow coastal habitats in particular. However, following the adoption of regulatory requirements for vessel discharges, which prevent discharges close to shorelines, discharges will have a negligible impact to habitats, fauna or protected area values. Furthermore, washing of vessels and equipment will take place only in defined offshore hot zones preventing impacts to shallow coastal habitats. As a consequence of impacts to fauna, operational discharges from vessels has the potential to impact supported industries, such as tourism and commercial fishing; however, as impacts to fauna are considered Negligible (I), any indirect impacts on socio-economic receptors will also be Negligible (I). Onshore, the use of flushing water has the potential to damage sensitive shoreline and intertidal habitats, e.g., mangroves. However, low-pressure flushing only will be used, preventing further damage to habitats or erosion of sediments. For sensitive habitats, the deployment of booms will be considered to retain flushed hydrocarbons, if this presents a net benefit. Following these control measures, the use of flushing to clean shorelines and intertidal habitats is seen to have a Negligible (I) additional impact to habitats, fauna or protected area values. The cleaning of contaminated vehicles and equipment onshore has the potential to spread oily waste and damage habitats if not contained. Decontamination units will be in used during the spill response, thus containing waste and preventing any secondary contamination. The consequence of cleaning discharges is therefore ranked as Negligible (I) in terms of impacts to habitats, fauna or protected area values. Sewage, putrescible waste and municipal waste generated onshore will be stored and disposed of at approved locations. The storage, transport and disposal of hydrocarbon-contaminated waste arising from spill response operation actions, such as containment and recovery and shoreline clean up, will be managed by Santos' appointed waste management contractor, and dedicated waste containment areas will prevent the spreading or leaching of hydrocarbon contamination. The consequence of sewerage discharges is therefore ranked as Negligible (I) in terms of impacts to habitats, fauna or protected area values.
Physical environment or habitat	
Threatened ecological communities	
Protected areas	
Socio-economic receptors	

Receptor	Consequence Level
Overall worst-case consequence level	I – Negligible
Spill Response Operations – Physical Presence and Disturbance	
Threatened, migratory or local fauna Physical environment or habitat Threatened ecological communities Protected areas Socio-economic receptors	The use of vessels and nearshore booms has the potential to disturb benthic habitats, including sensitive habitats in coastal waters, such as corals, seagrass, macroalgae and mangroves. A review of shoreline and shallow water habitats and of bathymetry and the establishment of demarcated areas for access and anchoring will reduce the level of impact to Negligible (I). The use and movement of vehicles, equipment and personnel during shoreline response activities has the potential to disturb coastal habitats, such as dune vegetation, samphire and mangroves, and important habitats of threatened and migratory fauna, including nests of turtles and birds and bird roosting areas. Furthermore, clean-up can involve physical removal of substrates that could impact habitats and fauna and alter coastal hydrodynamics. As with vessel use, an assessment of appropriate vehicles and equipment to reduce habitat damage, along with the establishment of access routes, demarcation zones, and operational restrictions on equipment and vehicle use, will limit sensitive habitat damage and damage to important fauna areas. The establishment of temporary camp areas will be done under direction of DoT and DBCA with suitable advice sought if access is needed to culturally significant areas. Following these and other control measures, the resultant consequence to the physical environment and habitat is assessed as Minor (II), indicating that there may be a detectable reduction in habitat area from response activities (as separate from spill impacts), but recovery will be relatively rapid once spill response activities cease. As with all spill response activities, this disturbance will only occur if there is a net benefit to accessing and cleaning shoreline areas. The main direct disturbance to fauna would be the hazing, capture, handling, transportation, cleaning and release of wildlife susceptible to oiling impacts, such as birds and marine turtles. This would only be done if this intervention were to deliver a net benefit to the species, but it may result in a Minor (II) consequence following compliance with the WA Oiled Wildlife Response Plan and the Pilbara Region Oiled Wildlife Response Plan. These habitats or environments are likely to be values of the protected area they occur in, and the impact to the protected areas from physical disturbance is therefore also considered Minor (II). The disturbance to marine and coastal natural habitat, as well as the potential for disruption to culturally sensitive areas, which may occur in specially protected areas, may have flow-on impacts to socio-economic values and industry (e.g., tourism, fisheries). This impact is considered Minor (II).
Overall worst-case consequence level	II – Minor
Spill Response Operations – Disruption to Other Users of Marine and Coastal Areas and Townships	

Receptor	Consequence Level
Socio-economic receptors	The use of vessels in the nearshore and offshore environment and spill response activities at shoreline locations and within townships may exclude general public and industry use. Note that this is distinct from the socio-economic impact of a spill itself, which would have a far greater detrimental impact to industry and recreation. Following the application of control measures, it is considered that the additional impact of spill response activities on affected industries would be Minor (II).
Overall worst-case consequence level	II – Minor

6.9.5 Demonstration of as low as reasonably practicable

A NEBA is the primary tool used during spill response to evaluate response strategies and has the goal of selecting strategies that result in the least net impact to key environmental sensitivities. The NEBA process will identify and compare net environmental benefits of alternative spill response options. The NEBA will effectively determine whether an environmental benefit will be achieved through implementing a response strategy or by undertaking no response. The NEBA will be undertaken by the relevant Controlling Agency for the activity. For those activities under the control of Santos, the IMT Environmental Team Leader will be responsible for reviewing the priority receptors and selected response strategies identified in this EP Addendum and coordinating the NEBA for each operational period. This will demonstrate that, at the strategy level, the response operations reduce additional environmental impacts to ALARP.

Spill response activities will be conducted in offshore and coastal waters using vessels and aircraft. The greatest potential for additional impacts from implementing spill response is considered to be on wildlife in offshore waters from oiled wildlife response activities and to shoreline habitats and fauna receptors within shallow waters or on shorelines from nearshore booming and shoreline clean-up activities.

Given the types of activities considered appropriate for responding to a worse-case spill and the scale of operations, standard control measures adopted by Santos for spill response to reduce the level of additional impacts are considered to reduce these impacts to ALARP. This includes working with the relevant Controlling Agency for spill response and applying the appropriate processes and standards, e.g., for oiled wildlife response as included within the WA Oiled Wildlife Response Plan and Pilbara Regional Oiled Wildlife Response Plan.

Santos considers the actions prescribed in the Recovery Plan for Marine Turtles in Australia 2017 to 2027 (Commonwealth of Australia, 2017a) and approved conservation advices for other threatened fauna (**Table 3-9**) relevant to spill responses for the activities to minimise noise and light impacts on cetaceans, sharks, marine turtles, seabirds and shorebirds. The proposed event will not result in significant impacts on these species, and implementation of identified control measures is in line with the relevant conservation advices and recovery plans. Pollution events (such as hydrocarbon spills) could impact on fauna (as described in **Section 7**), and the use of vessels and equipment during the spill response could result in potential impacts as described in this EP. Control measures in place for vessel and helicopter use as provided in **Sections 6.1** and **6.2** will reduce potential impacts to marine fauna, and these are consistent with current conservation advice. The assessed residual consequence for this impact is minor and cannot be reduced further without disproportionate costs. It is considered therefore that the impact of the activities conducted are acceptable and ALARP.

6.9.6 Acceptability evaluation

The implementation of spill response activities to reduce the potential impacts from a spill are required by legislation. The spill response options selected have been demonstrated to show a net environmental benefit, are standard industry practice and are consistent with relevant standards and guidelines, including the National Plan for Maritime Environmental Emergencies (AMSA, 2019). No concerns from stakeholders have been raised regarding response activities, and the controls proposed reduce the consequences of the potential impacts to Minor (II) and ALARP. The controls used during spill response activities are therefore considered to reduce additional impacts to an acceptable level.

Is the consequence ranked as I or II?	Yes – maximum consequence is II (Minor) from planned events.
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes – IUCN principles and strategic objectives of nearby reserves (Montebello AMP and the North-west MPNMP) are met. Consistent with relevant species recovery plans, conservation management plans and management actions set out in Table 3-9, including but not limited to: Conservation values of the identified protection priorities (**Section 3**) Relevant species recovery plans, conservation management plans and management actions, including but not limited to: + Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017a) + Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015d) + Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015a) + Conservation Management Plan for the Blue Whale, 2015 to 2025 (DoE, 2015b) + Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (TSSC, 2015c) + Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015b) + Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013a) + Approved Conservation Advice for *Pristis clavata* (Dwarf Sawfish) (DEWHA, 2009) + Approved Conservation Advice for *Pristis pristis* (large-tooth sawfish) (DoE, 2014a) + Commonwealth Conservation Advice on *Pristis zijsron* (green sawfish) (DEWHA, 2008a) + Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015a) + Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) (DoE, 2014b) + Approved Conservation Advice for *Glyphis garricki* (northern river shark) (DoE, 2014c) + Approved Conservation Advice for *Milyeringa veritas* (blind gudgeon) (DEWHA, 2008b)

	+ Approved Conservation Advice for *Nannatherina balstoni* (Balston's Pygmy Perch) (DEWHA, 2008c)
	+ Approved Conservation Advice for *Ophisternon candidum* (blind cave eel) (DEWHA, 2008d) + Conservation Management Plan for the Southern Right Whale 2011 to 2021 (DSEWPaC, 2012) + Recovery Plan for the Australian Sea Lion (*Neophoca cinerea*) (DSEWPaC, 2013b) + Approved Conservation Advice for *Aipysurus apraefrontalis* (Short-nosed Sea Snake) (DSEWPaC, 2011a) + National recovery plan for the Christmas Island Goshawk *Accipiter fasciatus natalis* (Hill and Dunn, 2004) + National recovery plan for the red goshawk (*Erythrotriorchis radiatus*) (DERM, 2012) + National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011 to 2016 (DSEWPaC, 2011b) + Approved Conservation Advice for *Calidris ferruginea* (Curlew Sandpiper) (DoE, 2015c) + Approved Conservation Advice for *Numenius madagascariensis* (Eastern Curlew) (DoE, 2015d) + Approved Conservation Advice *Pachyptila turtur* Subantarctica fairy prion (southern) (TSSC, 2015e) + Approved Conservation Advice for *Sternula nereis nereis* (Fairy Tern) (DSEWPaC, 2011c) + Approved Conservation Advice *Calidris canutus* (Red Knot) (TSSC, 2016a) + Approved Conservation Advice *Calidris tenuirostriss* (Great knot) (TSSC, 2016b) + Approved Conservation Advice *Charadrius leschenaultii* (Greater sand plover) (TSSC, 2016c) + Approved Conservation Advice *Charadrius mongolus* (Lesser sand plover) (TSSC, 2016d) + Approved Conservation Advice *Fregata andrewsi* (Christmas Island Frigatebird (TSSC, 2016e) + National recovery plan for the Christmas Island Frigatebird (*Fregata andrewsi*) (Hill and Dunn, 2004) + Approved Conservation Advice *Halobaena caerulea* (Blue petrel) (TSSC, 2015f) + Approved Conservation Advice for *Anous tenuirostris melanops* (Australian lesser noddy) (TSSC, 2015g) + Approved Conservation Advice for *Limosa lapponica baueri* (Bar-tailed godwit (western Alaskan)) (TSSC, 2016f) + Approved Conservation Advice *Limosa lapponica menzbieri* (Bar-tailed godwit (northern Siberian)) (TSSC, 2016g)

	+ Approved Conservation Advice for *Papasula abbotti* (Abbott's booby) (TSSC, 2015h) + Approved Conservation Advice for *Pterodroma mollis* (Soft-plumaged petrel) (TSSC, 2015i) + Approved Conservation Advice for *Rostratula australis* (Australian painted snipe) (DSEWPaC, 2013c) + Approved Conservation Advice for *Botaurus poiciloptilus* (Australasian bittern) (TSSC, 2019). Management is also consistent with the zoning of the Australian marine parks, in that risks have been reduced to ALARP, e.g., implementation of spill response activities will limit impacts, thereby conserving the marine park values. Management consistent with EPBC Act Regulations (Part 8), Marine Orders (91, 96 and 97) and Australian Ballast Water Requirements.
Are risks and impacts consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – During any spill response, a close working relationship with relevant regulatory bodies (e.g., DoT, DBCA, AMSA) will occur thus, there will be ongoing consultation with relevant stakeholders on the acceptability of response operations. Wildlife response will be conducted in accordance with the WA Oiled Wildlife Response Plan (DPAW, 2014a) and Pilbara Regional Oiled Wildlife Response Plan (DPAW, 2014b). DBCA reiterated comments provided to Santos for previously consulted activities on the need for comprehensive baseline monitoring of ecologically sensitive receptors and oil spill response preparedness, given the proximity of planned activities to the Montebello Islands Conservation Park and Marine Park, Lowendal Islands Nature Reserve, and Barrow Island Nature Reserve, Marine Park and Marine Management Area. Santos responded to DBCA acknowledging advising that EP will consider any impacts on these sensitive receptors and the Oil Pollution Emergency Plan will address baseline monitoring and oil spill preparedness (**Table 4-2**). Santos considers the request closed.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

Santos

7 Environmental Assessment for Unplanned Events

OPGGS(E)R 2009 Requirements
Regulation 13. Environmental assessment.
Evaluation of environmental impacts and risks 13(5) The environment plan must include: (a) details of the environmental impacts and risks for the activity; and (b) an evaluation of all the impacts and risks, appropriate to the nature and scale of each impact or risk; and (c) details of the control measures that will be used to reduce the impacts and risks of the activity to as low as reasonably practicable and an acceptable level. 13(6) To avoid doubt, the evaluation mentioned in paragraph (5)(b) must evaluate all the environmental impacts and risks arising directly or indirectly from: (a) all operations of the activity; and (b) potential emergency conditions, whether resulting from accident or any other reason. Environmental performance outcomes and standards 13(7) The environment plan must: (a) set environmental performance standards for the control measures identified under paragraph (5)(c); and (b) set out the environmental performance outcomes against which the performance of the titleholder in protecting the environment is to be measured; and (c) include measurement criteria that the titleholder will use to determine whether each environmental performance outcome and environmental performance standard is being met.

An ENVID workshop for unplanned events was held in July 2021, with a further workshop for loss of well control and hotspot consequence assessment held in August 2021 once modelling was received. A source control workshop was also held to assess the options for source control in the event of a LOWC, this is discussed further in Section 8 and Appendix B of the OPEP. These workshops identified seven potential sources of environmental risks associated with unplanned events for this activity. The results of the environmental assessment are summarised in **Table 7-1**. A comprehensive risk and impact assessment for each of the unplanned events and subsequent control measures proposed by Santos to reduce the risk and impacts to ALARP are detailed in the following subsections.

The following unplanned events were considered to not be a credible scenario and is not discussed further in this section:

+ Hydrocarbon release from an impact to existing operating subsea infrastructure during installation activities; and
+ hydrocarbon spill due to vessel grounding.

A hydrocarbon release from an impact to existing infrastructure during installation activities has been deemed not a credible scenario as dropped installation equipment (e.g. flexible flowline segments) onto existing infrastructure (e.g. JB pipeline) would lack the force to result in a leak or rupture.

Vessel grounding can occur due to a loss of propulsion or to navigational error resulting in the vessel running aground in shallow areas. Vessel grounding and subsequent fuel tank rupture were not considered a credible scenario for this activity because the operational areas are situated in deep water and there are no charted reefs or islands that could pose a grounding hazard in the operational areas.

Table 7-1: Summary of the risk assessment ranking for unplanned activities

EP Section Reference	Event	Consequence	Likelihood	Residual Risk Level
7.1	Release of solid objects	II (Minor)	B (Unlikely)	Very Low
7.2	Introduction of invasive marine species	III (Moderate)	A (Remote)	Very Low
7.3	Marine fauna interaction	II (Minor)	B (Unlikely)	Very Low
7.4	Non hydrocarbon and chemical liquid releases	II (Minor)	B (Unlikely)	Very Low
7.6	Hydrocarbon release (surface and subsurface) from LOWC	IV (Major)	B (Unlikely)	Low
7.7	Hydrocarbon release (marine diesel oil)	III (Moderate)	B (Unlikely)	Low
7.8	Minor hydrocarbon releases (surface and subsurface)	II (Minor)	B (Unlikely)	Very Low

7.1 Release of solid objects

Event	Solid objects, such as those listed below, can be accidentally released to the marine environment, and potentially impact on sensitive receptors: + non-hazardous solid wastes, such as paper and packaging + hazardous solid wastes, such as batteries, fluorescent tubes and aerosol cans + equipment and materials, such as hard hats, tools or infrastructure parts + ROV and installation activities. Release of these objects may occur as a result of overfull and/or uncovered bins, incorrectly disposed items or spills during transfers of waste, or dropped objects/lost equipment. In addition, accidental discharge of non-hydrocarbon solid materials has the potential to occur during product transfers or storage of dry bulk product (e.g., cement) and solid additives (e.g., barite and bentonite). Accidental dropped objects to the seabed could occur during vessel and ROV activities such as operations including lifting of objects and equipment needed to complete installation activities. Equipment and other items lost at sea could be caused by crane failure, adverse weather, human error, rigging failure and vessel motions and potentially lead to loss of or changes to benthic habitats.
Extent	The event will only occur within the operational areas, and all non-buoyant material or dropped objects are expected to remain within the operational areas. Buoyant objects could potentially move beyond the operational areas.
Duration	An unplanned release of solids may occur during operational activities and impacts may occur until the solid degrades.

7.1.1 Nature and scale of environmental impacts

Potential receptors: Physical environment (benthic habitats), threatened or migratory fauna (marine mammals, marine reptiles, sharks and rays, fish and birds), protected areas (Montebello AMP) and socio-economic receptors (tourism and recreation).

Physical environment

Objects accidentally dropped to the seabed could occur during the activity, such as the transfer and lifting of objects and equipment. Equipment and other items lost at sea could be caused by crane failure, adverse weather, human error, rigging failure and vessel motions and potentially could lead to loss of or changes to benthic habitats. The area of potential disturbance from a non-buoyant dropped object would be restricted to the operational area in which it was dropped.

The seabed within the operational areas are primarily soft sediments with sparse epifauna, this habitat type is widely distributed and well represented in the Northwest Province. While soft sediment benthic habits will not be destroyed, disturbance of the communities on and within them (i.e., the epifauna) will occur in the event of a dropped object and depressions may remain on the seabed for some time after removal of the dropped object as they gradually infill over time.

Impacts to benthic communities from dropped object disturbance are expected to be short term in duration due to the ability for such communities to recover. Recovery is expected within 6 to 12 months, based on previous surveys from drilling impacts (URS, 2010).

Buoyant dropped objects have the potential to be transported by marine currents and may impact on reefs, islands, shoals and banks within the region. Accidentally dropped objects, such as plastics, have the potential to smother benthic environments, and the release of hazardous solids (e.g., wastes such as batteries) could also impact water quality through pollution of the immediate receiving environment. Impacts from accidentally released liquids are discussed in **Section 7.4**.

Threatened, migratory or local fauna

Solids such as plastics have the potential to harm marine fauna through entanglement or ingestion. A number of BIAs for turtles (internesting buffer), whales (migration and distribution), whale sharks (foraging) and migrating marine birds (breeding) overlap the operational areas and therefore, these receptors may be present.

Marine turtles and seabirds are particularly at risk from entanglement. Turtles are known to be indiscriminate feeders and may mistake plastic for jellyfish (Mrosovsky et al., 2009). The Recovery Plan for Marine Turtles in Australia 2017 to 2027 (Commonwealth of Australia, 2017a) identifies ingestion of marine debris as a threat to all species of marine turtles. Seabirds at the sea surface foraging on plankton may eat floating plastic. Once ingested, plastics can damage internal tissues and inhibit physiological processes, which can both potentially result in fatality (Derraik, 2002). Marine debris has been highlighted as a threat to marine turtles, humpback whales and whale sharks in the relevant Recovery Plans and Approved Conservation Advice (**Table 3-9**). These recovery plan and approved conservation advices, as well as the Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans (DoEE, 2018), have specified a number of recovery actions to help combat this threat. Of relevance to this activity is the legislation for the prevention of garbage disposal from vessels.

Release of hazardous solid objects (e.g., wastes such as batteries) may result in the pollution of the immediate receiving environment, leading to very localised detrimental health impacts to marine flora and fauna. Physiological damage through ingestion or absorption may occur to individual fish, cetaceans, marine reptiles or seabirds.

The Recovery Plans and Approved Conservation Advice have specified a number of recovery actions to help combat this threat. Of relevance to this activity is the legislation for the prevention of garbage disposal from vessels, which Santos implements through adherence to MARPOL.

While soft sediment benthic habits will not be destroyed, disturbance of the communities on and within them (the epifauna and infauna) will occur in the event of a dropped object, and depressions may remain on the seabed for some time after removal of the dropped object as they gradually infill over time. The seafloor of this bioregion is strongly affected by cyclonic storms, long-period swells and large internal tides, which can resuspend sediments within the water column and move sediment across the seafloor. In this context, any potential sediment movement caused by the event is likely to have minimal impacts.

The area of potential disturbance due to a non-buoyant dropped object would be restricted to the operational area in which it was dropped. The seabed within the operational areas vary, but is generally made up of silts, sands and some low relief hard substrates and limited benthic faunal communities.

Protected areas

As discussed elsewhere, the drilling operational area overlaps a portion of the Montebello AMP, with the boundary of the AMP located approximately 390 m from the well location. The operational area that relates only to Spartan installation and pre-commissioning activities does not overlap the AMP. Consequently, and as discussed above, the physical values and sensitivities of the AMP are not expected to be impacted by non-buoyant dropped objects as these are expected to impact the seabed in very close proximity to their dropped location (e.g. the well location). Floating materials such as plastic could potentially enter the AMP if released, and may have impacts as described above for threatened and migratory fauna including those associated with the values and sensitivities of the AMP. However, such impacts are not expected to be significant if they were to occur.

Socio-economic receptors

Tourism activities, such as snorkelling, diving, surfing and recreational fishing are not expected to occur in the operational areas, given the water depth, lack of seafloor features and distance from shore. Although dropped solid objects have potential to float to nearby areas used for tourism or recreational purposes solid non-hydrocarbon releases are not expected to occur frequently or to a scale that may cause significant pollution that would impact the socio-economic values of these areas. Impacts to socioeconomic receptors could occur should debris interfere with other marine users or their equipment (for example, commercial fishing activities).

7.1.2 Environmental performance outcomes and control measures

The EPOs relating to this event include:

+ No unplanned objects, emissions or discharges to sea or air [ST-EPO-04].

The control measures for this event are shown in **Table 7-2**, and the EPSs and measurement criteria for the EPOs are described in **Table 8-2**.

Table 7-2: Control measure evaluation for the unplanned release of solid objects

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
ST-DC-CM-002 ST-IC-CM-029	Dropped object prevention procedures	Impacts to environment are reduced by preventing dropped objects and by retrieving dropped objects unless the environmental consequences are negligible or there are risks to safety. Minimises drop risk during MODU and ISV lifting operations. Ensures lifting equipment certified and inspected.	Personnel costs involved in implementing procedures and in incident reporting.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh cost to Santos.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
ST-DC-CM-004 ST-IC-CM-019	Waste (Garbage) Management Procedure	Reduces probability of garbage being discharged to sea, reducing potential impacts to marine fauna. Stipulates putrescible waste disposal conditions and limitations. Marine Order 95 (Marine pollution prevention – garbage).	Personnel cost of pre-mobilisation audits and inspections and in reporting discharge levels.	**Adopted –** Benefits of ensuring MODU/vessels are compliant outweighs the minimal costs of personnel time and it is a legislated requirement.
ST-DC-CM-005	Hazardous chemical management procedures	Reduces the risk of spills and leaks (discharges) to sea by controlling the storage, handling and clean-up.	Personnel cost associated with implementation of procedures and permanent or temporary storage areas.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh costs.
ST-DC-CM-008	General chemical management procedures	Aids in the process of chemical management that reduces the risk of accidental discharge to sea by controlling the storage, handling and clean-up of chemicals.	Personnel cost associated with implementation of procedures.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh costs.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
ST-DC-CM-009	Maritime Dangerous Goods Code	Dangerous goods managed in accordance with International Maritime Dangerous Goods Code (IMDG Code) to reduce the risk of an environmental incident, such as an accidental release to sea or unintended chemical reaction.	Cost associated with implementation of code/ procedure.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh costs.
ST-DC-CM-011	Bulk solid transfer procedure	Reduces potential impacts to the marine environment during bulk transfer through correct equipment maintenance and integrity to prevent accidental loss of solids.	Cost associated with implementation of procedure.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh costs.

Additional Controls				
N/A	Eliminate lifting in field	Reduces the risk release of non-hydrocarbon solid to the marine environment due to dropped object.	Eliminating lifting would require MODU/vessels storing more equipment and supplies on-board, and/or additional trips to shore. MODU/vessels will not have enough deck space to store all required equipment, materials, supplies needed for the duration of the activity.	**Rejected** – Not feasible to eliminate lifting in the field.

7.1.2.1 Environmental impact assessment

Description	
Receptors	Physical environment (benthic habitats) Threatened, migratory or local fauna (marine mammals, marine reptiles, sharks and rays, fish and birds) Socio-economic receptors (tourism and recreation)
Consequence	II – Minor
Physical environment Non-buoyant dropped objects are expected to impact the seabed and be limited to the size of the dropped object and given the size of standard materials transferred, any impact is expected to be very small and limited to within the operational area in which it was dropped. Any area of the seabed impacted through dropped objects would be expected to recover. Buoyant dropped objects have the potential to wash up on island beaches. It is considered that the application of management measures will effectively prevent this impact occurring on a significant scale. Therefore, impacts will result in a Minor (II) reduction in habitat area or function. *Threatened or migratory fauna (marine mammals, marine reptiles, sharks and rays, fish and birds)* In the event of a dropped object, the quantities would be limited. The release could cause localised impacts to water quality and the benthic environment if the solid can degrade, leading to localised impacts on flora and fauna. Ingestion of solid wastes by marine fauna could occur in small quantities. Only small volumes of non-hydrocarbon solids would be generated during the activity, as a result, any accidental loss to the environment would be small in size. Any impacts would be restricted to a small number of individuals, if any. Relevant recovery plans and conservation advice have identified marine debris as a potential threat. There is a Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans (DoEE, 2018). As such there is the potential for impacts only to a small proportion of a local population with no consequences for conservation status or reproductive success of cetaceans, marine turtles or fish species that may occur in the area.	

Description	
The limited quantities associated with this unplanned event indicate that even in a worst-case release of solid waste, the number of fauna fatalities would be limited to individuals and is not expected to result in a decrease of the local population size. Therefore, the consequence is Minor (II). *Protected areas* As discussed above, In the event of a dropped object, the impacts would be limited. The release could cause localised impacts to water quality and the benthic environment if the solid can degrade, leading to localised impacts on flora and fauna. Ingestion of solid wastes by marine fauna could occur in small quantities. Non-buoyant objects are expected to impact the seabed in close proximity to their release location, outside of the AMP. Buoyant objects such as plastic may drift into the AMP, however, quantities are expected to be minor the potential for impacts only to a small proportion of a local population with no consequences for conservation status or reproductive success for migratory or threatened fauna that use the AMP including cetaceans, marine turtles and seabeirds. Therefore, significant impacts to the values and sensitivities of the AMP are not expected. The consequence is considered Minor (II). *Socio-economic receptors (tourism and recreation)* Impacts to tourism and recreation have the potential to occur through buoyant objects floating into areas used for these activities, adversely impacting tourism and recreation values and creating poor aesthetics. Given the limited quantities associated with this unplanned event, even a worst-case release of solid waste is unlikely to have flow-on effects significant enough to impact the tourism and recreation industries. Therefore, the consequence is Negligible (I).	
Likelihood	B – Unlikely
Control measures proposed ensure that the risk of dropped objects, lost equipment or release of non-hydrocarbon solid waste to the environment has been minimised. Given the controls in place, the likelihood of releasing non-hydrocarbon solids to the environment resulting in a minor consequence is considered Unlikely (B).	
Residual Risk	The residual risk associated with this event is **Very Low**.

7.1.3 Demonstration of as low as reasonably practicable

Solid waste will be generated during the activity and lifting operations and MODU/vessel operations are required as part of the activity. Equipment loss and dropped objects, which might occur during MODU/vessel transfers in the field will be managed through lifting and transfer procedures and equipment management. The control measures proposed reduce the risk of non-hydrocarbon solid releases to a residual risk level that is Very Low and cannot be reduced further. There are no reasonably practicable additional control measures identified that would reduce the chance of a loss of non-hydrocarbon solid release.

Therefore, it is considered that the impact of the activities conducted is ALARP.

7.1.4 Acceptability evaluation

Is the risk ranked between Very Low to Medium?	Yes – residual risk is ranked Very Low.
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure, which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes – management consistent with Marine Order 95. Controls implemented will minimise the potential impacts from the activity to species identified in recovery plans and approved conservation advices as having the potential to be impacted by solid objects. Specific actions that contribute to the long-term prevention of marine debris (Objective 1 of the Threat Abatement Plan for the Impacts of Marine Debris on the Vertebrate Wildlife of Australia's Coasts and Oceans (DoEE, 2018)) have been adopted, including compliance with applicable legislation in relation to the improvement of waste management practices. Consistent with relevant species recovery plans, conservation management plans and management actions set out in **Table 3-9**. Consistent with the Threat Abatement Plan for Impacts of Marine Debris on Vertebrate wildlife of Australia's coasts and oceans (DoEE, 2018). Consistent with the North-west Marine Park Network Management Plan (Director of National Parks, 2018).
Are risks and impacts consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – no concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The handling and use of non-hydrocarbon solid materials is standard industry practice and the potential impacts well understood. This aspect will be managed consistent with relevant legislation, regulations and guidelines and the residual risks are low and ALARP.

The control measures proposed are consistent with applicable actions described in the relevant Recovery Plans, Approved Conservation Advice and the North-west Marine Park Network Management Plan. No stakeholder concerns have been raised regarding this event.

With the control measures in place to prevent accidental releases and the negligible impacts predicted from these types of solids, the low risk of a non-hydrocarbon solid release to the environment is considered environmentally acceptable.

7.2 Introduction of invasive marine species

7.2.1 Description of event

Aspect	Introduction of invasive marine species may occur due to: + biofouling on MODU or support vessels and external/internal (e.g., sea chests, seawater systems) niches; + biofouling on equipment that is routinely submerged in water (e.g.ROVs); + discharge of high-risk ballast water; and + cross contamination between vessels. Once established, invasive marine species (IMS) have the potential to out-compete indigenous species and affect overall native ecosystem function.
Extent	Localised (seabed within the operational area) to widespread if successfully translocated to new areas via ocean currents or project equipment transit.
Duration	Temporary to long-term (in the event of successful translocation and establishment).

7.2.2 Nature and scale of environmental impacts

Potential receptors: Physical environment (benthic habitats), threatened/migratory fauna (marine mammals, marine reptiles, sharks, fish and rays), protected areas (Montebello AMP) and socio-economic receptors (fisheries, tourism and recreation).

IMS are marine plants, animals and algae that have been introduced into a region that is beyond their natural range but that have the ability to survive and possibly thrive (DAWE, 2019). The majority of climatically compatible IMS to the Northwest Province are found in southeast Asian countries. Some IMS pose a significant risk to environmental values, biodiversity, ecosystem health, human health, fisheries, aquaculture, shipping, ports and tourism (DAWE, 2019; Wells et al., 2009). IMS can cause a variety of adverse effects in a receiving environment, including:

+ over predation of native flora and fauna;
+ displacement of native marine species;
+ outcompeting of native flora and fauna for food;
+ depletion of viable fishing areas and aquaculture stock; and
+ reduction of coastal aesthetics.

The above impacts can result in flow-on detrimental effects to fisheries, tourism and recreation.

IMS of concern are those that are not native to the region, are likely to survive and establish in the region, and are able to spread by human mediated or natural means. Species of concern vary from one region to another depending on various environmental factors, such as water temperature, salinity, nutrient levels and habitat type. These factors dictate their survival and invasive capabilities.

It is recognised that artificial, disturbed and/or polluted habitats in tropical regions are susceptible to invasive marine species introductions, which is why ports are often areas of higher IMS risk (Neil et al., 2005). However, in Australia there are limited records of detrimental impact from IMS compared to other tropical regions (such as the Caribbean). Following their establishment, eradication of IMS populations is difficult, limiting management options to ongoing control or impact minimisation. Case studies in Australia indicate that, from detection to eradication, this can take approximately four weeks (Bax et al., 2003). However, this depends on the environmental conditions and species. For this reason, increased management requirements have been implemented in recent years by Commonwealth and State regulatory agencies. Ballast water is responsible for 20 to 30% of all marine pest incursions into Australian waters. However, research indicates that biofouling (the accumulation of aquatic micro-organisms, algae, plants and animals on vessel hulls and submerged surfaces) has been responsible for more foreign marine introductions than ballast water (DAFF, 2011). The potential biofouling risk presented by vessels will relate to:

+ the length of time that these vessels have already been operating in Australian waters or, if they have been operating outside Australian waters;
+ the locations of the operations they have been undertaking;
+ the length of time spent at these locations; and
+ whether the vessels have undergone hull inspections, cleaning and application of new anti-foulant coating prior to returning to operate in Australia.

The risk of introducing IMS is limited by the operational area occurring in relatively deep, offshore waters that are not directly adjacent to any shoals or banks, including where the drilling operational area overlaps with a very small portion of the Montebello AMP. IMS are generally unable to establish in deep-water ecosystems (Geiling, 2014), most likely due to a lack of light or suitable habitat to sustain their growth and survival. Most IMS are found in tidal and subtidal zones, with only a few species known to extend into deeper waters of the continental shelf (Bax et al., 2003). Further, it is known that highly disturbed environments (such as marinas and jetties) 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).

7.2.3 Environmental performance outcomes and control measures

The EPO relating to this event is:

+ No introduction of marine pest species [ST-EPO-02].

The control measures for this event are shown in **Table 7-3**, and the EPSs and measurement criteria for this EPO are described in **Table 8-2**.

Table 7-3: Control measure evaluation for the introduction of invasive marine species

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
ST-DC-CM-024 ST-IC-CM-031	Implementation of the management controls in the Santos Invasive Marine Species Management Plan (IMSMP)	The risk of introducing IMS is reduced due to assessment procedure and management of ballast water.	Personnel costs involved in risk assessing vessels in accordance with the Invasive Marine Species Management Plan. Costs associating with reducing the vessel risk to 'low' (for example, dry docking, hull cleaning or	**Adopted** – Minimal personnel costs and potential delays or costs to project are considered outweighed by the benefits of reducing the risk of IMS.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
			additional costs due to inspections). Could lead to potential delays and therefore costs in vessel contracting process due to unavailability of vessels.	
ST-DC-CM-029 ST-IC-CM-032	Anti-foulant system	The risk of introducing IMS is reduced due to anti-foulant systems.	Could lead to potential delays and therefore costs, in vessel contracting process due to availability of vessels with appropriate anti-foulant systems.	**Adopted** – minimal potential delays or costs to project are considered outweighed by the benefits of reducing the risk of IMS.
Additional Controls				
N/A	Heat or chemical treatment of ballast water to eliminate IMS	Would reduce potential for IMS to establish by eliminating individuals present in ballast water.	High cost compared to existing risk; introduction of chemicals or water at much higher temperature than surrounding marine environment would likely be toxic or result in death of native marine species.	**Rejected** – Based on increased risk to marine environment and high cost considered disproportionate compared to base case risk (after application of standard controls (see above)).

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
N/A	Contract MODU/vessels only operating in local, State or Commonwealth Waters to reduce potential for IMS	Reduce potential for IMS to be transported into area since vessels would not have originated elsewhere.	MODU/vessels and equipment suitable for the activity may not be available in State/Commonwealth Waters. Potential significant costs and delay in activity schedule by only contracting MODU/vessels working in State/National waters.	**Rejected** – Not feasible.
N/A	Mandatory dry docking of vessels prior to entering field to clean vessel and/or equipment and remove biofouling	Ensure that no IMS are present on vessel or associated equipment.	Significant cost (grossly disproportionate to the risk) would lead to scheduling delays.	**Rejected** – Costs disproportionately high compared to environmental benefit given other controls in place already reduce the risk.
N/A	Utilise an alternative ballast system to avoid uptake and discharge of water in vessels	Eliminate need for ballast water exchange, therefore decreasing risk of introducing IMS through ballast water.	MODU/vessels suitable for the activity may not have options for alternative ballast, therefore would require modification at significant cost.	**Rejected** – Cost disproportionately high compared to environment benefit.
N/A	Zero discharge of ballast water	Would reduce the potential for IMS by implementation of no ballast water exchange policy on MODU and vessels.	Ballast water exchange required on the MODU and vessels for stability.	**Rejected** – On the basis that ballast water exchange is a safety-critical activity for marine operations.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
	Mandatory independent IMS survey of installation vessels	Eliminate invasive marine species	Cost is high compared to existing risk.	**Reject -** High additional cost is disproportionate compared to the environmental benefit.

7.2.4 Environmental impact assessment

Consequence Level	
Receptors	Physical environment (benthic habitats) Threatened, migratory and local fauna (marine mammals, marine reptiles, sharks, fish and rays) Protected areas (Montebello AMP) Socio-economic receptors (fisheries, tourism and recreation)
Consequence	III – Moderate
Ballast water is responsible for 20 to 30% of all marine pest incursions into Australian waters. However, research indicates biofouling (the accumulation of aquatic micro-organisms, algae, plants and animals on vessel hulls and submerged surfaces) has been responsible for more foreign marine introductions than ballast water (DAFF, 2011). IMS, if successfully established, can outcompete native species for food or space, prey on native species or change the nature of the environment and can subsequently impact on fisheries or aquaculture. If an IMS is introduced, the species has been known to colonise areas outside of the areas to which it is introduced. In the event that an invasive marine species is introduced into the operational area, including where the drilling operational area overlaps a portion of the Montebello AMP, given the lack of diversity and extensiveness of similar benthic habitat in the region, there would only be a minor reduction in the physical environment. No threatened ecological communities are present in the area that could be affected. The overall consequence level was assessed as Moderate, this also takes into consideration the distance of the activity to protected areas and the requirements of the North-west MPNMP which applies adjacent to the operational areas which requires that vessel ballast water exchange within the Montebello AMP (Multiple Use Zone) is completed in accordance with the Australian Ballast Water Management Requirements.	
Likelihood	A – Remote
The pathways for IMS introduction are well known, consequently, standard preventive measures are proposed. The ability for invasive marine species to colonise a habitat is dependent on a number of environmental conditions. It has been found that highly disturbed environments (such as marinas) are more susceptible to colonisation than open water environments where the number of dilutions and the degree of dispersal are high (Paulay *et al*., 2002). Given the depth of the operational areas (48 to 60 m) creating an unfavourable habitat for colonisation (i.e., light limiting and low habitat biodiversity with sparse epibiota) and distance from shallow coastal habitats, there is a very low likelihood that IMS would be able to survive translocation and subsequently establish and colonise. Given the dispersive open-ocean environment of the operational area, the successful translocation to surrounding shallower habitats of an IMS introduced to the operational areas is unlikely. With controls in place to reduce the risk of IMS introduction, the likelihood is considered Remote (A).	

Consequence Level	
Residual Risk	The residual risk associated with this event is **Very Low**.

7.2.5 Demonstration of as low as reasonably practicable

There are no alternatives to the use of a MODU, ISV and support vessels in order to undertake the activity. The risks from IMS are well understood and, with the proposed control measures, the activity will comply with relevant regulations and guidelines. The proposed management controls are considered appropriate to manage the risk of introduction of IMS to ALARP.

Ballast water exchange will be managed through Ballast Water Management actions consistent with the Australian Ballast Water Management Requirements, and a vessel biosecurity risk assessment in accordance with the Invasive Marine Species Management Plan (EA-00-RI-10172) will be undertaken to demonstrate that the MODU/vessels are low risk so that IMS are not introduced.

Santos has adopted a risk-based approach to managing biofouling given it is not practicable or reasonable to inspect and/or clean every vessel before each voyage. Such an approach is consistent with other petroleum operators on the North West Shelf and is beyond that enforced on the majority of commercial and recreation vessels that regularly transit the same bioregion. International vessels are given the highest priority to prevent the introduction of IMS into Australian waters. However, domestic vessels (interstate and locally sourced) are also risk-assessed to reduce the likelihood of spreading marine pest species already established in Australian waters. The biofouling risk assessment approach adopted by Santos will ensure the *Aquatic Resources Management Act 2016* and associated regulations prohibiting the introduction of non-endemic fish species will be met.

With adherence to the proposed management controls, the risk to the environment from IMS has been reduced to ALARP.

7.2.6 Acceptability evaluation

Is the risk ranked between Very Low to Medium?	Yes – introduction of IMS residual risk ranking is Very Low.
Is further information required in the consequence assessment?	No – potential impacts and risks well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure, which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes – management consistent with *Biosecurity Act 2015*, National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (Marine Pest Sectoral Committee, 2018), the *Aquatic Resources Management Act 2016* and the North-west Marine Park Network Management Plan.
Are risks and impacts consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – Santos will follow advice of DAWE to ensure vessels and MODU present low level biosecurity risk.

Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

The mobilisation of MODU/vessels and equipment to undertake offshore petroleum activities is industry standard practice, and the IMS risks are well understood and subject to regulation. The vessels and equipment that are internationally mobilised will meet Australian biosecurity requirements, and proposed management is consistent with National Biofouling Management Guidance for the petroleum Production and Exploration Industry (Marine Pest Sectoral Committee, 2018). Ballast water discharge and exchange compliant with Australian ballast water requirements is an allowable activity within the Montebello AMP (Multiple Use Zone, IUCN Category VI).

Application of the proposed control measures and adherence to legislation and regulations reduce the likelihood of introducing IMS into the operational area, and the dispersive offshore location in the operational areas reduces the probability of successful establishment in the unlikely event of introduction.

No stakeholder concerns have been raised regarding this aspect, and the proposed controls will reduce the residual level of risk to Medium and ALARP. Therefore, the residual risk associated with IMS is considered by Santos to be environmentally acceptable.

7.3 Marine Fauna Interaction

7.3.1 Description of event

Event	There is the potential for MODU and vessels or equipment from the vessels involved in operational activities to interact with marine fauna, including potential strike or collision, potentially resulting in severe injury or mortality. Fauna strike may also occur from helicopters during take-off and landing.
Extent	Within the operational areas, in the immediate vicinity of the MODU and vessels, or helicopters, while moving.
Duration	For the duration of the activity.

7.3.2 Nature and scale of environmental impacts

Potential receptors: Threatened or migratory fauna (marine mammals, marine turtles, sharks and rays, fish and birds).

Movement of the MODU and vessels in the operational area introduces the potential for interaction with marine fauna present at the same location during the activity. Marine fauna in surface waters that could be most at risk from vessel collision include marine mammals, marine turtles and whale sharks. As summarised in **Table 3-8**, the operational areas overlap several BIAs, including internesting BIAs for marine turtles, humpback whale (migration), whale shark (foraging) and pygmy blue whale (distribution).

Vessel strike and vessel disturbance are identified as potential threats to a number of marine fauna species in relevant recovery plans and conservation advices (**Table 3-9**). Incidents with marine fauna are recorded and reported by Santos as described in **Section 8.9**.

Marine mammals and sharks/rays

The Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015d) indicates that humpback whales are one of the most frequently reported whale species involved in vessel strikes worldwide (Laist et al., 2001; Jensen & Silber, 2003). This observation is supported by Australian studies referenced in The National Strategy for Reducing Vessel Strike on Cetaceans and Other Marine Megafauna (DoEE, 2017b). The increase in vessel numbers (Silber & Bettridge, 2012) is not only a threat to humpback whales in relation to vessel strikes but also in relation to disturbance and displacement from key habitats. Similarly, vessel strike is also recognised by the Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015a) as one of the threats to the recovery of whale sharks.

The most commonly sighted whale in continental shelf waters of the region is the humpback whale. As described in **Appendix C**, the humpback whale migrates between calving grounds in the Kimberley region of Western Australia to feeding grounds in Antarctica, with the northbound migration from early June to early August (BHPB, 2005) and the peak of the northbound migration between Exmouth Gulf and the Dampier Archipelago occurring around July, concentrated inshore of the 200-m depth contour (Jenner et al., 2001). The southern migration peaks around early September, with pods travelling in shallower waters, typically at 30 m to 100 m and passing west of Barrow Island and north of the Montebello Islands. Higher numbers may be encountered in the operational areas during the humpback whale southern migration, given the water depths of the operational areas.

Pygmy blue, sei, Bryde's, orca and/or fin whales may also transit through the operational area, although it is outside the blue whale migration corridor in the region (DoEE, 2016). Given the water depths in the operational area it is unlikely there will be significant numbers of these species encountered during the activity.

The worst potential impact from vessel collision would be mortality or serious injury of an individual. Collisions between vessels and cetaceans are most frequent on continental shelf areas where high vessel traffic and cetacean habitat occur simultaneously (WDCS, 2006). Instances of cetacean deaths as a result of vessel collisions in Australian waters have been recorded (e.g., a Bryde's whale in Bass Strait in 1992) (WDCS, 2006), although the data indicates this is likely to be associated with container ships and fast ferries. The Whale and Dolphin Conservation Society also indicates that some cetacean species, such as humpback whales, can detect and change course to avoid a vessel (WDCS, 2006). The reaction of whales to the approach of a ship is quite variable. Some species remain motionless when in the vicinity of a ship while others are known to be 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).

Whale sharks are at risk from vessel strikes when feeding at the surface or in shallow waters (where options to dive are limited). The operational area overlaps the whale shark foraging BIA (**Figure 3-9**), therefore individuals may be encountered during operational activities. However, the whale shark presence within the operational areas is not expected to comprise significant numbers given that no main aggregation area exists within the operational area, therefore, their presence would be transitory and of a short duration. No constraints within the operational area (e.g., shallow water or shorelines) would prevent whale sharks from moving away from vessels. Vessel speed has been demonstrated to be a key factor in relation to collision with marine fauna, particularly cetaceans, with faster-moving vessels posing a greater collision risk than slower vessels (Laist et.al., 2001; Jensen & Silber, 2003; Hazel, 2009). Laist et al. (2001) suggest the most severe and lethal injuries to cetaceans are caused by vessels travelling at 14 knots or faster.

Marine turtles

Turtle/vessel interactions arising from increased vessel traffic is recognised as one of a number of key threats to marine turtles in the Recovery Plan for Marine Turtles (DoEE, 2017a). It is likely that marine turtles may be transient within the operational areas due to the presence of internesting buffer BIAs.

Marine turtle mortality due to vessel strike has been identified as an issue in Queensland waters in the Recovery Plan for Marine Turtles in Australia (DoEE, 2017a). However, turtles appear to be more vulnerable to vessel strike in areas of high urban population where incidents of pleasure crafts are higher. WA turtle populations have not been highlighted as those most affected by vessel strike, possibly due to the relatively low human population density of the North West Shelf coastline.

Turtles will typically avoid vessels by rapidly diving however, their ability to respond varies greatly depending on the speed of the vessel. Hazel (2009) reported that the number of turtles that fled vessels decreased significantly as vessel speed increased. Turtles are also adapted to detect sound in water (Popper et al., 2014) and will generally move from anthropogenic noise-generating sources, including vessels, within their detection range.

Birds

A number of protected species of marine birds have potential habitats or migratory routes in and around the operational areas (**Section 3.2.4**). Furthermore, the breeding and foraging BIA for the wedge-tailed shearwater overlaps the operational area.

The number of helicopter flights required to support activities is relatively low and flights occur in the daylight, thereby reducing potential interactions with birds. The risk of helicopter strike is not high because helicopter noise is expected to elicit a behavioural response in birds to avoid collision and because of the relatively low speeds at which helicopters would be flying during take-off or landing.

7.3.3 Environmental performance outcomes and control measures

The EPO relating to this event is:

+ No injury or mortality to EPBC Act 1999 and WA Biodiversity Conservation Act 2016 listed marine fauna during activities [ST-EPO-05].

The control measures for this event are shown in **Table 7-4**, and the EPSs and measurement criteria for this EPO are described in **Table 8-2**.

Table 7-4: Control measure evaluation for marine fauna interaction

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
ST-DC-CM-001 ST-IC-CM-001	Procedure for interacting with marine fauna	Reduces risk of physical and behavioural impacts to marine fauna from vessels and helicopters. If marine fauna are sighted, then vessels can slow down or move away, and helicopters can increase distances from sighted fauna if required.	Operational costs to adhere to marine fauna interaction restrictions, such as vessel and helicopter speed and direction, are based on legislated requirements and must be accepted.	**Adopted** – Benefits in reducing impacts to marine fauna outweigh the costs incurred by Santos. Control measure ensures compliance with Part 8 of the EPBC Regulations.
ST-DC-CM-015	MODU support vessel	Constant bridge watch on vessels. Monitoring of surrounding marine environment to identify potential collision risks (and reducing harm) to cetaceans and	High cost associated with contracting vessel. No additional cost for constant bridge watch as it is industry practice and regulated by AMSA.	**Adopted** – Industry practice, benefits outweigh cost.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		other marine fauna.		
ST-IC-CM-017	Constant bridge watch on ISV	Constant bridge watch on vessels. Monitoring of surrounding marine environment to identify potential collision risks (and reducing harm) to cetaceans and other marine fauna.	No additional cost for constant bridge watch as it is industry practice and regulated by AMSA.	**Adopted –** Industry practice, benefits outweigh cost.
Additional Controls				
N/A	Restrict the timing of activities to operate outside of sensitive periods only	Reduce risk of collisions (causing harm) during environmentally sensitive periods for listed marine fauna.	High cost in moving or delaying schedule while the risk to all listed marine fauna cannot be reduced due to variability in timing of migration periods and unpredictable presence of some species.	**Rejected** – Grossly disproportionate to low incremental environmental benefit given existing low level of risk.
N/A	Dedicated MMO on vessels (EPBC Policy Statement 2.1 Part B)	Improved ability to spot and identify marine fauna at risk of collision (that may cause harm).	Additional cost of contracting MMO.	**Rejected** – Cost disproportionate to increase in environmental benefit and would severely limit operations, which are required to occur 24 hours a day, 7 days a week.
N/A	Activities will only occur during daylight hours	Reduced potential for a vessel-fauna collision occurring as	Lengthens duration of the activity as operations only continue for	**Rejected** – Substantial additional cost due to doubling of activity

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		activities only undertaken during daylight hours when visibility highest.	approximately ten hours per day. Increased cost due to increased activity time (more than double the cost). Lengthened schedule results in increased impacts and risks (e.g., planned emissions and discharges, interference with other marine users).	duration. No overall environmental benefit as results in increased impacts and risks.
N/A	Adopt further measures to those outlined in 'EPBC Regulations 2000 — Part 8 Division 8.1 during peak periods of ecological sensitivity, for example, additional management considerations for vessels outlined in the Australian National Guidelines for Whale and Dolphin Watching (DoEE, 2017c)	Potentially provide an additional level of protection of marine fauna.	Administrative costs to update existing procedure. Operational costs through interruption to activities through implementation of controls developed for an industry trying to get close to marine fauna, when Santos activities aim to avoid fauna.	**Rejected** – The existing control '*procedure for interacting with marine fauna*' has been written in accordance with the EPBC Act and other relevant guidelines. A review of this procedure against the Australian National Guidelines for Whale and Dolphin watching (DoEE, 2017c) found that there are no additional relevant controls in the Australian National Guidelines for Whale and Dolphin watching and therefore

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
				adopting this control is not ALARP.

7.3.4 Environmental impact assessment

Description	
Receptors	Threatened or migratory fauna (marine mammals, marine turtles, sharks and rays, fish and birds)
Consequence	II – Minor
In the event of a collision with marine fauna, there is the potential for injury or death to an individual. The number of receptors present in the operational area during the activity is expected to be limited to a small number of transient individuals. Given the presence of the marine turtle BIAs, there may be more of these species in the vicinity, but given the distance from the nearest nesting areas (24 km), significant numbers are not expected. Boat strike and vessel disturbance are identified as potential threats to a number of marine fauna species in relevant Recovery Plan and Conservation Advice (**Table 3-9**). The above information demonstrates that with control measures in place the activity will be conducted in a manner that reduces potential impacts to ALARP and of acceptable level. There is the potential for death or injury of EPBC Act listed individual species. However, as they would represent a small proportion of the local population it is not expected that it would result in a decreased population size over what would usually occur due to natural variation, at a local or regional scale, it is expected that the loss of an individual would be a minor consequence.	
Likelihood	B – Unlikely
Given the presence of a number of BIAs for turtles, marine mammals and birds, receptors are expected to be present in the operational area at various times of the year. The operational area overlaps the humpback whale northern and southern migration pathway, and as such migrating individuals may traverse this operational areas. No known aggregation areas (breeding, resting or calving) occur within the operational area and therefore concentrations of milling individuals are unlikely. Vessels will be moving very slowly whilst inside the operational areas, posing a low risk of collision with marine fauna. In addition, the noise generated from vessel operations will deter marine fauna from coming in close proximity to vessels. With controls in place ensuring the vessels are compliant with EPBC Regulations, the likelihood of a collision with marine fauna resulting in a very low/negligible consequence is considered to be Unlikely (B).	
Residual Risk	The residual risk associated with this event is Very **Low**.

7.3.5 Demonstration of as low as reasonably practicable

There are no alternatives to the use of the MODU, ISV and support vessels to undertake the activity. The inherent likelihood of encountering fauna in the operational area is limited by the separation from areas of high surface fauna density. With relatively low vessel speeds and compliance with fauna interaction procedures, including Regulation 8 of the EPBC Regulations 2000, a fauna collision is considered very unlikely.

In the event that vessels come in close proximity to EPBC Act listed marine fauna, such as whales and whale sharks, EPS have been implemented for limiting vessel operations, as well as for ensuring that the crew are aware through inductions of the risk posed by conducting the activity, in order to reduce the likelihood of a marine fauna collision to ALARP. Inductions for the crew of support vessels will include information about how to interact with cetaceans and whale sharks in accordance with the EPBC Regulations.

With the control measures adopted, the assessed residual risk for this impact is Low and cannot be reduced further. Additional control measures were considered but rejected since the associated cost or effort was grossly disproportionate to any benefit, as detailed in **Section 7.3.3**. Therefore, it is considered that the impact of the activities conducted is ALARP.

7.3.6 Acceptability evaluation

Is the risk ranked between Very Low to Medium?	Yes – marine fauna interaction residual risk ranking is Low.
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure, which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes – Management consistent with Part 8 of the EPBC Regulations. Controls implemented will minimise the potential impacts to species identified in recovery plans and conservation advice (**Table 3-9**). Relevant species Recovery Plans, Conservation Management Plans and management actions, including but not limited to: + Threat Abatement Plan for Impacts of Marine Debris on Vertebrate wildlife of Australia's coasts and oceans (DoEE, 2018) + Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia, 2017a) + Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015d) + Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015a) + Conservation Management Plan for the Blue Whale, 2015 to 2025 (DoE, 2015b) + Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (TSSC, 2015c) + Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015b)
Are risks and impacts consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.

Are risks and impacts consistent with stakeholder expectations?	Yes – no concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

Movement of the MODU, ISV and support vessels are unavoidable to undertake the activity. The possibility of vessel strike is a well understood risk for maritime operations, including for commercial shipping and fishing.

Vessel movements will comply with all relevant maritime standards and regulations, including EPBC regulations to minimise risks to marine fauna. Application of the proposed management controls and adherence to Commonwealth regulations reduces the likelihood of vessel interactions with marine fauna. While the potential exists for a collision to occur, it is considered an unlikely scenario. As part of Santos' reporting requirements for the activity, in the unlikely event that an impact did occur in the operational area, it will be reported in the National Ship Strike Database (refer to **Table 8-4**).

With application of the proposed control measures, the potential impacts and risks to threatened fauna will be managed consistent with relevant Recovery Plans and Approved Conservation Advice. No stakeholder concerns have been raised regarding this event. Therefore, the impact is considered to be ALARP and environmentally acceptable.

7.4 Non-hydrocarbon and chemical liquid releases

7.4.1 Description of event

Event	Non-hydrocarbon liquids including miscellaneous chemicals and waste streams (brine, mixed cement, cleaning and cooling agents, stored or spent chemicals and leftover paint materials) are used or stored on-board the MODU/vessels during the activity. The presence of non-hydrocarbons liquids and chemicals represents a potential spill risk during chemical storage and handling e.g., due to tank damage, or human error. Another credible spill is due to a hose that parts when loading/offloading brine. Rupture of the pumping hose used to transfer these chemicals may occur due to dropped object, vessel motion, or hose failure. An accidental release of chemicals and other non-hydrocarbon liquids into the marine environment has the potential to occur from: + MODU, ISV and support vessel operations; + transferring, storing or using bulk products (e.g., mixed cement); + mechanical failure of equipment; + handling and storage spills and leaks; + hose or hose connection failure or leak; and + lifting – dropped objects damaging liquid vessels (containers). Accidental loss of non-hydrocarbon liquids or chemicals to the marine environment could occur via tank pipework failure or rupture, inadequate bunding and/or storage, insufficient fastening or inadequate handling may result in impacts to water quality and hence sensitive environmental receptors.
Extent	The maximum volume of non-hydrocarbon liquids or chemicals that could be released during routine operations is likely to be small and realistically limited to the volume of individual containers (e.g., drums) stored on deck of vessels or the MODU. The worst-case credible scenario, however, would be the accidental dumping of a MODU mud pit (approximately 100 m^3 in any one pit for a nominal jack-up rig). Dilution from discharges in open waters is rapid, with 1 in 1,000 dilution usually occurring within 30 minutes (Costello and Read, 1994). In the event that the spill is not contained on deck, a release to the marine environment would be likely to rapidly disperse and evaporate within the operational areas. The environment that may be affected for non-hydrocarbon liquids or chemical release resulting in a decrease in water quality is likely to be restricted to around the MODU and vessels but predominantly contained within the operational area in which it was released.
Duration	The duration of the impact is limited to the time the released chemical/liquid takes to disperse to below toxic/harmful threshold concentrations. In the ocean, this is expected to be in the order of hours.

7.4.2 Nature and scale of environmental impacts

Potential receptors: Physical environment (water and sediment quality, benthic habitats), threatened, migratory or local fauna (marine mammals, marine reptiles, sharks and rays, fish and birds), protected areas (Montebello AMP) and socio-economic receptors (tourism and recreation).

Physical environment

Non-hydrocarbon liquids or chemicals released to the marine environment may lead to contamination of the water column in the vicinity of the MODU and vessels. The potential impacts would most likely be highly localised and restricted to the immediate area surrounding the spill, with rapid dispersal to concentrations below impact thresholds likely to occur in the open ocean.

Due to the small volumes and expected rapid dispersal to concentrations below impact thresholds, impacts to water quality are not expected to cause flow-on effects to sediment quality or benthic habitats, including reefs, and offshore islands. There is no emergent or intertidal habitat that could be impacted by a surface spill. Owing to the water depth, any spilled material is unlikely to reach land or affect any of benthic habitats.

Threatened or migratory species

Changes to water quality could potentially lead to short-term impacts on marine fauna (e.g., pelagic fish and sharks, marine mammals, marine reptiles and seabirds). As summarised in **Table 3-9**, the operational areas overlap several BIAs, including internesting BIAs for marine turtles, humpback whale (migration), whale shark (foraging), pygmy blue whale (distribution) and wedge-tailed shearwater (breeding).

Recovery plans and conservation advices for numerous bird species identify marine pollution and contamination impacts as a threat to the species. In addition, the Recovery Plan for Marine Turtles in Australia 2017 to 2027 (Commonwealth of Australia, 2017a) identifies deteriorating water quality as a threat to all species of marine turtles in Australia. These species have been identified as potentially being within the operational area from time to time.

Chemical spills are unlikely to have widespread ecological effects on threatened or migratory fauna, given the nature of the chemicals on board, the small volumes that could be released and the open-ocean environment of the location. Physical coating of marine fauna, in particular those present at the sea surface (e.g., seabirds), by entrained or surface hazardous liquids and sublethal or lethal effects from toxic chemicals are considered unlikely given the expected low concentrations and short exposure times.

Protected areas

Although the operational area overlaps a very small portion of the Montebello AMP, significant impacts to the sensitivities and values of the AMP are not expected. As described above, impacts to water quality would most likely be highly localised and restricted to the immediate area surrounding the spill, with rapid dispersal to concentrations below impact thresholds likely to occur in the open ocean. Impacts to sediment quality and benthic habitats are not expected. Widespread ecological affects on threatened and migratory marine fauna are not expected.

Socio-economic receptors

Given the localised and temporary impacts of an unplanned hazardous liquid spill, any impact to commercial fishing, tourism and recreation activities is considered unlikely.

7.4.3 Environmental performance outcomes and control measures

The EPOs relating to this event include:

+ No unplanned objects, emissions or discharges to sea or air [ST-EPO-04].

The control measures for this event are shown in **Table 7-5**, and the EPSs and measurement criteria for the EPOs are described in **Table 8-2**.

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Table 7-5: Control measure evaluation for hazardous liquid releases

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
ST-DC-CM-001 ST-IC-CM-029	Dropped object prevention procedure	Minimises dropped object risk during MODU/vessel lifting operations that may cause secondary spill resulting in reduction in water quality. Ensures lifting equipment certified and inspected.	Cost to maintain lifting equipment and implement procedure.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweighs costs.
ST-DC-CM-005 ST-IC-CM-033	Hazardous chemical management procedures	Reduces the risk of spills and leaks (discharges) to the sea by controlling the storage, handling and clean-up of hazardous chemicals.	Cost associated with permanent or temporary storage areas.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh the costs of personnel time.
ST-DC-CM-006 ST-IC-CM-020	Deck cleaning and product selection	Improves water quality discharge (reduced toxicity) to the marine environment. Those deck cleaning products planned to be released to sea meet the criteria for not being harmful to the marine environment according to	Personnel costs of implementing, potential additional cost and delays of chemical substitution.	**Adopted** – Benefits of ensuring MODU/ vessels are compliant and those deck cleaning products planned to be released to sea meet MARPOL criteria.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		MARPOL Annex V.		
ST-DC-CM-007 ST-IC-CM-022	Chemical selection procedure	Improves water quality discharge (reduced toxicity) to the marine environment in the event of an unplanned release.	Cost associated with implementation of procedure. Range of chemicals reduced but potentially higher costs. Potential additional cost and delays of chemical substitution.	**Adopted –** Benefits of ensuring procedures are followed and measures implemented outweigh the costs of personnel time.
ST-DC-CM-008 ST-IC-CM-021	General chemical management procedures	Potential impacts to the environment are reduced through following correct procedures for the safe handling and storage of chemicals.	Personnel costs associated with ensuring procedures are in place and implemented.	**Adopted –** Benefits of ensuring procedures are followed and measures implemented outweigh the costs of personnel time.
ST-DC-CM-009	Maritime Dangerous Goods Code	Dangerous goods managed in accordance with IMDG Code to reduce the risk of an environmental incident, such as an accidental release to sea or unintended chemical reaction.	Cost associated with implementation of code/procedure.	**Adopted –** Benefits of ensuring procedures are followed and measures implemented outweighs costs.
ST-DC-CM-010	Bulk liquid transfer procedure	Bulk liquid transferred in accordance with bulk transfer procedures to	Cost to implement ongoing procedure. Cost of purchasing and maintaining	**Adopted** – Benefits of ensuring procedures are followed and measures

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		reduce the risk of an unintentional release to the sea.	equipment (e.g., bulk hoses and connections).	implemented outweighs costs.
ST-DC-CM-012 ST-IC-CM-034	MODU and vessel spill response plans including predrilling relief well plan	Effective management of an accidental spill (discharge to sea) to reduce impact to the environment.	Personnel cost associated with ongoing management (spill response exercises) and implementation of plans.	**Adopted** – Benefits of ensuring response plans in place, are followed and measures implemented and that the MODU/vessels are compliant outweighs costs.
ST-DC-CM-044	MODU Planned Maintenance System (PMS).	Reduces potential for unplanned releases of chemicals from the MODU because equipment is operating within its parameters.	Costs are standard for routine PMS.	**Adopted-** benefits outweigh the cost.
ST-DC-CM-045 ST-IC-CM-002	Vessel PMS to maintain vessel DP, engines and machinery.	Reduces potential for unplanned releases of chemicals from the vessels because equipment is operating within its parameters.	Costs are standard for routine PMS.	**Adopted-** benefits outweigh the cost.
ST-DC-CM-013	Remotely operated vehicle (ROV) inspection and maintenance procedures	Reduces potential for unplanned releases of chemicals from the ROV.	Costs are standard for routine PMS.	**Adopted-** benefits outweigh the cost.

7.4.4 Environmental impact assessment

Description	
Receptors	Physical environment (water and sediment quality, benthic habitats) Threatened, migratory or local fauna (marine mammals, marine reptiles, sharks, fish, rays and birds) Protected and significant areas and Socio-economic receptors (Montebello AMP, tourism and recreation)
Consequence	II – Minor
In the event of a non-hydrocarbon liquid or chemical spill, the quantities of a worst-case liquid release is unlikely to be greater than 1 m^3 (the size of the largest storage container). The small volumes, dilution and dispersion from natural weathering processes such as ocean currents indicate that the extent of exposure will be limited in area and duration. The susceptibility of marine fauna to non-hydrocarbon liquids and chemicals is dependent on the type and exposure duration; however, given that exposures would be limited in extent and duration, exposure to marine fauna from this hazard is not expected to result in a fauna fatality. Impacts from discharges to the marine environment to water quality would be short-term and localised, due to the nature and behaviour of the chemicals identified as being at risk of spilling, only pelagic fauna present in the immediate vicinity of the spill would likely be at risk of impact. Habitat degradation, deteriorating water quality and marine pollution are identified as potential threats to a number of marine fauna species (that may be present in the operational area) in relevant Recovery Plans and Conservation Advice (**Table 3-9**) and to matters of national environmental significance (MNES) (DoE, 2013). However, the potential non-hydrocarbon releases of liquids or chemicals are not expected to significantly impact the receiving environment, including the Montebello AMP, with control measures proposed to prevent releases. Given that a non-hydrocarbon or chemical spill would not result in a decreased population size at a local or regional scale it is expected that a spill of this nature would result in a Minor (II) consequence.	
Likelihood	B - Unlikely
A small non-hydrocarbon liquid release is unlikely to have widespread ecological effects, given the nature of the chemicals on board, the small volume that could be released, the depth and transient nature of marine fauna in this area, and the prevention and management procedures in place to clean up a spill. Santos reviewed non-hydrocarbon liquid spills and leaks from equipment and machinery in recent history (due to split hoses, small leaks, or handling errors). Most of the spills and leaks reported occurred within bunded areas, were less than 100 L, did not reach the marine environment and were cleaned up immediately. The likelihood of a small hazardous liquids release occurring is limited given the set of mitigation and management controls in place for this program. Consequently, the likelihood of releasing hazardous liquids to the environment, which results in a minor consequence, is considered to be Unlikely (B).	
Residual Risk	The residual risk associated with this event is Very **Low**.

7.4.5 Demonstration of as low as reasonably practicable

Non-hydrocarbon liquids and chemicals will be required to undertake the activity, so their removal from the operation is not viable. Dangerous chemicals used during the drilling activity will be managed where applicable, in compliance with the Maritime Dangerous Goods Code. Procedures are in place for the transfer of bulk liquids, reducing the risk of unplanned releases to sea due to equipment failure, operational error, or overflows and leaks. Objects will need to be moved around the decks of the MODU and vessels and transferred between the MODU/ISV and the support vessels. Control measures in place will ensure correct lifting, storage and handling procedures are followed as well as ensuring the maintenance of equipment is undertaken according to preventative management systems. No beneficial additional control measures were identified to further reduce the risk of this hazard.

Other management controls that have been implemented include vessel maintenance systems, chemical management procedures, spill clean-up equipment and Shipboard Marine Pollution Emergency Plan (SMPEP)/OPEPs not only to minimise the risk of an accidental release, but also to reduce the impact in the event that a release does occur.

Containment of small spills from bunding, inherent in the design of vessels and from spill containment kits onboard these vessels (detailed in the SMPEP) provides a barrier to any spills reaching the marine environment. The inspection and maintenance of bunding and drainage systems and of spill response kits provides assurance that these are available to contain spills in the event of a small leak. It is considered that barriers in place to contain spills would prevent spills from reaching the marine environment and thus it is considered that there are no further controls that would offer a further benefit to the environment.

A thorough set of controls has been proposed to ensure the risks of minor hazardous liquid spills and leaks occurring and subsequent impacts are minimised. The resulting impacts to marine fauna that could potentially result from a spill of this size would be minor, with impacts restricted to a small number of individuals within a localised area.

The controls proposed are in line with applicable actions described in relevant recovery plans and conservation advice to reduce the risk of habitat degradation and deteriorating water quality (for example, from pollution) to a level considered to be ALARP by Santos. The assessed residual risk for this impact is low and cannot be reduced further. It is considered therefore that the impact of the activities conducted is ALARP.

7.4.6 Acceptability evaluation

Is the risk ranked between Very Low to Medium?	Yes – maximum hazardous liquid release (surface) residual risk is ranked Very Low.
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure, which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes – management consistent with Marine Order 94 (Marine pollution prevention – packaged harmful substances) and with relevant recovery plans and conservation advices for species that may occur in the operational areas (**Table 3-9**). Relevant species Recovery Plans, Conservation Management Plans, North-west Marine Park Network Management Plan, and management actions.
Are risks and impacts consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.

Are risks and impacts consistent with stakeholder expectations?	Yes – no concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

With the controls in place to prevent an accidental release of small volumes of non-hydrocarbon liquids and chemicals and the minor impacts predicted from an unplanned release of such material, the risk to the marine environment is considered low. Potential risks are unlikely to be greater than those caused by other commercial marine vessels or offshore petroleum activities in deep water.

The materials will be managed in accordance with relevant legislation and standards and Santos' procedures. The small volumes negate the need for any further contingencies to be in place that are included for some of the larger spill scenarios associated with the activity.

With the controls in place to prevent accidental spills and the low impacts predicted from a spill of this size, the environmental risk of using and handling the required chemicals is considered ALARP and environmentally acceptable.

7.5 Overview of Unplanned Release of Hydrocarbons

There is the potential for loss of well control (subsea and surface) resulting in a loss of liquid condensate, in addition to loss of containment of marine diesel due to a vessel collision event or refuelling activities within the operational areas. Liquid condensate and diesel spill trajectory modelling were used to predict the potential extent of a worst-case spill event for both the MDO spills and LOWC scenarios at one location within the operational areas (RPS, 2021b).

7.5.1 Spill scenario selection

7.5.1.1 Loss of well control

Santos has identified a loss of well control as the worst-case type of credible oil release scenario that could potentially occur during the activity. A LOWC incident may discharge directly to the sea surface or at the seabed, depending on the type of failure that occurs. The following worst-case credible LOWC oil spill scenarios were assessed:

+ A LOWC at the Spartan well location with the release of 53,811 m^3 of Spartan condensate at the seabed; and
+ A LOWC at the Spartan well location with the release of 53,291 m^3 of Spartan condensate at the sea surface.

7.5.1.2 Vessel collision

It is considered credible that a release of MDO to the marine environment could occur from a collision between the activity vessels and an errant third party vessel. Such events could have sufficient impact to result in the rupture of a diesel tank leading to a loss of integrity. This is considered credible given the diesel tanks may not be protected or double-hulled and fuel tank ruptures resulting in a hydrocarbon release have occurred before within the maritime industry.

The AMSA (2015) Technical Guidelines for Preparing Contingency Plans for Marine and Coastal Facilities recommend that the spill scenario for modelling and impact assessment should be based on the largest single fuel tank volume. A review of the contracted ISV fuel oil tank layout confirmed; that the largest single fuel tank is 186 m^3 in capacity. A conservative modelled spill volume of 329 m^3 has been used for this EP.

7.5.1.3 Refuelling

A minor spill (approximately 37.5 m^3) of MDO could occur during vessel to MODU or vessel to ISV refuelling resulting in a discharge of hydrocarbons to the marine environment at the sea surface. Spills during refuelling can occur through several pathways, including fuel hose breaks, coupling failure or tank overfilling.

Spills resulting from overfilling will be contained within the vessel drains and slops tank system. In the event that the refuelling hose is ruptured, the fuel bunkering activity will cease by turning off the pump, the fuel remaining in the transfer line will escape to the environment as well as fuel released prior to the transfer operation being stopped. The AMSA (2015) Technical Guidelines for Preparing Contingency Plans for Marine and Coastal Facilities provides guidance for calculating a maximum credible spill volume for a refuelling spill. The guidance provided by AMSA (2015) for a refuelling spill under continuous supervision is considered appropriate given refuelling will be constantly supervised. The maximum credible spill volume during refuelling is calculated as: transfer rate (150 m^3/hr) x 15 minutes of flow. The detection time of 15 minutes is seen as conservative but applicable following failure of multiple barriers, followed by manual detection and isolation of the fuel supply.

7.5.2 Spill modelling overview

To determine the spatial extent of impacts from potential hydrocarbon spills, modelling was completed for the vessel collision and LOWC scenarios (RPS, 2021b). A surface spill of MDO during refuelling is considered relatively small in comparison to a surface spill of MDO during a vessel collision. It is therefore assumed that the extent of a hydrocarbon spill during refuelling would remain within the extent of the worst-case spill trajectory of diesel from a vessel collision, subsequently, modelling of a smaller spill was not conducted.

In this study, oil spill modelling was undertaken using a three-dimensional oil spill trajectory and weathering model, SIMAP (Spill Impact Mapping and Analysis Program), which is designed to simulate the transport, spreading and weathering of specific oil types under the influence of changing meteorological and oceanographic forces. For the subsea release near-field subsurface discharge modelling was undertaken using OILMAP, which predicts the centreline velocity, buoyancy, width and trapping depth (if any) of the rising gas and oil plumes. A total of 150 individual ‘realisations’ made up the full stochastic simulation set for each of the spill scenarios.

For each set of 150 stochastic realisations, SIMAP spatially tracked the surface oil, entrained oil in the water column, dissolved oil and oil on shorelines.

The outputs of this modelling showed a number of different possible outcomes of a spill, which were then analysed to determine the concentrations of hydrocarbon at each grid cell of the model, providing information about the probability of contact and concentration at contact of hydrocarbons across the EMBA.

Deterministic modelling was also performed to understand the potential area of influence that could be expected from a single spill event. The worst-case deterministic scenario (highest mass of oil ashore) resulted from run #29 of the subsea LOWC.

All scenarios, including the vessel collision scenario were modelled at the Spartan well location, approximately 380 m from the boundary of the Montebello AMP.

7.5.2.1 Loss of well control spill modelling

Volume and type of release

Hydrocarbons that could be released to the environment are natural gas and hydrocarbon liquid (condensate) from a surface or subsea blowout. Quantitative hydrocarbon spill modelling was undertaken for the worst-case subsea and surface spill discharge rates and volumes from the Spartan well location to inform the environmental impact assessment and to assist with emergency planning. Key parameters for each scenario modelled are given in **Table 7-6** on the basis of Santos’ Spartan-2 Worst Case Discharge Technical File Note. Rev 0, April 2021 and include:

+ Worst-case seabed discharge cumulative volumes of up to 49,104 STB (53,811 m^3) and 3,721 MMscf of condensate and gas respectively may be released to the marine environment until well control can be re-established.
+ The worst-case sea surface discharge cumulative volumes are predicted to be similar with up to 52,373 STB (53,291 m^3) and 3,741 MMscf of condensate and gas, respectively.

Table 7-6: Summary of spill scenarios modelled for surface and subsea loss of well control scenarios

Spill Scenario	Surface Blowout	Subsea Blowout
Depth of release	Sea Surface	Seabed @ 60 m
Location of release	20° 32' 4.47" S 115° 14' 52.90" E	
Diameter of subsea release orifice	N/a	0.22 m
Total volume of condensate	52,373 STB 53,291 m^3	49,104 STB 53,811 m^3
Total volume of associated gas	3,741 MMscf	3,721 MMscf
Time of year	All *	
Spill duration	77 days	
Modelling duration	105 days**	

**The stochastic model was run based on drilling occurring at any time of the year, with 150 realisations per scenario.*

***Four weeks following end of spill to allow hydrocarbons to undergo fate and transport processes sufficiently to define the environment at risk.*

7.5.3 Hydrocarbon characteristics

7.5.3.1 Condensate

The characteristics of Spartan condensate are provided in **Table 7-7**.

Table 7-7: Characteristics of Spartan Condensate

Parameter	Spartan Condensate
API Gravity	46.0
Density (g/cm^3)	0.797
Residual Content (%)	3.3
Pour Point (°C)	-15
Asphaltene (%)	1
Viscosity (cP)	0.62 (@ 20°C)

Condensate weathering

Evaporation is the primary weathering mechanism for volatile condensates such as Spartan condensate. Under constant calm wind speeds of 2.6 m/s, approximately 90% of the surface slick is predicted to evaporate in the first 24 hours, with approximately less than 9% remaining on the sea surface after seven days (**Figure 7-1**). Under variable wind speeds, the evaporation rate was similar, while wind-driven entrainment meant approximately less than 1% remained on the sea surface after 7 day (**Figure 7-2**). Given it's characteristics, Spartan condensate on the sea surface is not expected to form emulsions.

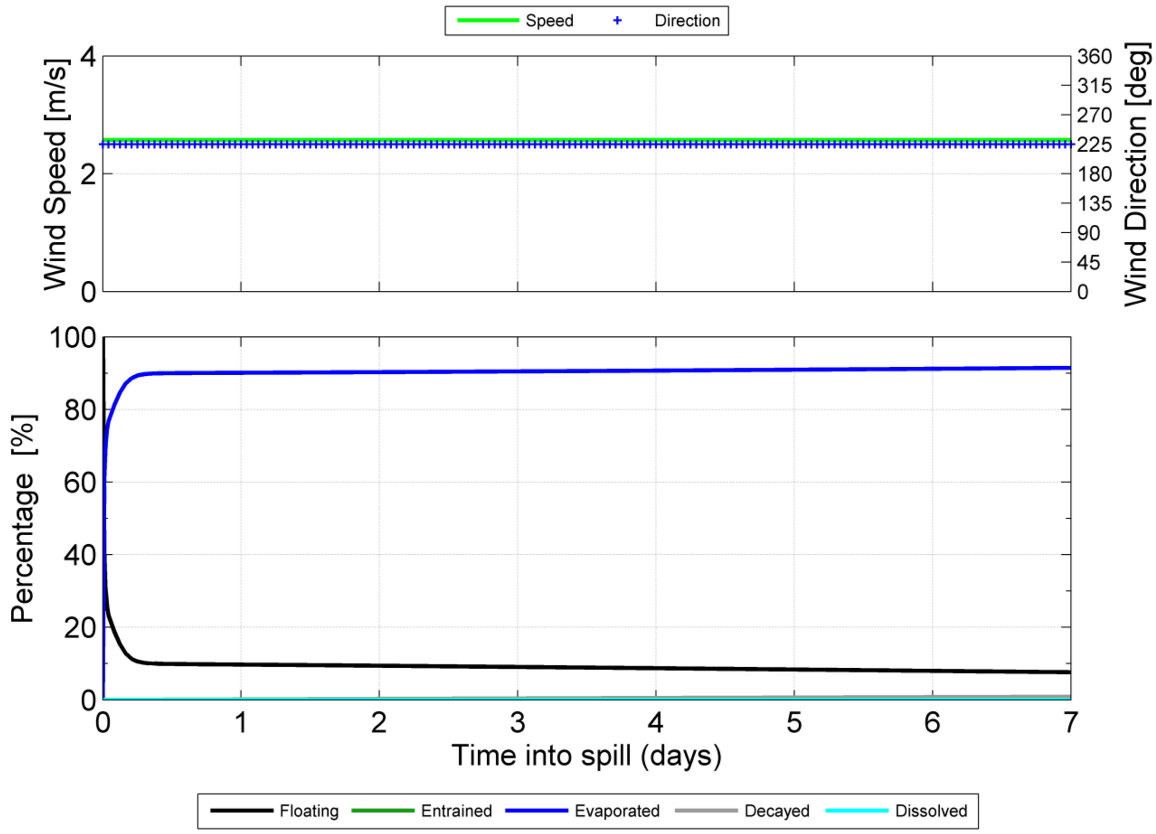

Figure 7-1: Simulated weathering of Spartan condensate for constant wind speeds of 2.6 m/s (RPS, 2021b)

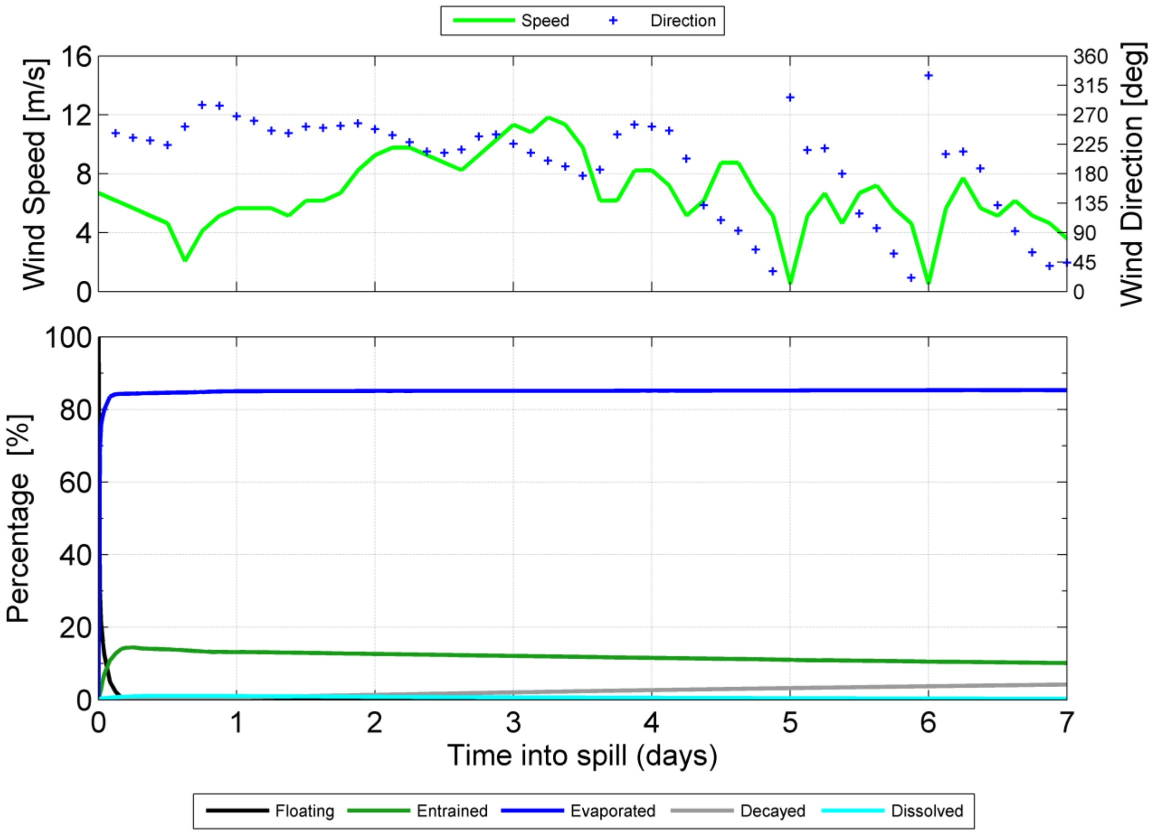

Figure 7-2: Simulated weathering of Spartan condensate for variable wind speeds (RPS, 2021b)

7.5.3.2 Marine diesel

International Tanker Owners Pollution Federation (2011) and the Australian Marine Oil Spill Centre (AMOSC, 2011) categorise diesel as a light 'group II' hydrocarbon. In the marine environment, a 5% residual of the total quantity of diesel spilt will remain after the volatilisation and solubilisation processes associated with weathering. In the marine environment, diesel is expected to behave as follows:

- diesel will spread rapidly in the direction of the prevailing wind and waves;
- evaporation will be the dominant process contributing to the fate of spilled diesel from the sea surface and will account for 60 to 80% reduction of the net hydrocarbon balance;
- the evaporation rate of diesel will increase in warmer air and sea temperatures; and
- diesel residues usually consist of heavy compounds that may persist longer and will tend to disperse as oil droplets into the upper layers of the water column.

A surface release of 329 m^3 of diesel was modelled from the vessel. Upon release, the diesel is forecast to spread rapidly out to a thin film on the sea surface, and evaporation is forecast to remove approximately 50% of the released volume within several days of release. The diesel will also become increasingly subject to entrainment into the water column as the density increases after losing the lighter components through evaporation (RPS, 2021b).

A summary of the representative characteristics of diesel, as assessed in this EP, is provided in Table 7-8.

Table 7-8: Summary of diesel characteristics

Parameter	Diesel
API Gravity	36.4
Specific Gravity	0.843
Wax content (%)	0.05
Pour Point (°C)	Less than -36
Asphaltene (%)	Less than 0.05
viscosity (cSt)	3.9 (@ 20°C)

Source: RPS (2021b)

Marine diesel weathering

Marine diesel is a moderate weight and moderately persistent oil in the marine environment. Under constant low winds (2.6 m/s), 41% of the surface slick is predicted to evaporate in the first 24 hours, and approximately 20% would remain on the sea surface after five days (**Figure 7-3**). Under variable wind conditions, where the winds are of greater strength, entrainment into the upper water column is indicated to be significant. Approximately 72% is expected to entrain after 24 hours and further 24% is forecast to evaporate, leaving less than 1% floating on the sea surface **(Figure 7-4**). Marine diesel has a very low tendency for emulsion formation.

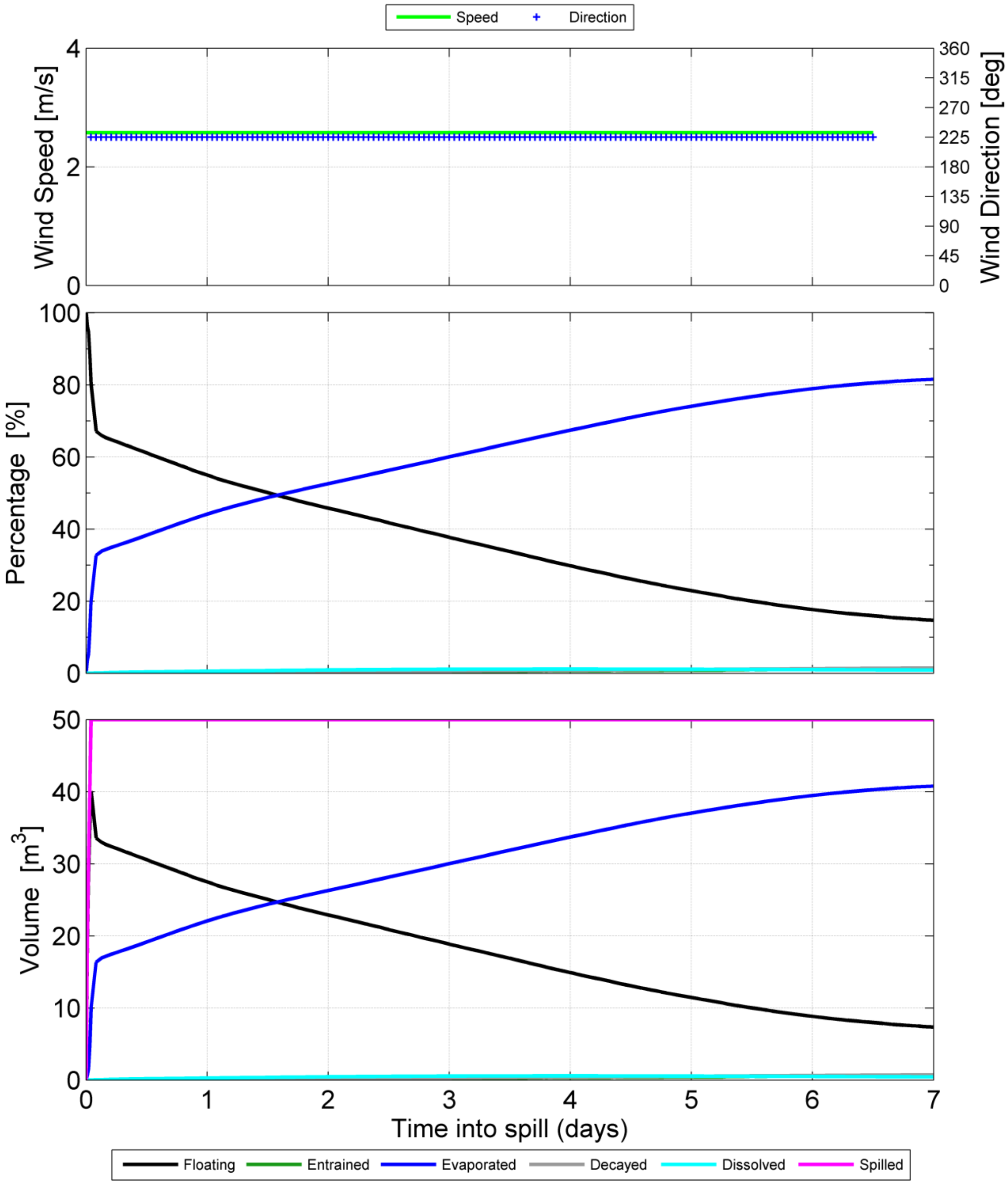

Figure 7-3: Simulated weathering of marine diesel for constant wind speeds of 2.6 m/s

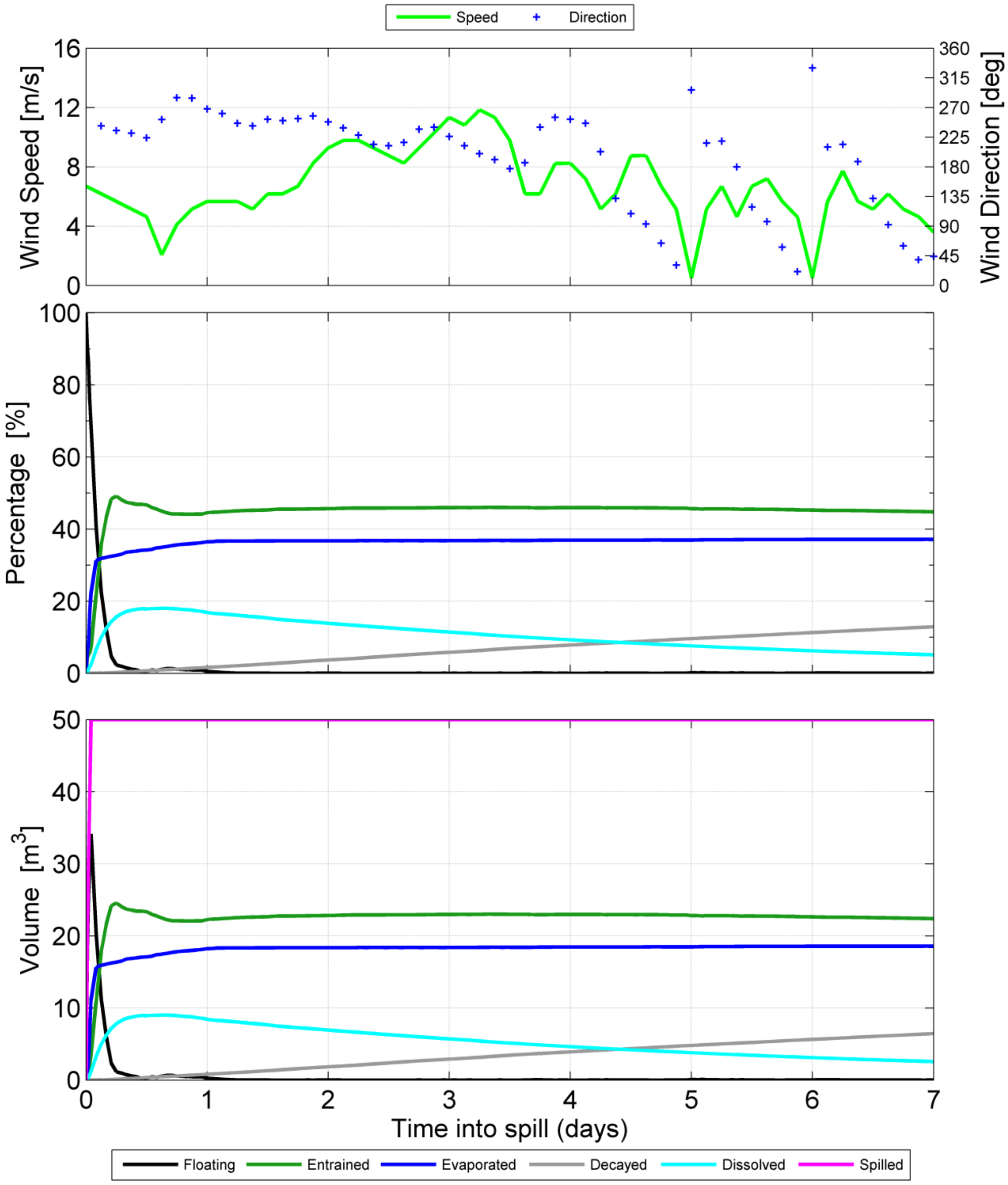

Figure 7-4: Simulated weathering of marine diesel for variable wind speeds

7.5.4 Hydrocarbon exposure values

To inform the impact assessment it is important to understand the profile of the concentrations of hydrocarbons after a spill. To do this NOPSEMA recommends identifying hydrocarbon exposure values that broadly reflect the range of consequences that could occur at certain concentrations (NOPSEMA, 2019a). The exposure values that have been applied to this EP Addendum are described below.

The EMBA shown in **Figure 3-1** was identified using low exposure values. These low exposure values are not considered to be representative of a biological impact, but they are adequate for identifying the full range of environmental receptors that might be contacted by surface and/or subsurface hydrocarbons (NOPSEMA, 2019a) and a visible sheen.

To inform impact assessment, exposure values that may be representative of biological impact have also been identified. These are called 'moderate exposure values' (defined by the MEVA) and 'high exposure values' (defined by the HEVA) and are shown in **Figure 3-2**. Moderate and high exposure values are modelled for each fate of hydrocarbon to identify what contact is predicted for surface (floating oil), subsurface (entrained oil and dissolved aromatic hydrocarbons), and shoreline accumulation of hydrocarbon at sensitivities.

Determining exposure values that may be representative of biological impact is complex since the degree of impact will depend on the sensitivity of the receptors contacted, the duration of the exposure and the toxicity of the hydrocarbon type making the contact. The toxicity of a hydrocarbon will also change over time, due to weathering processes altering the composition of the hydrocarbon. To identify appropriate exposure values Santos has considered the advice provided by NOPSEMA Bulletin #1 Oil Spill Modelling (NOPSEMA, April 2019) and scientific literature. The selected hydrocarbon exposure values applied to the Spartan Development oil spill modelling are discussed in **Table 7-9 to Table 7-11**. These tables explain how the exposure value is relevant to the risk evaluation and provides context on how that exposure value is used to inform response planning (which is addressed further in the OPEP).

Table 7-9: Floating hydrocarbons exposure values

Surface Oil Concentration (g/m^2)	Exposure Value	Description
1	Low	**Risk Evaluation** It is recognised that a lower floating oil concentration of 1 g/m^2 (equivalent to a thickness of 0.001 mm or 1 ml of oil per m^2) is visible as a rainbow sheen on the sea surface. Although this is lower than the exposure value for ecological impacts, it may be relevant to socio-economic receptors and has been used as the exposure value to define the spatial extent of the environment that might be contacted (EMBA) from floating oil. **Response Planning** Contact at 1 g/m^2 (as predicted by oil spill trajectory modelling) is used as a conservative trigger for activating scientific monitoring plans as detailed in the OPEP.
10	Moderate	**Risk Evaluation** There is a paucity of data on floating oil concentrations with respect to impacts to marine organisms. Hydrocarbon concentrations for registering biological impacts resulting from contact of surface slicks have been estimated by different researchers at about 10 to 25 g/m^2 (French *et al.*, 1999; Koops *et al.*, 2004; NOAA, 1996). The impact of floating oil on birds is better understood than on other receptors. A conservative exposure value of 10 g/m^2 has been applied to impacts from surface hydrocarbons (floating oil) in this EP. Although based on birds, this hydrocarbon exposure value is also considered appropriate for turtles, sea snakes and marine mammals (NRDAMCME, 1997). This value has been used to define the MEVA.

		Response Planning Contact at 10 g/m² is not specifically used for spill response planning.
50	High	**Risk Evaluation** At greater thicknesses the potential for impact of surface oil to wildlife increases. All other things being equal, contact to wildlife by surface oil at 50 g/m² is expected to result in a greater impact. **Response Planning** Containment and recovery effectiveness drops significantly with reduced oil thickness (McKinney *et al*., 2017; NOAA, 2014). McKinney *et al.* (2017) tested the effectiveness of various oil skimmers at various oil thicknesses. Their results showed that the oil recovery rate of skimmers dropped significantly when oil thickness was less than 50 g/m² (less than Bonn Agreement Code 4). Hence, 50 g/m² has been set as a guide for planning effective containment and recovery operations. Similarly, surface oil greater than 50 g/m² (Bonn Agreement Code 4/5 and equivalent to oil observed as discontinuous or continuous true colour) is considered to be a lower limit for effective dispersant operations and is therefore considered for planning.

Table 7-10: Shoreline hydrocarbon accumulation exposure values

Shoreline Accumulation (g/m²)	Exposure Value	Description
10	Low	**Risk evaluation** An accumulated concentration of oil above 10 g/m² on shorelines is considered to represent a level of socio-economic effect (NOPSEMA, 201b9). For example, reduction in visual amenity of shorelines. This value has been used in previous studies to represent a low contact value for interpreting shoreline accumulation modelling results (French-McCay, 2005a, 2005b). **Response planning** Not specifically used for response planning because below the limit that can be effectively cleaned.
100	Moderate	**Risk evaluation** The impact exposure value for exposure to hydrocarbons stranded on shorelines is derived from levels likely to cause adverse impacts to marine or coastal fauna and habitats. These habitats and marine fauna known to use shorelines are most at risk of exposure to shoreline accumulations of oil, due to smothering of intertidal habitats (such as mangroves and emergent coral reefs) and coating of marine fauna. Environmental risk assessment studies (French-McCay, 2009) report that an oil thickness of 0.1 mm (100 g/m²) on shorelines is assumed as the lethal exposure value for invertebrates on hard substrates (rocky, artificial or man-made) and sediments (mud, silt, sand or gravel) in intertidal habitats. Therefore, a conservative exposure value for impacts of 100 g/m² has been applied to impacts from shoreline accumulation of hydrocarbons. This value has been used to define the MEVA.

		Response planning A shoreline concentration of 100 g/m², or above, is likely to be representative of the minimum limit that the oil can be effectively cleaned according (AMSA, 2015; NOPSEMA, 2019) and is therefore used as a guide for shoreline clean-up planning. This exposure value equates to approximately ½ a cup of oil per square metre of shoreline contacted.
1,000	High	**Risk evaluation** At greater thicknesses, the potential for impact of accumulated oil to shoreline receptors increases. All other things being equal, accumulation of oil above 1000 g/m² is expected to result in a greater impact. **Response planning** As oil increases in thickness the effectiveness of oil recovery techniques increases. This value can therefore be used to prioritise oil recovery efforts, assuming oil recovery is deemed to have an environmental benefit.

Table 7-11: Dissolved aromatic hydrocarbon exposure values

Dissolved hydrocarbons (ppb)	Exposure Value	Description
10	Low	**Risk evaluation** Dissolved Aromatic Hydrocarbons (DAH) include the monoaromatic hydrocarbons (compounds with a single benzene ring such as benzene, toluene, ethyl benzene, and xylenes) and polycyclic aromatic hydrocarbons [PAHs] (compounds with multiple benzene rings such as naphthalenes and phenanthrenes). These compounds have a greater bioavailability that other components of oil and are considered to be main contributors to oil toxicity. The toxicity of DAHs is a function of the concentration and the duration of exposure by sensitive receptors with greater concentration and exposure time causing more severe impacts. Typically tests of toxicity done under laboratory conditions measure toxicity as proportion of test organisms affected (for example, 50% mortality or LC50) at the end of a set time period, often 48 or 96 hours. French-McCay (2002) in a review of literature, reported LC50 for dissolved PAHs with 96 hour exposure, range between 30 ppb for sensitive species (2.5th-percentile species) and 2,260 ppb for insensitive species (97.5th-percentile species), with an average of about 250 ppb. The range of LC50s for PAHs obtained under turbulent conditions (this includes fine oil droplets) was 6 ppb to 410 ppb with an average of 50 ppb (French-McCay, 2002). More recently, French-McKay (2018) described in-water thresholds as 10 – 100 µg / L (equivalent to ppb). Regarding the effect of UV on PAH toxicity, French-McKay et al (2018) uses the findings of DWH NRDA Trustees (2016) to adjust for this affect by reducing the water column exposure thresholds by 10 x in the top 20 m of the water column. The dissolved hydrocarbon 10 ppb exposure value has been used to inform the EMBA within **Section 3**. An exposure value of 10 ppb is

		appropriate as it is concentration that could have some potential negative effect. **Response planning** Contact at 10 ppb (as predicted by oil spill trajectory modelling) is used as a trigger for activating scientific monitoring plans as detailed in the OPEP. Establishes planning area for scientific monitoring based on potential for exceedance of water quality triggers (NOPSEMA, 2019).
50	**Moderate**	**Risk evaluation** Approximates potential toxic effects, particularly sublethal effects to sensitive species (refer to above text). Consistent with NOPSEMA (2019). This value has been used to define the MEVA. **Response planning** Encompassed by response to 10 ppb. There is nothing different for higher exposure values.
400	**High**	**Risk evaluation** Approximates toxic effects including lethal effects to sensitive species (NOPSEMA, 2019). **Response planning** Encompassed by response to 10 ppb. There is nothing different for higher exposure values.

7.5.5 Spill risk assessment approach

The spill risk assessment approach adopted is based on Santos' Oil Spill Risk Assessment and Response Planning Procedure (SO-91-II-20003).

A consistent risk assessment approach is applied to unplanned hydrocarbon release scenarios. The spill risk assessment approach is based on Santos' Oil Spill Risk Assessment and Response Planning Procedure (SO-91-II-20003). The procedure describes the spill risk assessment process as follows:

+ identify the spatial extent of the EMBA. This has been completed for this Spartan Development Addendum to the Varanus Island Hub Operations EP as part of the assessment of the existing environment and receptors that are known to occur or may occur within the EMBA are described in **Section 3.2** and **Appendix C**;
+ identify areas of high environmental value (HEV) within the EMBA (HEVs are described in **Section 7.5.5.2**);
+ Identify and then risk assess hot spots. Hot spots are effectively a subset of HEVs, and their determination is described in **Section 7.5.5.3;** and
+ identify priorities for protection (for consideration of spill response strategies in the OPEP)

7.5.5.1 Spill environment that may be affected

Defining the EMBA by an oil spill is the first step in oil spill risk and impact assessment. For activities where there is the potential for multiple spill scenarios, the spill scenario, or combination of spill scenarios, resulting in the greatest spatial extent is used to define the overall EMBA for the activity. The EMBA is further described in **Section 3.1**. To determine the potential impact to receptors within the EMBA, the MEVA is used to determine them as described in **Section 3.1**.

7.5.5.2 Areas of high environmental value

Santos has predetermined areas of HEV along the Western Australian coastline by ranking these areas based on:

+ Protected area status – This is used as an indicator of the biodiversity values contained within that area, where a World Heritage Area, RAMSAR Wetland and Marine Protected Area will score higher than areas with no protection assigned.
+ BIAs of listed threatened species – These are spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour, such as breeding, feeding, resting or migration. Each one of these within the predefined areas contributes to the score.

  Further input to determine areas of HEV included:

+ sensitivity of habitats to impact from hydrocarbons in accordance with the guidance document Sensitivity Mapping for Oil Spill Response produced by IPIECA, the International Maritime Organisation and International Association of Oil and Gas Producers;
+ sensitivities of receptors with respect to hydrocarbon-impact pathways;
+ status of zones within protected areas (IUCN (1A) and sanctuary zones compared to IUCN (VI) and multiple use zones);
+ listed species status and predominant habitat (surface versus subsurface); and
+ social values, socio-economic and heritage features (such as commercial fishing, recreational fishing, amenities, aquaculture).

Tallied scores for each predefined area along the Western Australian coastline were then ranked from 1 to 5, with an assignment of 1 representing areas of the highest environmental value and those with 5 representing the areas of the lowest environmental value. HEVs for the worst case oil spill EMBA, MEVA and HEVA associated with the Spartan Development activities are shown in **Figure 7-5.**

7.5.5.3 Hot Spots

While the entire MEVA will be considered during risk assessment and spill response planning, it is best practice to concentrate greatest effort and level of detail on those parts of the EMBA that have the:

+ greatest intrinsic environmental value – considered by Santos to be HEV areas ranked 1 to 3;
+ highest probability of contact by oil (either floating, entrained or dissolved aromatic); and
+ greatest potential concentration or volume of oil arriving at the area.

These areas are termed ‘hot spots’. Defining hots pots is typically the first step in undertaking detailed spill risk assessment and spill response planning. Hot spots are a subset of HEV areas that:

+ have the highest probability of contact (at least higher than 5%) above the impact assessment exposure value for surface hydrocarbons and shoreline accumulation based on modelling results; and
+ receive the greatest concentration or volume of oil, either floating or stranded oil, entrained oil or DAH above contact exposure values described in **Section 7.5.4**.

A workshop was held to review the hotspots for the Spartan Development activities worst case oil spill scenario. During the workshop, additional hotspots may be included through discretion of workshop attendees where they do not strictly meet all of the above criteria. E.g. an HEV ranked 1-3 with <5%

probability, or an HEV ranked 4 or 5 with >5% probability, depending on the concentrations and volumes presented in the modelling report.

During a hotspot workshop, an environment consequence assessment is conducted against each of the hotspots identified using the Santos risk assessment process identified in **Section 5**, the outcome of this is provided in **Appendix G**.

7.5.5.4 Priorities for protection

For the purposes of a spill response preparedness strategy, it is not necessary for all hot spots to have detailed planning. For example, wholly submerged hot spots may only be contacted by entrained oil, and the response would be largely to implement scientific monitoring to determine impact and recovery. Hot spots with features that are not wholly submerged (emergent features) should have specific spill response planning conducted. This final determination of 'Priority for Protection' sites, for the oil spill response strategy, is based on the worst-case estimate of floating oil concentration, shoreline loading and minimum contact time at exposure value concentrations.

Further detail on selection of Protection Priority Areas process is detailed in the Oil Spill Risk Assessment and Response Planning Procedure (SO-91-II-20003).

The following Hot Spot locations have been identified as Priorities for Protection areas for oil spill response planning for the Spartan Development activities within the Varanus Island Hub Operations OPEP and are based on the worst-case estimate of surface oil concentration, shoreline loading and minimum contact time at exposure value concentrations for the Spartan Development activities:

+ Muiron Islands;
+ Ningaloo Coast North;
+ Montebello Islands; and
+ Barrow Island

The oil spill response strategies for Priority for Protection areas are undertaken within the Varanus Island Hub Operations OPEP.

An assessment of each protection priority will be undertaken to determine the most appropriate spill response strategies based on the type of oil and the values of the protection priority area. This can be done through a strategic NEBA approach.

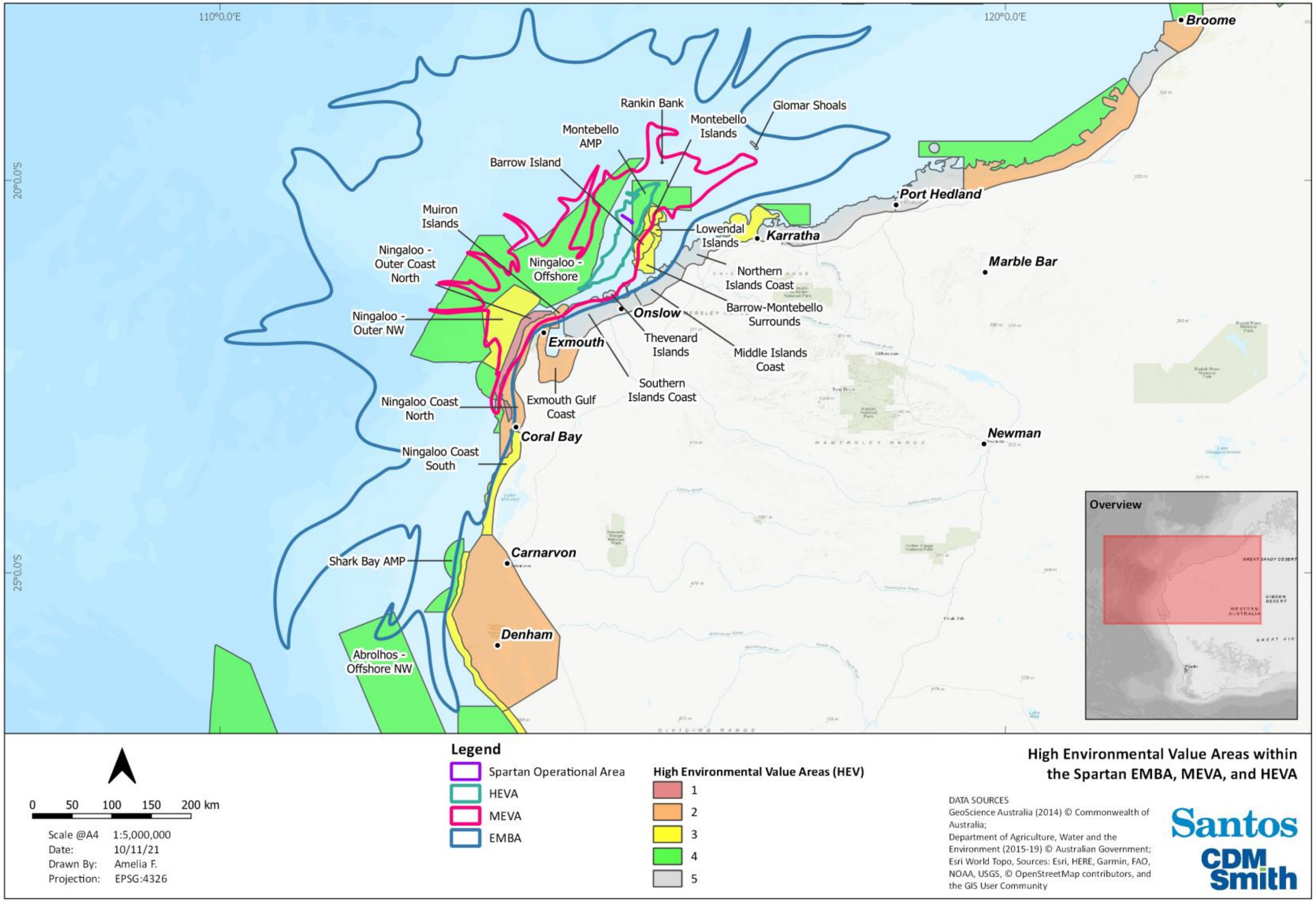

Figure 7-5: High environmental values within the EMBA, MEVA and HEVA

7.5.5.5 Potential hydrocarbon impact pathways

To help inform the hydrocarbon spill risk assessment receptors within the EMBA and potential impact pathways have been defined (**Table 7-12**). The potential impact pathways consider physical and chemical pathways. Physical pathways include contact from floating oil, accumulated shoreline oil, or entrained oil droplets. Chemical pathways include ingestion, inhalation or contact from any hydrocarbon phase. These are summarised in **Table 7-12** and the information is drawn upon within the hydrocarbon risk assessment for the spill scenario. **Table 7-13** further describes the nature and scale of the hydrocarbon spills for this activity on marine fauna and socio-economic receptors found within the MEVA.

Table 7-12: Physical and chemical pathways for hydrocarbon exposure and potential impacts to receptors

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Rocky shorelines	Shoreline loading and attachment may result in thin and sporadic coating of hydrocarbon residues. Degree of oil coating is dependent upon the energy of the shoreline area, the type of the rock formation and continual biodegradation of the oil.	Impacts to flora (mangroves) and fauna further described below.	Chemical pathway to fauna and flora via adsorption through cellular membranes and soft tissue, ingestion, irritation/ burning on contact and inhalation.	Impacts to flora (mangroves) and fauna further described below.
Sandy beaches	Shoreline loading and water movement may allow hydrocarbon residue to filter down into sediments, continue to biodegrade on the surface or remobilise into surf zone. Degree of loading is dependent upon the energy and tidal reach of the shoreline, the type of the sandy shore and continual weathering of the oil.	Indirect impacts to nesting and foraging habitats for birds and turtles. Direct impacts to infauna.	Chemical pathway to fauna and flora via adsorption through cellular membranes and soft tissue, ingestion, irritation/burning on contact and inhalation.	Indirect impacts to nesting and foraging habitats for birds and turtles. Direct impacts (mortality) to infauna through toxic effects and smothering.
Intertidal platforms	Shoreline loading and water movement may allow hydrocarbon residue to filter down into sediments (e.g. within wetlands) or continue to biodegrade on the surface or remobilise into surf zone. Degree of loading is dependent upon the energy and tidal reach of the shoreline, the type of the substrate and continual weathering of the oil.	Indirect impacts to foraging habitats for birds and turtles. Direct impacts to infauna.	Chemical pathway to fauna and flora via adsorption through cellular membranes and soft tissue, ingestion, irritation/burning on contact and inhalation.	Indirect impacts to foraging habitats for birds. Direct impacts (mortality) to infauna through toxic effects and smothering.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Shallow sub-tidal soft sediments	Hydrocarbon residue in the shallow waters adjacent to shorelines may settle to filter down into sediments. Degree of loading is dependent upon the energy and tidal reach of the shoreline, the type of the substrate and continual weathering of the oil.	Indirect impacts to foraging habitats for turtles and fish. Direct impacts to infauna.	Adsorption via cellular membranes and soft tissue, ingestion, irritation/burning on contact and inhalation.	Indirect impacts to foraging habitats for turtles and fish. Direct impacts (mortality) to infauna through toxic effects and smothering.
Mangroves	Coating of root system reducing air and salt exchange. Degree of coating is dependent upon the energy and tidal reach of the shoreline, the type of the substrate and continual weathering of the oil.	Yellowing of leaves. Defoliation. Increased sensitivity to stressors. Tree death. Reduced growth. Reduced reproductive output. Reduced seed viability.	External contact by oil and adsorption across cellular membranes.	Yellowing of leaves. Defoliation. Increased sensitivity to stressors. Tree death. Reduced growth. Reduced reproductive output. Reduced seed viability. Growth abnormalities.
Seagrasses and macroalgae	Coating of leaves/thalli reducing light availability and gas exchange. Degree of coating depends upon the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the oil.	Bleaching or blackening of leaves. Defoliation. Reduced growth.	External contact by oil and adsorption across cellular membranes.	Mortality. Bleaching or blackening of leaves. Defoliation. Disease. Reduced growth. Reduced reproductive output. Reduced seed/propagule viability.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Hard corals (coral reefs)	Coating of polyps, shading resulting in reduction on light availability. Degree of coating is dependent upon the metocean conditions, dilution, if corals are emergent at all and continual weathering of the oil.	Bleaching. Increased mucous production. Reduced growth.	External contact by oil and adsorption across cellular membranes.	Mortality. Cell damage. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Reduced egg/larval success. Growth abnormalities.
Non-coral benthic invertebrates	Coating of adults, eggs and larvae. Degree of coating is dependent upon the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the oil.	Mortality. Behavioural disruption. Impaired growth.	Ingestion and inhalation. External contact and adsorption across exposed skin and cellular membranes. Uptake of DAH across cellular membranes. Reduced mobility and capacity for oxygen exchange.	Mortality. Cell damage. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Reduced egg/larval success. Growth abnormalities. Behavioural disruption.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Sharks, rays and fish	Coating of adults but primarily eggs and larvae – reduced mobility and capacity for oxygen exchange.	Mortality. Oxygen debt. Starvation. Dehydration. Increased predation. Behavioural disruption.	Ingestion. External contact and adsorption across exposed skin and cellular membranes. Uptake of DAH across cellular membranes (for example, gills).	Mortality. Cell damage. Flesh taint. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Reduced egg/larval success. Growth abnormalities. Behavioural disruption.
Birds (seabirds and shorebirds)	Degree of coating is dependent upon the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the oil.	Feather and skin irritation and damage, with the potential to cause secondary impacts such as: Physical restriction of flight and swimming movement. Mortality. Hypothermia / impairing the waterproofing of feathers. Disruption to feeding / starvation. Disruption to breeding. Disruption to migration.	Ingestion (during feeding or preening). External contact and adsorption across exposed skin and membranes.	Mortality. Cell damage, lesions. Secondary infections. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Growth abnormalities. Behavioural disruption.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Marine reptiles	Degree of coating is dependent upon the energy and tidal reach of the shoreline, the type of the receptor and continual weathering of the oil.	Irritation of eyes/mouth and potential illness, which may cause secondary impacts such as: Mortality. Disruption to feeding / starvation. Physical restriction. Behavioral disruption.	Inhalation. Ingestion. External contact and adsorption across exposed skin and membranes.	Mortality. Cell damage, lesions. Secondary infections. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced hatchling success. Reduced reproductive output. Growth abnormalities. Behavioural disruption.
Marine mammals	Fur damage and matting, reduced mobility and buoyancy (for applicable species). Coating of feeding apparatus in some species (baleen whales).	Irritation of eyes/mouth, damage to fur and potential illness, which may cause secondary impacts such as: Mortality. Disruption to feeding / starvation. Physical restriction. Behavioural disruption.	Inhalation. Ingestion. External contact and adsorption across exposed skin and membranes.	Mortality. Cell damage, lesions. Secondary infections. Reduced metabolic capacity. Reduced immune response. Disease. Reduced growth. Reduced reproductive output. Growth abnormalities. Behavioural disruption.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Plankton	Coating of feeding apparatus. Reduced mobility and capacity for oxygen exchange.	Mortality. Behavioural disruption (for example, reduced mobility).	Inhalation. Ingestion. External contact.	Mortality. Impairment of biological activities (for example, feeding, respiration). Reduced mobility.
Water quality and sediment quality	Presence of hydrocarbon residue in the water, which may filter down to sediments or continue to biodegrade on the surface. Degree of loading in the water column is dependent upon the influence of wave energy and tidal range.	Impacts to flora and fauna, as discussed in rows above.	Adsorption via cellular membranes and soft tissue, ingestion, irritation/burning on contact and inhalation. Impacts to flora and fauna, as discussed in rows above.	Impacts to flora and fauna, as discussed in rows above.
Protected areas	Coating of benthic habitats, shoreline habitats and marine fauna/flora within protected areas as discussed in rows above.	Mortality, injury or behavioural disruption to marine fauna. Death or impairment of habitats within protected areas. Reduction in the quality of the marine environment within protected areas. Environmental value of protected areas is degraded.	Impacts to flora and fauna, as discussed in rows above.	Mortality, injury or behavioural disruption to marine fauna. Death or impairment of habitats within protected areas. Reduced growth of benthic habitats. Reduction in the quality of the marine environment within protected areas. Environmental value of protected areas is degraded.

Receptor	Physical pathway	Potential impacts	Chemical pathway	Potential impacts
Socio-economic environment (fisheries, tourism, shipping, defence, shipwrecks, Indigenous users, oil and gas)	Presence of hydrocarbon residue in the water, which may filter down to sediments or continue to biodegrade on the surface. Coating of benthic habitats, shoreline habitats and marine fauna/flora within protected areas as discussed in rows above.	Degradation of cultural or maritime heritage sites. Disruption to tourism, recreation or shipping activities. Reduction in resource available for commercial and recreational fisheries.	Impacts to flora, fauna and the physical environment as discussed in rows above. Commercial/recreational fish species – refer to 'fish' as discussed above.	Degradation of cultural or maritime heritage sites. Disruption to tourism, recreation or shipping activities. Reduction in resource available for commercial and recreational fisheries.

Table 7-13: Nature and scale of hydrocarbon spills on environment and socio-economic receptors within the EMBA and MEVA

Receptor	Impacts of Hydrocarbon Spills	
	Entrained and dissolved aromatic hydrocarbons in the water column	Surface hydrocarbons
Threatened/Migratory Fauna		
Plankton (including zooplankton, fish and coral larvae)	There is potential for localised mortality of plankton due to reduced water quality and toxicity. Also, through physical contact of small oil droplets, plankton mobility, feeding and/or respiration may be impaired. Plankton could include the eggs and larvae of marine invertebrates and fish and therefore entrained oil could impact on recruitment of invertebrate/fish species. 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.	Plankton utilising the sea surface layer could be impacted by floating oil.
	Plankton could include the eggs and larvae of marine invertebrates and fish and therefore impact on recruitment of invertebrate/fish species. The operational area has the potential to overlap with spawning of some fish species given the year-round spawning of some species. In the unlikely event of a spill occurring, fish larvae may be impacted by hydrocarbons entrained in the water column. Following a hydrocarbon release a portion of the slick will rapidly evaporate and disperse in the offshore environment, reducing the concentration and toxicity of the spill. Maximum entrained oil concentrations were predicted at Glomar Shoals. Plankton utilising the sea surface layer, as well as pelagic invertebrates, could be impacted from floating oil. Exposure to entrained oils and DAHs may result in lethal or sub-lethal impacts to plankton or pelagic	

Receptor	Impacts of Hydrocarbon Spills	
	Entrained and dissolved aromatic hydrocarbons in the water column	**Surface hydrocarbons**
	invertebrates through a direct contact pathway. Such contact could impair the mobility, feeding and respiration of these fauna and exchange of chemicals could occur.	
Marine mammals	Lethal or sub-lethal physical and toxic effects such as irritation of eyes/mouth and potential illness.	At risk of direct contact with surface hydrocarbons due to chance of surfacing within slick. Effects include irritation of eyes/mouth and potential illness. Surface respiration could lead to accidental ingestion of hydrocarbons or result in the coating of sensitive epidermal surfaces. Potential impact to feeding apparatus of some species (baleen whales).
	Thirteen migratory marine mammal species were identified by the PMST as occurring within the EMBA. Of these, two are listed as endangered (blue whale and southern right whale) and three as vulnerable (humpback whale, fin whale and sei whale). The operational area and EMBA overlap with blue whale, humpback whale and dugong BIAs (**Figure 3-10** and **Figure 3-11**). For further information about environmental impacts to marine mammals from hydrocarbon exposure and increased toxicity, refer to **Table 7-12**. Other migratory marine mammals may encounter either surface or water column hydrocarbons in the EMBA. Dugongs may be particularly susceptible to surface slicks, a reduction of seagrass habitat for foraging and/or ingestion of seagrass coated with oil. Dugongs occur throughout the shallow waters between the Pilbara offshore islands and the mainland and have been observed in the shallow waters along the east coast of Barrow Island and over the Lowendal Shelf. The EMBA overlaps a BIA for dugongs (**Figure 3-11**). Aerial surveys of dugong distribution have found that the animals occur around Barrow Island, Airlie Island, Lowendal Islands and the Montebello Islands further offshore (Prince, 2001).	
Marine reptiles	Lethal or sub-lethal physical and toxic effects such as irritation of eyes/mouth and potential illness. The Recovery Plan for Marine Turtles in Australia: 2017–2027 (CoA, 2017) highlights acute chemical discharge as one of several threats to marine turtles.	At risk of direct contact with surface hydrocarbons due to chance of surfacing within slick. Effects include irritation of eyes/mouth and potential illness. Surface respiration could lead to accidental ingestion of hydrocarbons or result in the coating of sensitive epidermal surfaces. Contact with hydrocarbons that have accumulated on shorelines particularly at nesting beaches. Oiling of eggs/hatchlings may occur. Shoreline hydrocarbons are expected to be less toxic than fresh oils due to weathering processes such as photo oxidation and biodegradation reducing the levels of lighter chain hydrocarbons which are generally more toxic.

<table>
<tr><th rowspan="2">Receptor</th><th colspan="2">Impacts of Hydrocarbon Spills</th></tr>
<tr><th>Entrained and dissolved aromatic hydrocarbons in the water column</th><th>Surface hydrocarbons</th></tr>
<tr><td></td><td colspan="2">Nine species of threatened marine reptile were identified as possibly being impacted by a spill. Loggerhead, green, leatherback, hawksbill, flatback and Olive Ridley turtles are widely dispersed across the NWS and in the unlikely event of a hydrocarbon spill occurring, individuals traversing open water may come into contact with water column or surface hydrocarbons. The EMBA overlaps with BIAs and critical habitat for four turtle species (flatback, green, hawksbill and loggerhead) as shown in Figure 3-12 to Figure 3-15. Sea snakes are associated with the offshore reefs and banks within the EMBA, particularly those at Rankin Bank and Glomar Shoals.

Critical habitat including interesting habitat offshore form important nesting beaches for turtle species are present within the EMBA. The highest shoreline accumulations above the 100 g/m² exposure value were predicted for Ningaloo Coast North, Barrow Island, Montebello Islands and Muiron Islands. In the event of a spill, the presence of hydrocarbons on beaches would disrupt behaviour and potentially threaten turtle populations. For further detailed environmental impacts to marine reptiles from hydrocarbon exposure and increased toxicity, refer to Table 7-12.</td></tr>
<tr><td rowspan="2">Birds (seabirds and shorebirds)</td><td>Lethal or sub-lethal physical and toxic effects such as irritation of eyes/mouth and potential illness.

May encounter entrained hydrocarbons while diving and foraging.</td><td>Particularly vulnerable to surface slicks. As most fish survive beneath floating slicks, they will continue to attract foraging seabirds, which typically do not exhibit avoidance behaviour. Smothering can lead to reduced water proofing of feathers and ingestion while preening. In addition, direct contact with hydrocarbons can erode feathers causing chemical damage to the feather structure that subsequently affects ability to thermoregulate and maintain buoyancy on water.

Shorebirds may be impacted by the presence of hydrocarbons accumulated on shorelines which may result in exposure to eggs and ingestion by foraging individuals. Shoreline hydrocarbons are expected to be less toxic than fresh oils due to weathering processes such as photo oxidation and biodegradation reducing the levels of lighter chain hydrocarbons which are generally more toxic.</td></tr>
<tr><td colspan="2">46 threatened or migratory species of seabirds and shorebirds were identified within the EMBA by the PMST (Table 3-7). Of these, only 11 species were identified within the operational area. A BIA for wedge-tailed shearwater breeding and foraging overlaps the operational area.</td></tr>
</table>

Receptor	Impacts of Hydrocarbon Spills	
	Entrained and dissolved aromatic hydrocarbons in the water column	Surface hydrocarbons
	Migratory seabird BIAs for breeding and resting overlap with the EMBA (**Table 3-9**) therefore, species may be impacted by surface and entrained hydrocarbons while foraging (dive and skim feeding) with higher numbers expected during the breeding periods. Birds (seabirds and shorebirds) are highly susceptible to hydrocarbon spills, with impacts primarily attributed to oiling of birds at the sea surface from slicks and oil on shorelines. Given the EMBA contacts multiple areas where seabirds are known for breeding including Montebello Islands, Barrow Island, Muiron Islands, Ningaloo Coast and Pilbara Islands, impacts to birds may include coating by oil when floating in open water, diving into open and coastal waters to feed on fish, wading and foraging on shallow intertidal mud/sand flats and wetlands or roosting on oil affected sandy beaches. Other impacts could include behavioural impacts whereby birds avoid important nesting and migratory stop-over areas including RAMSAR wetlands or reduced food availability if important foraging areas are impacted. For further information about environmental impacts to seabirds/shorebirds through hydrocarbon exposure and toxicity effects, refer to **Table 7-12**.	
Sharks, Rays and Fish	Hydrocarbon droplets can physically affect fish, sharks and rays exposed for an extended duration (weeks to months). Smothering through coating of gills can lead to the lethal and sub-lethal effects of reduced oxygen exchange, and coating of body surfaces may lead to increased incidence of irritation and infection. Fish may also ingest hydrocarbon droplets or contaminated food leading to reduced growth. There is potential for localised mortality of fish eggs and larva due to reduced water quality and toxicity. 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 and therefore demersal fish communities (including those associated with the Ancient Coastline at 125m depth contour KEF, Continental Slope Demersal Fish Communities KEF) and Glomar Shoals may be exposed. For further information about environmental impacts to fish/sharks/rays from hydrocarbon exposure and toxicity effects, refer to **Table 7-12**.	While fish, sharks and rays do not generally break the sea surface, individuals may feed at the surface. For condensate/diesel spills where a slick is expected to quickly disperse and evaporate, prolonged exposure to surface hydrocarbons by fish, shark and ray species is unlikely. Due to the filter-feeding nature of whale sharks they may be susceptible to ingesting surface hydrocarbons, both fresh and weathered (tar balls) if feeding at the sea surface particularly from diesel spills.
	The NWS supports a diverse assemblage of fish, including 456 species of finfish, particularly in shallower water near the mainland and islands. Threatened species identified by the PMST include the white shark, whale shark, grey nurse shark, sawfishes (freshwater, dwarf, green, narrow and large-tooth), giant manta ray and reef manta ray, mako sharks, blind gudgeons and cave eel, porbeagle, and oceanic white tip sharks which may be present in the EMBA. However, given the absence of critical habitat for most of these species, significant numbers are not expected to be exposed to hydrocarbons in the event of a spill. These threatened and migratory fish and sharks could be present at low densities all year round	

Receptor	Impacts of Hydrocarbon Spills	
	Entrained and dissolved aromatic hydrocarbons in the water column	Surface hydrocarbons
	within the operational area and EMBA; however, the absence of any known feeding, resting or breeding areas means significant numbers are unlikely to be impacted if an unplanned release were to occur. The whale shark foraging BIA is presented in **Figure 3-9** and the main whale shark aggregation location (Ningaloo Marine Park) is more than 400 km southwest of the operational area. The EPBC Act-listed whale shark may occur in the EMBA, particularly off the Ningaloo coastline between March and June and is known to feed in surface waters. There is, therefore, the potential for this species to ingest oil from surface slicks with resultant damage to gills, other tissues and organs. For further information about environmental impacts to fish/sharks/rays from hydrocarbon exposure and toxicity effects, refer to **Table 7-12**.	
Socio-economic		
Commercial, Recreational and Traditional Fisheries	Hydrocarbons in the water column can have toxic effects on fish (as outlined above) potentially reducing catch rates and rendering fish unsafe for human consumption.	In addition to the effects of entrained and DAHs, exclusion zones surrounding a spill can directly impact fisheries by restricting access for fishermen. Weathered diesel slicks may form tar balls which may result in oiling of nets and fishing infrastructure.
	A number of commercial fisheries operate within the EMBA (**Section 3.2.5.1**). Impacts to these fisheries from a spill may range from disruption of fishing activities caused by the physical presence of the slick, loss of (or loss of function of) coastal intertidal habitat (for example, seagrass meadows, mangrove communities, intertidal mudflats) which may provide nursery habitat for fishery species (for example, fish and crustaceans) and contact of surface and entrained hydrocarbons with the eggs and larvae of commercially important species. Exposure to entrained and DAHs could result in the accumulation of oil in fish tissues to the extent that could result in hydrocarbon taint of fish flesh. Connell and Miller (1981) compiled a summary of studies listing the exposure value concentrations at which tainting occurred for hydrocarbons. The results contained in their review indicate that tainting of fish occurs when fish are exposed to ambient concentrations of 4 to 300 ppm (4,000 to 300,000 ppb) of hydrocarbons in the water, for durations of 24 hours or more, with response to phenols and naphthenic acids being the strongest. Given that entrained hydrocarbons are predicted to exceed the moderate threshold at some locations in the MEVA, hydrocarbon taint is possible in fish flesh although it is difficult to assess how long fish might be exposed for, small, less mobile fishes would be more susceptible. It is possible that impacts could be detected to fisheries on a stock level although it is more likely that natural variation in fish abundance would be on a greater scale than any impacts attributable to a hydrocarbon spill. This would most likely be the case for fisheries species that utilise shallow waters around the Barrow and Montebello Islands and could occur through direct impacts to fish or to fish habitats (for example, seagrass, coral reef, mangrove habitats). The same negative impacts could also occur to important recreational fish species and the recreational fisheries they support although impacts to commercial fisheries could result in the additional impact of loss of income for commercial fishers.	

Receptor	Impacts of Hydrocarbon Spills	
	Entrained and dissolved aromatic hydrocarbons in the water column	Surface hydrocarbons
Recreation and Tourism	A number of tourism destinations occur within the EMBA, including Ningaloo Reef (which is within a World Heritage Area, National Heritage Place and a Commonwealth Heritage Place) and offshore islands such as the Montebello Islands. A number of areas with high diversity or which have unique ecological values are protected within AMPs. As well as reducing the visual amenity of these areas, a LOWC spill could impact the habitats and marine fauna of these areas thereby impacting the environmental values of these tourism areas. Depending upon the extent of impact, loss of revenue to coastal towns and communities could also occur.	
Shipping	Multiple shipping fairways intersect the EMBA (**Figure 3-21**). Hydrocarbons in the water column will have no effect on shipping.	Exclusion zones surrounding a spill will reduce access for shipping vessels for the duration of the response undertaken for spill clean-up (if applicable), vessel may have to take large detours leading to potential delays and increased costs.
Defence	The level of defence activities performed in the vicinity of operational area is low, though the EMBA does overlap some of the North West Exercise Area. Interference of defence activities due to a hydrocarbon spill is expected to be minimal.	
Shipwrecks	There are a number of historic (more than 75 years old) shipwrecks within the EMBA. Shipwrecks may be of important heritage value and/or act as dive sites. Surface hydrocarbons will have no impact on shipwrecks. Hydrocarbons in the water column either as entrained oil or DAHs may extend thousands of kilometres from the release location. The potential for in-water hydrocarbons to impact on shipwrecks is poorly documented. However, it has been proposed that exposure to oil may alter bacterial community composition (biofilms) inhabiting shipwrecks possibly altering corrosion potential (Salerno *et al.,* 2016).	
Indigenous users	Marine resource use by Indigenous people is generally restricted to coastal waters. Fishing, hunting and the maintenance of maritime cultures and heritage through ritual, stories and traditional knowledge continue as important uses of the nearshore region and adjacent areas. The level of activities undertaken by indigenous users is expected to be low.	
Existing oil and gas activity	A number of oil and gas operators operate within the EMBA which encompasses the entire NWS with existing projects and infrastructure in place as well as continuing drilling and exploration programs. A surface slick has the potential to disrupt activity potentially halting production or exploration with associated economic impact. Exclusion zones surrounding spills will reduce access potentially resulting in delays to work schedules with possible subsequent financial implications.	
Protected Areas		
Marine Parks and	Protected areas are described in **Section 3.2.3**. These areas provide key habitats that support an array of marine flora and fauna along with unique natural phenomena.	

Receptor	Impacts of Hydrocarbon Spills	
	Entrained and dissolved aromatic hydrocarbons in the water column	Surface hydrocarbons
Commonwealth Heritage Areas	These protected areas support all the habitats and faunal groups described above and support unique/protected habitats/marine fauna or ecological features. Impacts to the habitat/fauna receptors described above therefore have an impact on the values of these reserves which could have flow-on effects to tourism revenue for coastal communities that provide access to these marine reserves. The protected areas may also support nursery/feeding/aggregation areas for fisheries species and therefore may assist in maintaining healthy fish stocks and commercial/recreational fisheries.	
RAMSAR wetlands	No RAMSAR wetlands ae located within the EMBA.	
KEFs	KEFs overlapping the EMBA are described in **Section 3.2.3**.	
	While some features associated with the KEFs are subtidal or submerged and would not be directly contacted by a surface slick, they all may support increased productivity or abundance of marine fauna that use surface waters above the features (including plankton, pelagic invertebrates and fish, marine mammals, marine reptiles and seabirds) which may be impacted by floating oil. Impacts to these marine fauna are described above.	
Threatened Ecological Communities	No Threatened Ecological Communities are located within the EMBA.	

7.5.6 Spill response strategies

Numerous oil spill response strategies are available to be implemented in the event of a spill. These are generally strategies that have been implemented in the past or are considered good industry practice. Section 7 of the OPEP provides a detailed description of the applicable response strategies for this activity, which include, depending on the type and size of the spill:

- source control
- monitor and evaluate
- mechanical dispersion
- shoreline protection and deflection
- shoreline clean-up
- oiled wildlife
- scientific monitoring.

7.6 Hydrocarbon Spill – Loss of Well Control

7.6.1 Description of event

Event	A loss of well control during drilling may occur due to a number of reasons, including: + shallow gas; + well kick; + tripping/swabbing; + loss of primary and secondary well control; + failure to keep the correct mud density; and + failure to keep the hole full. In the event of a LOWC, condensate and associated gas may be released to the marine environment with the most likely release points at either the MODU floor or seabed. The worst-case credible spill scenarios were predicted by selecting the most likely hydrocarbon flow parameters from the well to yield the credible maximum blowout volumes and rates (i.e., environmentally credible worst-case volume and rate) from both subsurface (seabed) and surface (MODU floor) unplanned releases. Key parameters for input to this 'worst-case' blowout were taken from key Santos well design documents and Well Design Automation System, suitable analogues, latest reservoir models, or Santos best estimates where information was unavailable. Quantitative hydrocarbon spill modelling was undertaken for the worst-case subsurface and surface spill scenarios. The LOWC worst-case discharge volumes that were used for the hydrocarbon spill modelling were based on Santos' Spartan-2 Worst Case Discharge Technical File Note. Rev 0, April 2021 (Santos Doc No. SN-35-RR-20001). Outputs from the modelling were used to inform the environmental impact assessment and to assist with emergency planning. The environmental consequences of a LOWC are highly variable, dependent on the characteristics of the hydrocarbon released, the dynamics of the receiving environment and the proximity of the release point to sensitive environmental receptors.
Extent	The MEVA and EMBA for the worst-case hydrocarbon spill from a LOWC associated with the Spartan Development drilling was defined in **Section 3.1**. For information on the extent of potential impact associated with a LOWC, refer to **Section 7.6.1.1**.
Duration	The worst-case duration of a LOWC is predicted as 77 days (refer to the OPEP). This is the estimated time required to drill a relief well and gain control of the primary well. Hydrocarbons would persist within the environment for a longer period of time, although the condensate released is expected to weather quickly through evaporation and dispersion.

7.6.1.1 Stochastic spill modelling – summary of results for moderate exposure thresholds

The spill modelling results above the moderate threshold at moderate to very high probabilities are summarised below for subsea and surface LOWC at the Spartan well location. **Appendix G** includes the full results and has been provided for the purposes of risk evaluation.

Further parameters required to inform spill response strategies are described in the OPEP.

Subsea LOWC

The subsea dynamics of the subsea LOWC are highly energetic due to the significant gas volume that accompanies the release of liquid condensate for this scenario. Whereas a surface release scenario will result in the gas being immediately lost to the atmosphere, the gas in a subsea discharge scenario contributes to the velocity and momentum of the subsea plume as it exits the release orifice.

Accumulated shoreline oil above 100 g/m^2

At the moderate threshold the spatial extent of shoreline accumulation is within approximately 250 km to the southwest and approximately 40 km to the northeast.

Shoreline accumulation above the moderate threshold was predicted at a number of environmental receptors with the highest probability and values as follows:

+ A moderate contact probability of 44% was predicted for the island receptor of Muiron Islands. This receptor was predicted to receive a maximum shoreline accumulation of 18 m^3, with a minimum arrival time of 9 days and maximum oiled shoreline length of 5 km.
+ Lower contact probabilities of between 18% and 22% were predicted for Barrow Island, Montebello Islands Ningaloo Coast North.
+ Maximum accumulated shoreline loads at these locations ranged from 33 m^3 at the Montebello Island, 54 m^3 at Ningaloo Coast North and 17 m^3 at Barrow Island. Minimum arrival times at these location ranged from 6.9 days to 17.5 days. Maximum length of shoreline loading ranged from 6 km at Barrow Island to 16 km at Ningaloo Coast North.

Surface oil greater than 10 g/m^2

Surface oil above the moderate threshold extends up to approximately 3 km from the release location. Surface oil impacts at the moderate threshold include:

+ The surface waters of the Montebello AMP was the only receptor apart from the open ocean to be contacted by surface oil greater than 10 g/m^2, with a maximum probability of 14% and minimum time to contact of 3.3 days.

Entrained oil greater than 100 ppb

Entrained oil at the moderate threshold was predicted to occur up to 314 km from the release location.

Entrained oil impacts at the moderate threshold with the highest probabilities and concentrations include:

+ Very high contact probability was predicted at the Montebello AMP (100%) and Ningaloo- Offshore (90%) and with maximum worst-case concentrations of 2,791 ppb and 661 ppb and a minimum arrival times of 2hrs and 4.9 days respectively.
+ Moderate to high contact probabilities of 16-70% were predicted at Ningaloo – Outer Coast North, Muiron Islands, Ningaloo North Coast, Barrow-Montebello Surrounds, Barrow Island, Montebello Islands, and Ningaloo - Outer NW. Maximum worst-case concentrations at these locations ranged between 203 ppb and 526 ppb, with minimum arrival times of 3.1 to 12.1 days.

Dissolved oil greater than 50 ppb

Dissolved hydrocarbons at the moderate threshold were predicted to be within approximately 298 km of the release site.

Dissolved oil impacts at the moderate threshold with the highest probabilities and concentrations include:

- Very high contact probability was predicted at the Montebello AMP (100%) and high contact probability at Ningaloo- Offshore (76%) and with maximum worst-case concentrations of 2,131 ppb and 597 ppb and a minimum arrival times of 2hrs and 4.9 days respectively.
- Moderate to high contact probabilities of 18-64% were predicted at Montebello Islands, Ningaloo – Outer Coast North, Barrow Island and Barrow-Montebello Surrounds. Maximum worst-case concentrations at these locations ranged between 245 ppb and 456 ppb, with minimum arrival times of 3.1 to 12.1 days.

Surface LOWC

Accumulated shoreline oil above 100 g/m²

At the moderate threshold the spatial extent of shoreline accumulation is within approximately 250 km to the southwest and approximately 40 km to the northeast.

Shoreline accumulation above the moderate threshold was predicted at a limited number of environmental receptors as follows at the highest probabilities and volumes:

- Muiron Islands was the only receptor with a contact probability above 20% (26%). This receptor was predicted to receive a maximum shoreline accumulation of 9 m^3, with a minimum arrival time of 9 days and maximum oiled shoreline length of 3 km.

Surface oil greater than 10 g/m²

Surface oil above the moderate threshold extends up to approximately 6 km from the release location. Surface oil impacts at the moderate threshold include:

- The surface waters of the Montebello AMP was the only receptor apart from the open ocean to be contacted by surface oil greater than 10 g/m^2, with a maximum probability of 40% and minimum time to contact of 3.3 days.

Total entrained oil greater than 100 ppb

Entrained oil at the moderate threshold was predicted to occur up to 327km from the release location.

Entrained oil impacts at the moderate threshold with the highest probabilities and concentrations include:

- Very high contact probability was predicted at the Montebello AMP (100%) and Ningaloo- Offshore (94%) and with maximum worst-case concentrations of 4,868 ppb and 1,071 ppb and a minimum arrival times of 2hrs and 4.5 days respectively.

Moderate to high contact probabilities of 32-86% were predicted at Ningaloo – Outer Coast North, Muiron Islands, Ningaloo Coast North, Barrow-Montebello Surrounds, Barrow Island, Montebello Islands, Ningaloo - Outer NW and Pilbara Southern Islands Coast. Maximum worst-case concentrations at these locations ranged between 229 ppb and 821 ppb, with minimum arrival times of 2.4 to 10.1 days.

Dissolved oil greater than 50 ppb

Dissolved hydrocarbons at the moderate threshold were predicted to be within approximately 213 km of the release site.

Dissolved oil impacts at the moderate threshold with the highest probabilities and concentrations include:

- Very high contact probability was predicted at the Montebello AMP (100%) and Ningaloo- Offshore (94%) and with maximum worst-case concentrations of 852 ppb and 356 ppb and a minimum arrival times of 2hrs and 4.5 days respectively.
- Moderate to high contact probabilities of 32-86% were predicted at Montebello Islands, Ningaloo – Outer Coast North, Barrow Island, Barrow-Montebello Surrounds and the Pilbara Southern Islands Coast. Maximum worst-case concentrations at these locations ranged between 55 ppb and 254 ppb, with minimum arrival times of 2.4 to 10.1 days.

7.6.1.2 Deterministic modelling

The stochastic simulation output provides a probabilistic temporal and spatial representation of potential impacts from an oil spill incident. To further inform the OPEP, individual stochastic realisations were selected to characterise shoreline loading (i.e., loads). The deterministic simulations were selected based on the following criteria:

- Highest accumulated shoreline loading >10 g/m^2 and >100 g/m^2

Subsea LOWC

Stochastic realisation 29 of the subsea LOWC scenario resulted in the highest accumulated shoreline load of 58 m^3 across all shorelines above 100 g/m^2.

This realisation resulted in:

- The maximum oil loading on along an individual shoreline receptor was predicted at Ningaloo Coast North as 54 m^3;
- The maximum distance from the spill location to the outer edge of hydrocarbon exposure during this spill is predicted as 217 km for entrained hydrocarbons (100 ppb threshold); and
- The greatest length of shoreline with concentrations exceeding 100 g/m^2 was predicted for Ningaloo Coast North receptor at 16 km.

Surface LOWC

Stochastic realisation 3 of the surface LOWC scenario resulted in the highest accumulated shoreline load of 32 m3 across all shorelines above 100 g/m^2.

This realisation resulted in:

- The maximum oil loading on along an individual shoreline receptor was predicted at Ningaloo Coast North as 23 m^3;
- The maximum distance from the spill location to the outer edge of hydrocarbon exposure during this spill is predicted as 222 km for entrained hydrocarbons (100 ppb threshold); and
- The greatest length of shoreline with concentrations exceeding 100 g/m^2 was predicted for Ningaloo Coast North receptor at 5 km

7.6.2 Nature and scale of environmental impacts

Hydrocarbon spills will cause a decline in water quality and may cause chemical (e.g., toxic) and physical (e.g., coating of emergent habitats, oiling of wildlife at sea surface) impacts to marine species. The severity of the impact of a hydrocarbon spill depends on the magnitude of the spill (i.e., extent, duration) and sensitivity of the receptor.

The magnitude of potential environmental impact from a condensate release (which behaves in a similar manner in the marine environment to MDO) is dependent on multiple factors including hydrocarbon type, release volume and rate, and ocean and weather conditions.

An assessment of the sensitive environmental receptors at risk from a condensate release has been determined based on a literature review and trajectory and fate modelling described above. Section 3 includes a description of biological environment present in the operational and/or spill (MEVA) trajectory area.

Potential receptors: Physical environment (water and sediment quality, shoals and banks, benthic habitats, offshore reefs and islands), threatened or migratory fauna (marine mammals, marine reptiles, sharks, fish, rays and birds), protected and significant areas (marine parks, heritage areas, KEFs), socio-economic receptors (fisheries, tourism, recreation and other third-party operators).

A LOWC release to the marine environment would result in reductions in water quality for at least one model time step (approximately an hour) at a probability greater than 10% across the 150 individual realisations per scenario over the following worst case spatial extent from any modelled location are:

- For a seabed release scenario at the moderate (impact) thresholds:
  - Shoreline accumulation (more than 100 g/m^2) within approximately 250 km;
  - Surface oil (10 g/m2) within approximately 3 km;
  - Entrained oil (100 ppb) within approximately 314 km;
  - Dissolved oil (50 ppb) within approximately 298 km.
- For a surface release scenario at the moderate (impact) thresholds:
  - Shoreline accumulation (more than 100 g/m^2) within approximately 250 km;
  - Surface oil (10 g/m^2) within approximately 6 km;
  - Entrained oil (100 ppb) within approximately 327 km;
  - Dissolved oil (50 ppb) within approximately 213 km.

The potential impact pathways (physical and chemical) of hydrocarbon exposure to relevant habitat and marine fauna receptors are summarised in **Table 7-12** and an impact assessment I completed for receptors within the EMBA in **Table 7-13**.

7.6.3 Net environmental benefit analysis

NEBA is a structured approach used by the response community and stakeholders to select spill response strategies that will effectively remove oil, are feasible to use safely in particular conditions, and will reduce the impact of an oil spill on the environment.

The NEBA process is used during pre-spill planning (strategic NEBA) and during a response (operational NEBA). A strategic NEBA is an integral part of the contingency planning process and is used to ensure that response strategies for scenarios are well informed. An operational NEBA is used to ensure that evolving conditions are understood, so that response strategies can be adjusted as necessary to manage individual response actions and end points.

Balancing trade-offs may involve differing and conflicting priorities, values and perceptions of the importance of sensitive receptors. There is no universally accepted way to assign perceived value or importance, and it is not a quantitative process. Overall, the NEBA process provides an estimate of potential environmental effects that are sufficient to allow the parties to compare and select preferred combinations of response strategies to reduce environmental impacts to ALARP.

A strategic NEBA has been developed for all response strategies identified as applicable to credible spills identified in the OPEP related to an unplanned release of condensate, with the potential environmental benefit or potential impact to each protection priority area. This will provide information that will help to select response strategies tailored to the key environmental values within the areas of highest priority. A summary of spill response strategies is available for each of the priorities for protection and the potential impact that a response strategy has on the area's environmental values.

This information is to be considered in the NEBA process that takes place during a spill response (i.e., an operational NEBA). An operational NEBA will also consider real-time monitoring of the effectiveness and potential impacts of a response and will also consider accessibility, feasibility and safety of responders (refer to Section 5.7.2 of the OPEP).

7.6.4 Environmental impact assessment

The below environmental impact assessment follows the risk assessment approach detailed in **Section 7.5.5**.

7.6.4.1 Identification of hot spots for consequence assessment

As described in **Section 7.5.5**, all HEVs within the MEVA and EMBA for LOWC are listed in **Table 7-14**. The values and sensitivities associated with these HEVs have been described in **Appendix C**. Further to this, **Table 7-14** filters the HEV to identify the Hot Spots where they meet the criteria (as described in **Section 7.5.5**) from either the subsea or surface loss of well control scenario of any hydrocarbon phase. As noted in **Section 7.5.5**, discretion was applied during the workshop to include hotspots that didn't meet the criteria, these are marked with an asterisk and the rationale for their inclusion as a hotspot is included in **Table 7-14** below.

Note that the worst-case values were taken from both surface and subsea modelling scenarios to identify the hot spots; e.g., very low shoreline loading in a subsea scenario, but high in the surface scenario, then that would be allocated as a hot spot.

Table 7-14: Identified high environmental value and hot spot receptors for surface and subsea release scenarios of loss of well control

Receptor	HEV ranking	Exposure Threshold		Hot Spot[1]	Hotspot Selection rationale
		Low (EMBA)	Moderate (MEVA)		
Outer Ningaloo Coast North	1	✓	✓	Y	HEV = 1 & in MEVA
Muiron Islands	2	✓	✓	Y	HEV = 2 & in MEVA
Exmouth Gulf Coast	2	✓	x	N	Not in MEVA
Ningaloo Coast North	2	✓	✓	Y	HEV = 2 & in MEVA

Receptor	HEV ranking	Exposure Threshold		Hot Spot[1]	Hotspot Selection rationale
		Low (EMBA)	Moderate (MEVA)		
Barrow-Montebello Surrounds	3	✓	✓	Y	HEV = 3 & in MEVA
Montebello Islands	3	✓	✓	Y	HEV = 3 & in MEVA
Lowendal Islands	3	✓	✓	Y	HEV = 3 & in MEVA
Barrow Island	3	✓	✓	Y	HEV = 3 & in MEVA
Outer NW Ningaloo	3	✓	✓	Y	HEV = 3 & in MEVA
Ningaloo Coast South	3	✓	x	Y	Not in MEVA, however low shoreline accumulation
Dampier Archipelago	3	✓	x	N	Not in MEVA
Montebello AMP	4	✓	✓	N	Low probability of surface oil contact at MEV. 100% probability Entrained oil and dissolved oil contact. HEV does not abut nature reserves. Submerged feature with low HEV ranking.
Offshore Ningaloo	4	✓	✓	N	>90% probability of entrained oil contact above moderate threshold, however a submerged feature with low HEV ranking.
Shark Bay AMP	4	✓	x	N	Not in MEVA
Glomar Shoals	5	✓	x	N	Not in MEVA
Northern Islands Coast	5	✓	x	N	Not in MEVA
Rankin Bank	5	✓	✓	N	Submerged feature, low HEV ranking
Middle Islands Coast	5	✓	x	N	Not in MEVA
Southern Islands Coast	5	✓	✓	N	Low HEV ranking
Thevenard Islands	5	✓	✓	N	12% probability of entrained contact, minimum time 13 days. No shoreline contact. Low HEV ranking.

[1] Greater than 5% probability of contact at the medium/high exposure value for consideration for further Hot Spot assessment.

* discretionary hotspot

This process identified the following hot spots:

+ Outer Ningaloo Coast North

- Muiron Islands
- Ningaloo Coast North
- Barrow-Montebello surrounds
- Montebello Islands
- Montebello AMP
- Barrow Island
- Outer NW Ningaloo
- Offshore Ningaloo
- Southern Islands Coast

Appendix G provides a simplified summary of the consequence assessment results for each of the Hot Spot areas. The consequence assessment was based on predicted contact and concentration of floating oil, accumulated oil, total submerged oil and dissolved oil. For each Hot Spot area, the consequence to the key values were assessed using the methodology described in **Section 7.5.5**.

Table 7-15: Impact, likelihoods and consequence ranking – loss of well control

Description	
Receptors	Physical environment (water and sediment quality, benthic habitats, offshore reefs and islands) Threatened or migratory fauna (marine mammals, marine reptiles, sharks, rays, fish, and birds) Protected and significant areas (marine parks and KEFs) Socio-economic receptors (fisheries, tourism and recreation)
Consequence	IV – Major
The detailed consequence assessment for each hot spot is provided in **Appendix G**. A summary of the consequence assessment for each receptor category is presented below. *Physical environment or habitat* In the highly unlikely event of a LOWC subsea or surface, hydrocarbons will likely reach both subsea and shoreline habitats. Hydrocarbons that reach nearshore environments also have the potential to impact benthic coral reefs and mangrove areas, which may result in a long-term decrease in ecological values given toxicity impacts associated with hydrocarbon exposure. The worst-case consequence assessment for physical environment at any identified hotspot was IV – Major at Ningaloo Coast-North, Montebello Islands, Barrow Island, Lowendal Islands and Muiron Islands. *Threatened or migratory fauna* In the highly unlikely event of a LOWC, the volume of condensate released would result in a reduction in water quality with the potential to impact marine fauna. Marine fauna present in the area may be potentially impacted by a spill through exposure to floating oil, entrained oil, or dissolved aromatic hydrocarbons. A description of impacts to marine fauna from exposure to condensate is provided in **Table 7-13**. Impacts from a LOWC release would be greatest within several kilometres from the spill when the toxic aromatic components of the hydrocarbon will be at their highest concentration and when the hydrocarbon is at its thickest on the surface of the receiving waters. Upon release to the marine environment, the condensate will rapidly lose toxicity with time and will spread thinner at the surface as evaporation continues or will become entrained within the water column. The potential sensitive	

receptors in the surrounding areas of the spill will include fish, marine mammals, marine reptiles and seabirds at the sea surface, as discussed in **Table 7-13**.

Habitat modification, degradation, disruption or loss, deteriorating water quality and marine pollution are identified as potential threats to a number of marine fauna species in relevant recovery plans and conservation advices (**Table 3-9**). With controls in place that align with relevant actions described in various recovery plans, the activity will be conducted in a manner that reduces potential impacts to ALARP and an acceptable level.

The worst-case consequence assessment for threatened or migratory fauna at any identified hotspot was IV – Major at Ningaloo Coast-North, Montebello Islands, Barrow Island, Lowendal Islands and Muiron Islands.

Protected areas

The MEVA intersects several protected areas including AMPs and marine management areas (**Section 3.2.3**). Combined, these areas support all the habitats and faunal groups described above. Impacts to the habitat or fauna receptors described above therefore have an impact on the values of these reserves, which could have flow-on effects to tourism revenue of coastal communities that provide access to these marine reserves. Many of these receptors are values of protected areas, and there could be moderate-term effects to them.

The worst case consequence assessment for protected areas at any identified hotspot was IV – Major at Montebello Islands, Barrow Island, Muiron Islands and Ningaloo Coast – North.

Socio-economic receptors

There is the potential for entrained oil to temporarily disrupt fishing activities if the surface or entrained oil moves through fishing areas.

Entrained oil at more than 100 ppb could reach pearl farming activities at the Montebello Islands. Pearl oysters are filter feeders therefore, entrained oil droplets could create negative impacts through ingestion and accumulation of hydrocarbon compounds in oyster tissues or interference with respiratory structures. Ecotox (2009) reported that no observable effect concentration levels from weathered condensates for a comparable oyster species ranged from approximately 9,000 to 28,000 ppm. Significant impacts on aquaculture would therefore be unlikely, as predictive modelling reported that the maximum entrained and dissolved oil concentrations for the worst realisation at the Montebello Islands were 286 ppb and 446 ppb respectively. Some loss of value to the local industry could occur in the event of a LOWC that results in a condensate spill.

In addition, recreational fishing hot spots including the Montebello Islands, Barrow Island, Lowendal Islands, Muiron Islands and Ningaloo are of high value to recreational fishers.

Tourism could be affected by spilled condensate, either from reduced water quality or shoreline oiling preventing recreational activities, reducing aesthetic appeal or from impacts to habitats and marine fauna as described in **Table 7-13**.

Indigenous users may be impacted in the event that a land-based response is required. However, consultation will help manage activities such that potential impacts are reduced to acceptable levels.

A number of oil and gas operators operate within the MEVA with existing projects and infrastructure in place, as well as continuing drilling and exploration programs. A LOWC in the operational areas has the potential to disrupt these activities, with associated economic impact, albeit on a temporary basis.

The worst case consequence assessment for socio-economic receptors at any identified hotspot was III Moderate - Montebello Islands, Lowendal Islands and Muiron Islands.

On the basis of the above assessment, a LOWC has the potential to impact an array of receptors. Given the extent and the presence of protected areas within the MEVA, the worst-case consequence is considered to be Major (IV).

Likelihood	B – Unlikely

In accordance with the Santos Risk Matrix, a worst-case surface release of crude as a result of LOWC has been defined as an 'Unlikely' event as it 'has occurred elsewhere OR could occur within decades'. The likelihood of a LOWC event occurring is based on industry statistics, Santos statistics and the standard preventive control measures in place. Wells are designed with essential engineering and safety control measures to prevent a loss of containment occurring. Blowout events during development well drilling has been reported at a frequency of 3.9 x 10^{-5} per drilled well (IOGP, 2019; development drilling, normal operations on deep, normal wells of North Sea standard). This frequency is based on two blowout incidents occurring in the UK between 1980 and 2014 during development well drilling (IOGP, 2019) and supports the likelihood of 'has occurred elsewhere OR could occur within decades' Management controls in place to control the flow of hydrocarbons include well construction design, safety shutdown systems, regular inspection, testing and maintenance, and competent personnel. Additional industry-standard and activity-specific control measures to reduce the chance of a loss of containment event have also been implemented including (but not limited to) procedures such as a NOPSEMA accepted WOMP, safety case, crew training and awareness, and a spill response plan (OPEP). These control measures are considered to reduce the risk of a loss of containment (and minimise impacts) occurring to a level that is acceptable. In accordance with the Santos Risk Matrix, given the control measures in place, the likelihood of worst-case seabed release of crude as a result of LOWC resulting in a Major (IV) consequence is considered to be Unlikely.

Residual Risk	The residual risk associated with this event is **Low**.

7.6.5 Environmental performance outcomes and control measures

The EPOs relating to this hazard include:

+ No loss of containment of hydrocarbon to the marine environment [ST-EPO-03].
+ No unplanned objects, emissions or discharges to sea or air [ST-EPO-04].
+ No injury or mortality to EPBC Act 1999 and WA Biodiversity Conservation Act 2016 listed fauna during activities [ST-EPO-05].

The extensive planning, risk assessment of the activity and the engineering and operational control measures in place are considered to result in a low risk of a hydrocarbon release due to LOWC occurring. The control measures considered for this activity are shown below in **Table 7-16** with EPSs and measurement criteria for the EPOs described in **Table 8-2**.

Operational controls that would be implemented to guide and effective response after a spill has occurred are provided within relevant sections of the OPEP, together with corresponding EPSs and measurement criteria.

Table 7-16: Control measure evaluation for a loss of well control hydrocarbon spill

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
ST-DC-CM-039	Lighting will be used as required for safe work conditions and	Ensures vessels meet minimum safety standards therefore reducing	Costs associated with personnel time in checking vessel	**Adopted** – Benefits considered to outweigh costs

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
	navigational purposes	potential for collision events with the MODU.	certifications are in place. Negligible costs of operating navigational equipment.	
ST-DC-CM-017	Drilling and Completions Management Process	Includes control measures for well integrity and well control in an accepted WOMP, and MODU Safety Case that reduce the risk of unplanned discharges to the marine environment. The WOMP and Safety Case also include cyclone response plans (including monitoring for cyclones) and procedures for well suspension in the event of a cyclone.	Costs associated with personnel time in writing, reviewing and implementing the WOMP and Safety Case.	**Adopted** – Regulatory requirement must be adopted.
ST-DC-CM-012	MODU and support vessel spill response plans (including pre-drilling well relief plan)	Implements response plan to deal with an unplanned hydrocarbon spills quickly and efficiently in order to reduce impacts to the marine environment.	Personnel cost and administrative costs associated with preparing documents, ongoing management (spill response exercises) and implementation of plans.	**Adopted** – Environmental benefits of ensuring response plans in place, are followed and measures implemented, and that the MODU/support vessels are compliant outweighs the costs of personnel time associated with preparation and

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
				implementation of spill response plans.
ST-DC-CM-015	Support vessel	Minimises risk of collision of third party vessels with MODU through visual identification and avoidance of other vessels.	Negligible costs as vessels are required to be in area for safety reasons.	**Adopted** – Benefits considered to outweigh costs.
ST-DC-CM-016	Accepted OPEP	Implements response plans to deal with an unplanned hydrocarbon release quickly and efficiently to reduce impacts to the marine environment.	Administrative costs of preparing documents and large costs of preparing for and implementing response strategies.	**Adopted** Regulatory requirement must be adopted.
ST-DC-CM-036	Well test procedures	Ensures well testing fluids are appropriately managed and that oil-water content in formation water, if produced, is below 30 ppm.	Cost associated with implementation of procedure.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh costs.
ST-DC-CM-044	MODU PMS	MODU equipment is operating within its parameters, reducing the risk of unplanned discharges to the marine environment.	Costs are standard for routine PMS.	**Adopted** – benefits in reducing atmospheric emissions impacts outweigh the minimal costs.
Additional Controls				
ST-DC-CM-046	Pre-campaign commencement assurance check	Ensures consideration of worst case hydrocarbon	Administrative costs to undertake assurance check	**Adopted –** Benefits considered to outweigh costs.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		spill scenario for the proposed activity based on actual MODU, vessel and activity details.	and risk assessments for each campaign.	
N/A	Manage the timing of the activity to avoid sensitive periods (e.g., spawning, whale and whale shark migration, bird and turtle nesting)	Reduce risk of impacts from highly unlikely LOWC during environmentally sensitive periods for listed marine fauna (e.g., spawning, whale and whale shark migration, bird and turtles nesting).	High cost in moving or delaying activity schedule. Would double duration of activity; increase impacts or potential impacts in other areas including increase in waste, air emissions, risk of vessel collisions etc. The risk to all listed marine fauna cannot be reduced due to variability in timing of environmentally sensitive periods and unpredictable presence of some species.	**Rejected** – Given the minimal risk of impacts to listed marine species (e.g., turtles) occurring, the financial and environmental costs of extending activity duration deemed grossly disproportionate to low environmental benefits.
N/A	Mange the timing to avoid drilling during cyclone season	Reduce the consequence of impact in the event of a loss of well control due to cyclonic conditions potentially spreading an oil spill further or hindering oil spill response activities	During cyclone season the weather can provide some of the best weather windows for drilling with calm sea state. Drilling within cyclone season does not increase the likelihood of a	**Rejected –** The cost of mobilising a MODU either side of cyclone season adds a grossly disproportionate cost to the activity. In addition, during cyclone season the weather can provide some of the best

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
			loss of well control as procedures are in place (as per the NOPSEMA accepted WOMP and Safety Case) to ensure that cyclone response plans are in place (including monitoring of cyclones) and barriers for cyclone suspension that are implemented as required. Cyclones are a known risk on the NWS and drilling within cyclone season is well managed under current industry standards. Adjusting the timing to avoid cyclone season would preclude drilling for 6 months of the year, significantly reducing MODU availability and increasing the length of the drilling campaign as the MODU would need to be demobilised part way through the	weather windows for drilling with calm sea state. Given that drilling year-round on the NWS is well managed and understood, and there are cyclone management procedures in place, the control is considered grossly disproportionate to the cost and risk of a LOWC event.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
			campaign and re-mobilised after cyclone season therefore increasing costs estimated at ~5MM USD per mobilisation.	
N/A	Dedicated resources (e.g., dedicated spill response facilities on location) in the event of loss of hydrocarbons to allow rapid response	May allow for quicker response to a spill as resources will be within close proximity.	Large costs associated with a dedicated resources on location. Modelling shows shoreline contact albeit with low maximum volumes. Condensate has low to no persistence in the environment and therefore prolonged loading on shorelines is not expected.	**Rejected** – Large cost associated with dedicated resources on location deemed grossly disproportionate to very low risk of LOWC and very high natural dispersion and low persistence of condensate.
N/A	A dedicated second MODU on standby for the purpose of relief well drilling	Could reduce the length of time taken to drill a relief well and may reduce the timeframe for stopping a blowout by up to two weeks, although planning/approval/set-up requirements mean the reduction would likely be less.	For the dedicated second MODU to be ready for relief well drilling, it would need to be contracted, crewed and hold a valid NOPSEMA Safety Case. This could cost between $200-250KUSD per day for a minimum negotiated contract term, plus a cost	**Rejected** – Considered grossly disproportionate to the environmental benefit (reduction of two weeks of release), considering the rare likelihood of a LOWC, the existing preventative control measures in place to prevent a well blowout and the

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
			associated for MODU mobilisation and demobilisation. After reviewing availability, it is anticipated a MODU would need to be brought in from overseas to guarantee availability of this rig. It is conceivable that to cover a 50 day well activity (for example) with a relief MODU on standby cost over the same duration would be in the order 15-20MMUSD, depending on where the MODU were mobilised from/to and the market at the time.	additional safety and environmental risks of having another MODU and support equipment/personnel on standby. In addition, there are adequate MODUs covered under the MOU to execute a relief well, this option was rejected as the cost is grossly disproportionate to the potential reduction in environmental impact.
N/A	Time the drilling campaign to align with the other Santos drilling activities so that nearby MODU could be used for the relief well drilling.	Could reduce the length of time taken to drill a relief well and may reduce the timeframe for stopping a blowout by 20-30 days, although planning/approval/set-up requirements mean the reduction would likely be less.	Delays in drilling campaign schedule to align with other activities in the area	**Rejected –** Santos have no foreseeable plans to contract 2 MODUs to operate in the same region.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		Reduction in spill duration by 20-30 days, results in less hydrocarbon exposure and reduced shoreline loading volumes		
N/A	Pre-drill riserless intervals for a potential relief well, prior to drilling the main well	Reduce the time taken for the relief well to be drilled by approximately 10 days, therefore stopping the LOWC event sooner and resulting in less hydrocarbon exposure and reduced shoreline loading volumes	It is not practicable with a jack-up and surface well head to pre-drill any riserless intervals for a potential relief well before drilling the main well. The activity itself would require approximately 10 days and a complete rig move to perform at a cost of approximately $6-7MM USD. Once the main well was completed, the partially completed relief well would need to be abandoned. At a further cost of approximately $6-7MM USD. A different wellhead/conductor system would need to be procured to facilitate this at estimate cost of $0.75MM USD.	**Rejected –** Detailed relief well designs will be re-evaluated and revised for an actual LOWC event. There will be several locations for the relief well identified before an incident, with the optimal location selected after a LOWC incident, based on real-time information (i.e. prevailing weather). A pre-drilled relief well top-section might result in having to use a sub-optimal design and location. It is not industry practice, and such a pre-drilled riseless interval may adversely affect functionality and reliability of this response strategy. The additional cost associated

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
			Additional environmental impacts from drilling wells from drill cuttings and discharges.	with drilling the riserless intervals would be ~$15MM USD per well which is considered grossly disproportionate to the reduction in the duration that could potentially be achieved of a LOWC event.
N/A	Undertake drilling with a semi-submersible MODU	Potentially allows the use of an emergency BOP and capping stack in the event of a loss of well control event and potentially reducing the loss of hydrocarbons to sea by stopping the LOWC sooner.	Water depths at the Spartan well location are approximately 50m. This water depth precludes the use of DP vessels (Drillships and DP Semis) and would require a moored semi-submersible configurable for 12 point mooring. With the change in rig fleet over the last 10 years, most of the mid-water semi submersibles that operate in the <100m water depth range have been retired. 5th generation moored semis are much harder to moor in shallow water due to the larger size of the	**Reject** - Selecting a semi-submersible purely to allow the possibility of using a capping stack in the event of a worst-case discharge to cap the well in a shorter duration than a relief well only provides a disproportionate reduction in environmental risk to the additional cost. Additionally, the BOP equipment on a jack-up is at surface rather than subsea, and it is inherently more reliable, reducing the likelihood of a worst case discharge at all.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
			vessels & BOP resulting in increased metocean loads on mooring equipment and the BOP/Wellhead/Flex Joints. At these water depths, a semi-submersible may be able to be moored, but would likely be limited to older 3rd/4th generation units and would require extensive use of pre-laid moorings, heavy duty subsea wellheads to handle the bending loads and possibly wellhead fatigue reduction tethering equipment installed on the seabed. The exact MODU needs to be known to perform the detailed engineering work to confirm the MODU can be moored on location. Selecting a moored semi-submersible only would preclude a significant	

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
			number of drilling units from being able to perform the work, which of course affects schedule and cost. Complications with Capping Stack Installation: The premise is that using a semi-submersible unit enables the use of a capping stack for WCD. This is based on the assumption that the LMRP and/or BOP can be disconnected and the rig moved off location enough to enable vertical access to the BOP/Wellhead. It is estimated that the MODU would need to be kedged off location >100m to allow vertical access from a vessel. This kedging process involves moving up to 12 anchor winches and takes several hours to complete, all in an emergency situation when in reality the rig	

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
			crew would be evacuated. It is not realistic to assume that this would happen in a WCD event. With the shallow water depth, it is less likely that a vessel would be unaffected by the boil/gas cloud at surface. Offset installation of a capping stack would be precluded given the presence of the rig and mooring lines over the location.	

7.6.6 Demonstration of as low as reasonably practicable

The use of industry standard safe drilling methodologies, including the inherently safe well design and its operations with primary well control features (i.e., maintaining the appropriate hydrostatic pressure via a monitored fluid column) and secondary well control features (i.e., blowout preventers), reduces the probability of a loss of containment occurring to a very low level. All safety options have been considered in well design and equipment choice for the activity, with no additional safety options possible, it is considered that the risk of a loss of containment occurring has been reduced to ALARP.

The combination of the standard prevention control measures (**Section 7.6.5**) (which reduce the likelihood of the event happening), and the spill response strategies (which may reduce the consequence) together reduce the hydrocarbon spill risk.

Based on the stochastic spill modelling, Santos has determined applicable source control response measures to limit the spill volume from a LOWC event to ALARP. Further detail is provided below.

Source control

A number of source control options have been evaluated for the activity (refer to OPEP). Of these source control options, the drilling of a relief well is considered the primary means of controlling the source in the event of an unplanned well release. Spill response and impact assessment for this activity has been based on the relief well taking 77 days (11 weeks) to execute. A breakdown of the key tasks and their timeframe to drill a relief well in 11 weeks have been included in Section 8.3.3 of the OPEP.

Supporting controls to allow the relief well schedule to be met include:

- "Assurance Review 4: Readiness to Spud" is conducted under the Drilling & Completions Management Process (DCMP).
- Rig capability register is maintained.
- A well-specific Source Control Plan (SCP) is prepared in accordance with the Santos Source Control Planning and Response Guidelines. The SCP contains information and considerations for relief well operations including but not limited to:
  - Relief well surface locations (primary and secondary)
  - Relief well trajectory and interception target point
  - Dynamic well kill modelling calculations for controlling a worst-case discharge (e.g. kill mud weight, kill pump rate/pressure and kill mud volume required)
  - Status of relief well tangible equipment.
  - Australian Petroleum Production and Exploration Association (APPEA) Memorandum of Understanding (MoU) provides for access to other Operator rigs.
  - Contracts and MoUs for 3rd party independent well control specialist personnel are in place.

The implementation timeframe of this control is key to its effectiveness. A second MODU positioned on standby in the vicinity of the activity during the drilling activity was considered as an additional control that could reduce the length of time taken to drill a relief well. This would involve hiring an additional rig for the duration of the activity. If adopted, this may reduce the timeframe for stopping a blowout by up to two weeks, although planning/approval/set-up requirements mean the reduction would likely be less. The cost of having a MODU and personnel/equipment on standby (at a rate of ca. $250,000/day) would double the cost of the activity and introduce additional safety and environmental risks due to presence of an additional MODU and support vessels/equipment being on standby. This is considered grossly disproportionate to the environmental benefit (a potential reduction of two weeks to stop the LOWC, particularly considering the likelihood of a LOWC and the existing preventative control measures in place to prevent a well blowout. Having a dedicated second MODU on standby for the purpose of relief well drilling was therefore rejected as a control measure.

In order to minimise lead times a rig with a NOPSEMA approved Safety Case will be preferred. These rigs are tracked on the Rig Capability Register and access is covered under the APPEA MoU. For the water depths at this location, it is possible that a semi-submersible MODU may be feasible to drill the relief well instead of a jack-up, but this would also depend on the exact circumstances of the LOWC scenario and therefore feasibility is not guaranteed. The well specific Source Control Plan will assess the feasibility and availability of suitable MODUs prior to each drilling activity occurring.

Direct surface intervention (i.e., deployment onto the jack-up rig) using specialised well control personnel is a strategy that could be adopted and supported through contractual arrangements with well control vendors. This strategy is contingent on technical aspects of the LOWC event and safety considerations which could only be assessed at the time of a spill event. For this reason, the current preparedness measures for well intervention experts is considered ALARP.

Santos has access to a subsea first response toolkit (SFRT) and deployment personnel through contract to AMOSC and Oceaneering respectively. Deployment of a capping stack is not feasible for jack-up wells. Consequently, the majority of items in the SFRT are of no use in a LOWC event. However, some items can be used to gather information or increase situation awareness. Additionally, the SFRT can be used to inject dispersant subsea which may have an environmental benefit in reducing the volume of hydrocarbons reaching shorelines. Notwithstanding the above, the use of SFRT is considered unlikely due to safety and technical constraints (i.e., shallow water depths and high predicted gas release rates).

In the unlikely event SFRT was required, SFRT equipment can be mobilised to Dampier from the Jandakot storage yard in two days, under existing arrangements. Locating this equipment in Dampier could potentially reduce deployment time by two days providing a suitable vessel was on standby for immediate mobilisation. However, the equipment is a shared resource across AMOSC SFRT subscription members so relocating for a drilling campaign is not considered viable. Providing a vessel on standby for SFRT deployment could reduce deployment time, but given SFRT deployment may not be suitable or feasible a potential reduction in deployment time due to a vessel being on standby is not seen to offer sufficient environmental benefit given crewed vessel standby costs would be tens of thousands of dollars each day over the drilling period.

Spill mitigation controls

Santos considers that through the selection of appropriate spill response strategies, development of spill response controls and maintenance of preparedness arrangements and resources to implement these controls, spill risk is mitigated to ALARP. Preparedness spill response controls are outlined in **Table 7-16** while those that would be implemented in the event of a spill are outlined within the OPEP.

7.6.7 Acceptability evaluation

Is the risk ranked between Very Low and Medium?	Yes – maximum credible hydrocarbon spill volume (condensate from a LOWC) residual risk is ranked as Medium.
Is further information required in the consequence assessment?	Yes – hydrocarbon spill modelling results were used to determine consequence and risk.
Are risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure, which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes – management consistent with OPGGS(E)R 2009 Regulations, including safety case and WOMP. Santos has considered the values and sensitivities of the receiving environment, including but not limited to: conservation values of the identified protection priorities (**Section 3**) relevant species recovery plans, conservation management plans and management actions, including but not limited to: + Recovery Plan for Marine Turtles in Australia (DoEE, 2017a) + Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015d) + Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015a) + Conservation Management Plan for the Blue Whale, 2015 to 2025 (DoE, 2015b)

	+ Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (TSSC, 2015c) + Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015b) + Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013a) + Approved Conservation Advice for *Pristis clavata* (Dwarf Sawfish) (DEWHA, 2009) + Commonwealth Conservation Advice on *Pristis zijsron* (green sawfish) (DEWHA, 2008a) + Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015a) + Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) (DoE, 2014b) + Approved Conservation Advice for *Milyeringa veritas* (blind gudgeon) (DEWHA, 2008b) + Approved Conservation Advice *for Ophisternon candidum* (blind cave eel) (DEWHA, 2008d) + Conservation Management Plan for the Southern Right Whale 2011 to 2021 (DSEWPaC, 2012) + Approved Conservation Advice for *Aipysurus apraefrontalis* (Short-nosed Sea Snake) (DSEWPaC, 2011a) + National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011 to 2016 (DSEWPaC, 2011b) + Approved Conservation Advice for *Calidris ferruginea* (Curlew Sandpiper) (DoE, 2015c) + Approved Conservation Advice for *Numenius madagascariensis* (Eastern Curlew) (DoE, 2015d) + Approved Conservation Advice for *Sternula nereis nereis* (Fairy Tern) (DSEWPaC, 2011c) + Approved Conservation Advice *Calidris canutus* (Red Knot) (TSSC, 2016a) + Approved Conservation Advice *Charadrius leschenaultii* (Greater sand plover) (TSSC, 2016c) + Approved Conservation Advice for *Anous tenuirostris melanops* (Australian lesser noddy) (TSSC, 2015g) + Approved Conservation Advice *Limosa lapponica menzbier*i (Bar-tailed godwit (northern Siberian)) (TSSC, 2016g) + Approved Conservation Advice for *Papasula abbotti* (Abbott's booby) (TSSC, 2015h) + Approved Conservation Advice for *Pterodroma mollis* (Soft-plumaged petrel) (TSSC, 2015i)

	+ Approved Conservation Advice for *Rostratula australis* (Australian painted snipe) (DSEWPaC, 2013c) Management is also consistent with the zoning of the Australian marine parks, and their management plans in that risks have been reduced to ALARP, e.g., implementation of spill response activities will limit impacts, thereby conserving the marine park values which and other habitats critical to the diversity and value of the protected areas.
Are risks and impacts consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – During stakeholder consultation for the EP Addendum, Santos received a request from WAFIC seeking confirmation that the OPEP considered the following aspects (**Table 4-2**): + Baseline scientific data on aquatic organisms and the aquatic environment + Detailed post spill scientific monitoring of aquatic organism and aquatic environment + Communication strategy that considers the commercial fishing industry in the event of a spill event + Support to the commercial fishing industry with regards to traceability of fish products to manage tainting risks, if required. + Financial assistance to the commercial fishing industry in the event of a spill event. + Santos responded to WAFIC's request and confirmed: + The OPEP will include an overview of Santos' Scientific Monitoring Plan, which includes a description of the approach to collecting baseline data. + The OPEP will include an overview of the process for scientific monitoring post spills. + In the event of a major spill, notifications will be made if applicable to State and Commonwealth Government fisheries agencies, including the Australian Fisheries Management Authority and WA Department of Primary Industries and Regional Development (Fisheries). WAFIC is listed as a key stakeholder in Santos' communications register and would be contacted in the event of an oil spill. + There is a dedicated Scientific Monitoring Plan for Seafood Quality which aims to identify potential human health risks due to the presence of hydrocarbon concentrations in the flesh of targeted seafood species for consumption.

	+ If any claims are received from parties who consider themselves affected by our activities, we would seek to respond to these claims in a timely and respectful manner. + Santos considers the request closed.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes (see ALARP above)

The likelihood of a LOWC event during the activity is unlikely when considering industry statistics, Santos statistics and the preventative controls in place. Wells are designed with essential engineering and safety control measures to prevent a LOWC incident occurring. Additional industry-standard and activity-specific control measures to reduce the chance of the event occurring (and minimise impacts) have also been implemented, including (but not limited to) procedures such as the safety case, WOMP, personnel training and awareness, and a spill response plan (OPEP). In accordance with Santos' risk assessment process, the residual risk is considered to be ALARP. The proposed control measures will reduce the risk of impacts from a LOWC to a level that is considered acceptable.

7.7 Hydrocarbon Spill - Marine Diesel Oil

7.7.1 Description of event

Event	*Worst-credible marine diesel oil spill* It is considered credible that a release of MDO to the marine environment could occur between the support vessels, between a support vessel and the MODU or ISV, or between a passing third party vessel and the MODU, ISV or a support vessel. The worst-case environmental incident resulting from a vessel collision is the rupturing of a vessel fuel tank resulting in the release of MDO to the environment. Vessel collision could occur due to factors such as human error, poor navigation, vessel equipment failure or poor weather. A maximum credible spill volume has been determined based on technical guidance provided by AMSA (2015). This guidance states that for a vessel other than an oil tanker, the maximum credible spill from a collision can be determined from the volume of the largest single fuel tank. In reviewing the general arrangements and fuel tank capacities of the ISV, the largest single fuel tank capacity identified was 186 m^3. *Refuelling incident* There will be no helicopter refuelling on the MODU. The second most significant MDO spill scenario identified is a MODU or ISV refuelling incident (fuel hose failure or rupture, coupling failure or tank overfilling) where fuel bunkering would need to be stopped manually. Fuel released prior to the cessation of pumping as well as fuel remaining in the transfer line may escape to the environment. The AMSA (2015) Technical Guidelines for Preparing Contingency Plans for Marine and Coastal Facilities provides guidance for calculating a maximum credible spill volume for a refuelling spill. The guidance provided by AMSA (2015) for a refuelling spill under continuous supervision is considered appropriate given refuelling will be constantly supervised. The maximum credible spill volume during refuelling is calculated as: transfer rate (150 m^3/hr) x 15 minutes of flow giving a volume of 37.5 m^3. The detection time of 15 minutes is seen as conservative but applicable following failure of multiple barriers followed by manual detection and isolation of the fuel supply. For the purpose of the EP Addendum the impacts of a MDO spill of 329 m^3 has been assessed as this is the largest credible MDO spill associated with the activity.
Extent	Diesel spill trajectory modelling (RPS 2021b) indicated that there was some probability of a 329 m^3 MDO spill extending as follows (using the moderate exposure thresholds) based on a summary from the modelling locations: Shoreline loading was predicted to occur within 40 km (albeit at very low probability and very low predicted maximum loading of < 1 m^3). Surface oil was predicted to occur within approximately 41 km. Entrained oil was predicted to occur within approximately 299 km. Dissolved hydrocarbons were predicted to occur within approximately 154 km.
Duration	A 329 m^3 release of MDO was modelled for a release over 0.5 hour, replicating the potential duration of a spill arising from a significant collision.

7.7.2 Nature and scale of environmental impacts

Hydrocarbon spills will cause a decline in water quality and may cause chemical (e.g., toxic) and physical (e.g., coating of emergent habitats, oiling of wildlife at sea surface) impacts to marine species. The severity of the impact of a hydrocarbon spill depends on the magnitude of the spill (i.e., extent, duration) and sensitivity of the receptor. The nature and scale of a hydrocarbon spill is described throughout this chapter for a vessel collision scenario, given smaller hydrocarbon spills (from refuelling) will impact a smaller area than a vessel collision.

Potential receptors: Physical environment (water and sediment quality, shoals and banks, benthic habitats, offshore reefs and islands), threatened or migratory fauna (marine mammals, marine reptiles, sharks, fish, rays and birds), protected and significant areas (marine parks, heritage areas, KEFs), socio-economic receptors (fisheries, tourism, recreation and other third-party operators).

A surface release of MDO to the marine environment would result in a localised reduction in water quality in the upper surface waters of the water column near the location of the spill. To ensure conservatism, the diesel release scenario modelling from locations outside of the. Potential impact pathways (physical and chemical) of hydrocarbon exposure for receptors are summarised in **Table 7-12** and potential impacts to receptors found within the EMBA are further described in **Table 7-13**. The locations predicted to receive hydrocarbons above the moderate threshold are within the MEVA described for a LOWC and are also identified as hotspots (Refer **Section 7.6.4.1**). Therefore, a consequence assessment has been conducted on these receptors assuming contact with hydrocarbons from a LOWC event (refer **Appendix G**) which is considered worse than an MDO spill event, therefore impacts described within the EP Addendum are conservative. The locations contacted by diesel spill modelling above moderate thresholds are also considered for oil spill response strategies as appropriate (Refer Section 5. of OPEP).

7.7.3 Spill modelling results

The modelling results (RPS, 2021b) are presented for the fate of hydrocarbon from a vessel collision at the exposure values defined in **Section 7.5.4**, and has been provided for the purposes of risk evaluation, displaying the parameters of:

- minimum time to contact from moderate and high exposure value;
- maximum hydrocarbon concentration from high exposure value;
- maximum oil loading on shoreline from moderate and high exposure value; and
- length of shoreline oiled.

Further parameters required to inform spill response strategies are described in the OPEP. A summary of the modelling results is provided below.

Shoreline accumulation

The maximum oil volume loading on shorelines during a single spill event was predicted as <1 m^3, at only one receptor (Barrow Island), with a very low probability (at a threshold of > 100 g/m^2) of less than 2%.

Floating oil

Low – Surface oil above the low threshold (1 g/m^2) was predicted to extend up to approximately 48 km from the release location.

Moderate and High – At the moderate threshold (10 g/m^2), surface oiling was reduced in spatial extent to within approximately 41 km of the release location. At the high threshold (50 g/m^2) surface oiling was reduced in spatial extent to within approximately 22 km of the release location.

Receptors predicted to be contacted by surface oiling above the moderate threshold (10 g/m^2) were the Montebello AMP (44% probability) and Barrow – Montebello Surrounds (2% probability).

Entrained oil

Low – Entrained oil at the low threshold (10 ppb) was predicted to primarily occur within approximately 486 km of the release location.

Moderate – At the moderate threshold (100 ppb), predicted contact was reduced in spatial extent primarily within approximately 299 km of the release location.

Receptors predicted to be contacted by entrained oil at the moderate threshold (100 ppb) included Montebello AMP (64% probability), Ningaloo – offshore (44%), Barrow – Montebello Surrounds (22%), Muiron Islands (20%), Southern Islands Coast (16%), Ningaloo – outer coast north (12%), Barrow Island (10%), Ningaloo – outer NW (10%), Thevernard Islands (6%) and Ningaloo Coast North (4%) .

Dissolved oil

Low – Dissolved hydrocarbons at the low threshold (10 ppb) were predicted to extend a maximum distance of approximately 250 km from the release location.

Moderate and High – At the moderate threshold (50 ppb), the spatial extent was within approximately 154 km of the release location. Exceedance of the high threshold (400 ppb) was limited to within 1 km of the release site.

Receptors predicted to be contacted by dissolved hydrocarbons at the moderate threshold (50 ppb) included Montebello AMP (20% probability), Ningaloo – offshore (4%), Ningaloo Coast North (2%), Barrow Island (2%) and Barrow – Montebello Surrounds (2%).

7.7.4 Environmental performance outcomes and control measures

The EPOs relating to this event include:

+ No loss of containment of hydrocarbon to the marine environment [ST-EPO-03].

The control measures applied to prevent hydrocarbon spill from refuelling and vessel collision are shown in **Table 7-17** with EPSs and measurement criteria for the EPOs described in **Table 8-2**.

Selection of oil spill response strategies and associated performance outcomes, control measures and performance standards, including those required to maintain preparedness and for response, are detailed within the OPEP. The OPEP contains an evaluation of oil spill preparedness arrangements to demonstrate that oil spills will be mitigated to ALARP.

Santos

Table 7-17: Control measure evaluation for the surface release of diesel (vessel collision/bunkering)

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
ST-DC-CM-015	Support vessel for drilling activities	Minimises risk of collision with the MODU through visual identification and avoidance of other vessels.	Negligible costs.	**Adopted** – Benefits considered to outweigh costs.
ST-DC-CM-039 ST-IC-CM-003	Lighting will be used as required for safe work conditions and navigational purposes	Ensures vessels meet minimum safety standards therefore reducing potential for vessel collision events with associated diesel spill to the environment. Marine Order Part 30: Prevention of Collisions, and with Marine Order Part 21: Safety of Navigation and Emergency Procedures requires vessels to have navigational equipment to avoid collisions. Requirement of the *Navigation Act 2012*.	Costs associated with personnel time in checking vessel certifications are in place. Negligible costs of operating navigational equipment.	**Adopted** – Benefits considered to outweigh costs.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
ST-DC-CM-020 ST-IC-CM-005	Fuel oil quality	Use of diesel reduces the potential impacts to marine environment in the event of unplanned hydrocarbon spills or leaks during bunkering.	Additional personnel costs of ensuring vessels are using the required fuel.	**Adopted** – Benefits of ensuring procedures are followed outweighs the minimal costs of personnel time.
ST-DC-CM-040 ST-IC-CM-011	Seafarer Certification	Requires appropriately trained and competent personnel, in accordance with Marine Order 70, to navigate vessels to reduce interaction with other marine users. Requires appropriately trained and competent personnel to navigate vessels.	Costs associated with personnel time in obtaining qualifications.	**Adopted** – Benefits considered to outweigh costs.
ST-DC-CM-012 ST-IC-CM-034	MODU, ISV and support vessel spill response plans including pre-drilling relief well plan	Implements response plans on board vessels to deal with unplanned hydrocarbon releases and spills quickly and efficiently in order to reduce impacts to the marine environment.	Administrative costs of preparing documents. Generally undertaken by vessel contractor so time for Santos personal to confirm and check Shipboard Oil Pollution Emergency Plan (SOPEP)/ SMPEP in place.	**Adopted** – Benefits of considered to outweigh costs.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
ST-DC-CM-016 ST-IC-CM-035	Accepted OPEP	Implements response plans to deal with an unplanned hydrocarbon release quickly and efficiently in order to reduce impacts to the marine environment.	Administrative costs of preparing documents and large costs of preparing for and implementing response strategies.	**Adopted** – Regulatory requirement must be adopted.
ST-DC-CM-041 ST-IC-CM-036	Marine assurance standard	Ensures vessels meet Marine assurance standards to reduce the likelihood of unplanned discharge.	Costs associated with personnel time in checking vessel.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented and that the vessels are compliant outweigh the costs. Regulatory requirement must be adopted.
ST-DC-CM-046	Pre-campaign commencement assurance check	Ensures consideration of worst case hydrocarbon spill scenario for the proposed activity based on actual vessel, MODU and activity details.	Administrative costs to undertake assurance check and risk assessments for each campaign.	**Adopted –** Benefits considered to outweigh costs.
ST-DC-CM-042 ST-IC-CM-037	Refuelling and chemical transfer procedure	Minimises risk of pollution to ALARP during hydrocarbon transfers between MODU and vessels.	Personnel costs associated with ensuring procedures are in place and implemented during refuelling and chemical transfers.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh the costs.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
ST-DC-CM-038	Petroleum Safety Zone (PSZ) established around MODU	Reduces potential for collision or interference with other marine user activities	Negligible costs, standard industry practice	Adopted – Benefits considered to outweigh negligible costs to Santos
ST-IC-CM-016	Safety Exclusion Zone established around the ISV to reduce potential for collision or interference with other marine user activities	Requested Safety Exclusion Zone around the ISV prevents other vessels from getting too close and causing damage to equipment of either party.	No additional costs to Santos. Other marine users may be temporarily excluded from small areas.	**Adopted** – The exclusion of other marine users is temporary. Marine users will still be able to access the operational area. Normal navigation at sea process whereby shipping vessels avoid navigational risks. Hence, the safety benefits to all marine users outweighs any potential costs.
ST-DC-CM-044	MODU PMS	MODU equipment is operating within its parameters, reducing the risk of unplanned discharges to the marine environment.	Costs are standard for routine PMS.	**Adopted** – benefits in reducing atmospheric emissions impacts outweigh the minimal costs.
ST-DC-CM-045 ST-IC-CM-002	Vessel PMS	Vessel equipment is operating within its parameters, reducing the risk of unplanned discharges to the marine environment.	Costs are standard for routine PMS.	**Adopted** – benefits in reducing atmospheric emissions impacts outweigh the minimal costs.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
ST-DC-CM-023 ST-IC-CM-012	Santos stakeholder consultation strategy	Santos will notify all relevant stakeholders listed, or as revised, in **Section 4**, of relevant activity details prior to commencement, including activity timing, vessel movements, proposed cessation date and vessel details.	Costs associated with personnel time in preparing and distributing information and collating/addressing any feedback provided.	**Adopted** – Benefits considered to outweigh negligible costs to Santos.
ST-IC-CM-038	Dynamic positioning system	Ensure vessel is running efficiently and routine maintenance endeavours to ensure risk of collision form vessel system failure is reduced.	No additional costs, is industry best practice.	**Adopted** – No additional costs
Additional Controls				
N/A	Schedule activities to avoid coinciding with sensitive periods for marine fauna present in the operational area	Potential reduction in risk of a hydrocarbon spill to some sensitive receptors	Impracticable to schedule activities to avoid all listed marine fauna due to variability in timing of environmentally sensitive periods and the constant or unpredictable presence of some species. Short duration activity (i.e., a few days) that is low risk to marine fauna.	**Rejected** – Cost is disproportionate to increase in environmental benefit

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
N/A	Zero fuel bunkering via hose	Removes spill risk from hose operations.	Cost associated with transfer of MDO via drums or containers. Not possible to modify MODU or ISV to allow additional fuel storage. Cost associated with vessel transits and risk transfer to Health and Safety issues with additional trips to port instead. Would significantly increase the schedule to include multiple trips.	**Rejected** – Storage of fuel on MODU and ISV would result in unacceptable transfer of environmental risks to occupational health and safety/ operational risks and would not eliminate risk of MDO spills to sea. Costs associated with implementing control is deemed grossly disproportionate to environmental benefit and low risk activity with standard controls in place.
N/A	Require all vessels involved in the activity to be double hulled.	Reduces the likelihood of a loss of hydrocarbon inventory in the highly unlikely event of a vessel collision, minimising potential environmental impact.	Vessels are subject to availability and are required to meet Santos' standards during activities, requirement of a double hull on vessels would limit the number available to Santos Also, requiring vessels to be refitted to ensure double hulls would be of high cost.	**Rejected** – Large costs associated with vessel selection and by having an activity schedule determined by vessel availability considered to be grossly disproportionate compared to low risk of a vessel collision and low risk of a large diesel spill.

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
	Dedicated standby vessel on location during installation activities.	Reduces potential for collision or interference with other marine users	Large costs associated with a dedicated standby vessel given the existing facilities (John Brookes Pipeline) is already marked on marine charts and is within 1 km of the installation activities	**Rejected -** large cost associated with dedicated standby vessel which outweigh any benefits

7.7.5 Environmental impact assessment

Description	
Receptors	Physical environment – water quality, Shallow benthic, intertidal and shoreline habitats Threatened/migratory fauna – plankton, invertebrates, marine mammals, marine reptiles, sharks, rays and fish, birds (seabirds and shorebirds) Protected Areas – KEFs, Marine Parks and Commonwealth Heritage Areas Socio-economic – commercial, recreational and traditional fisheries, recreation and tourism, oil and gas industry)
Consequence	III – Moderate

A summary of the consequence assessment for each receptor category is presented below. Potential impact pathways (physical and chemical) of hydrocarbon exposure for receptors are summarised in **Table 7-12**, and potential impacts to receptors found within the MEVA in the event of a LOWC are further described in **Table 7-13**, this encompasses the MEVA and EMBA for a vessel collision resulting in a release of MDO.

Threatened/migratory fauna

A surface release of MDO to the marine environment would result in a localised reduction in water quality in the upper surface waters of the water column. As a light hydrocarbon, MDO undergoes rapid spreading and evaporative loss in warm waters, indicating that a surface slick will be temporary. Under moderate winds (5 m/s), 40% of the initial surface slick is predicted to remain as surface oil after 24 hours, decreasing further to approximately 10% after 48 hours and approximately 1% after 72 hours (RPS, 2021b). The high rate of evaporation means that little MDO will become entrained and few aromatic hydrocarbons are predicted to become dissolved reducing impact to marine fauna. Surface oil, and entrained hydrocarbon in the sea surface layer, could have the physical effect of coating fauna interacting within and under the surface, including plankton, pelagic invertebrates and fishes, marine reptiles, marine mammals and seabirds, and may also affect some species through ingestion of oiled fish (as described in **Table 7-12**).

The diesel EMBA overlaps breeding/foraging BIAs for a number of seabirds. An unplanned release of MDO is not expected to interfere with their breeding activity, but could cause slight secondary effects through ingestion after preening or ingestion of oiled fish (as described in **Table 7-12** and **Table 7-13**).

The humpback whale (migration) and pygmy blue whale (distribution, migration and foraging) BIAs and whale shark foraging BIA overlap the EMBA. An unplanned release of MDO is not expected to interfere

Description
with their migration activity. There is the potential for behavioural disruption to the local population as individuals traverse the area affected with potential for coating of baleen (in whales) and ingestion of oiled prey (plankton/fish) as described in **Table 7-12** and **Table 7-13**. The EMBA overlaps nesting/internesting and critical habitat BIAs for a number of marine turtle species and therefore turtle behaviour could be disrupted with the potential to threaten turtle populations (as described in **Table 7-13**), particularly those at significant rookeries on Barrow Island and Montebello Islands. Deteriorating water quality/chemical and terrestrial discharge is identified as a potential threat to turtles in the marine turtle recovery plan, and some bird and shark species. Habitat modification, degradation and disruption, pollution and/or loss of habitat are also identified as threats to sharks, birds, cetaceans and turtles in conservation management and recovery plans. Given the offshore location of the release, and volume of potential hydrocarbon release there is little potential for modification to or a decrease in the availability of quality habitat (shorelines/subsurface). Shoreline accumulation may present a major disruption to shoreline individuals (as described in **Table 7-13**). However, there is very little potential for shoreline accumulation, with volumes ashore expected to be < 1 m^3. Volumes of accumulated hydrocarbon may result in a reduction in area available for seabirds and/or turtle species. The quality of habitat (shorelines/subsurface) may be reduced for a period, with recovery over the medium term (decades). *Physical environment and habitats* In the event of MDO release, hydrocarbons that reach nearshore environments have the potential to impact benthic coral reefs and mangrove areas which may result in a decrease in ecological values given toxicity impacts associated with hydrocarbon exposure. The quality of habitat may be reduced for a significant period with recovery over the medium term (two to ten years). As described above, accumulated hydrocarbons on shorelines could impact marine fauna that utilize beaches such as shorebirds and turtles, dependent upon the timing of a spill. Beaches on the Ningaloo Coast, Barrow Island and Montebello Islands are important for green turtles, and to a lesser extent hawksbills turtles and flatback turtles, while Muiron Islands has a regionally important nesting site for loggerhead turtles. Impacts to turtles could occur from surface hydrocarbons if MDO accumulates on nesting beaches. However, there is very little potential for shoreline accumulation, with volumes ashore expected to be < 1 m^3. Entrained hydrocarbon could also contact sandy beaches at high tide. Such impacts would be most likely to nesting females as they move up and down beaches or to turtle hatchlings as they emerge from nests six to eight weeks following nesting. The quality of habitat available to the turtles will be reduced, with recovery over the medium term. *Protected areas* The EMBA intersects several Marine Parks, AMPs, Commonwealth Heritage Areas and marine management areas. Combined, these areas support all the habitats and faunal groups described above. Impacts to the habitat/fauna receptors described above therefore have an impact on the values of these reserves which could have flow-on effects to tourism revenue of coastal communities that provide access to these marine reserves. *Socio-economic receptors* There is the potential for hydrocarbons to temporarily disrupt fishing activities if the surface or entrained hydrocarbon moves through fishing areas. However, the high rate of evaporation means that little MDO will become entrained and few aromatic hydrocarbons are predicted to become dissolved. It is possible that there could be accumulation of oil in fish tissues to the extent that could result in hydrocarbon tainting of fish flesh. Connell and Miller (1981) compiled a summary of studies listing the exposure value concentrations at which tainting occurred for hydrocarbons. The results contained in their review indicate that tainting of fish occurs when fish are exposed to ambient concentrations of 4 to 300

Description	
ppm (4,000 to 300,000 ppb) of hydrocarbons in the water, for durations of 24 hours or more, with response to phenols and naphthenic acids being the strongest. Given the volume of oil that could potentially be released, it is possible that impacts could be detected to fisheries on a stock level although it is more likely that natural variation in fish abundance would be on a greater scale than any impacts attributable to a hydrocarbon spill. This would most likely be the case for fisheries species that utilise shallow waters around the Lowendal, Barrow and Montebello Islands and could occur through direct impacts to fish or to fish habitats (e.g., seagrass, coral reef, mangrove habitats). Entrained and surface oil could impact pearl farming activities at the Montebello Islands. Given that pearl oysters are filter feeders, entrained oil droplets could create negative impacts through ingestion and accumulation of hydrocarbon compounds in oyster tissues or interference with respiratory structures. Such impacts could lead to sub-lethal (e.g., reduced oyster growth rates, reduced reproductive success) or at worst lethal impacts. Given that dissolved hydrocarbons could reach acutely toxic levels, mortality could occur. A number of oil and gas operators operate within the EMBA with existing projects and infrastructure in place as well as continuing drilling and exploration programs. An unplanned hydrocarbon release has the potential to disrupt these activities, with associated economic impact, albeit on a temporary basis. Tourism could also be affected by a spill, either from reduced water quality/shoreline oiling preventing recreational activities or reducing aesthetic appeal or from impacts to habitats and marine fauna as described in **Table 7-12** and **Table 7-13**.	
Likelihood	B – Unlikely
A worst-case hydrocarbon release resulting from a vessel collision could result in major disruption and long-term effects on the receiving environment. Impacts could decrease local populations and result in loss of critical habitats; however, recovery would be expected within decades. With the proposed CMs in place to prevent releases, any decline in local populations or degradation of habitats is considered unlikely and therefore the activity will be conducted in a manner that is considered acceptable. The likelihood of a hydrocarbon release occurring due to a vessel collision/bunkering is limited given the set of mitigation and management controls in place. Subsequently the likelihood of a vessel collision releasing hydrocarbons to the environment resulting in a major consequence is considered to be Unlikely (b).	
Residual Risk	The residual risk associated with this hazard is **Low**.

7.7.6 Demonstration of as low as reasonably practicable

The use of vessels is integral to activity and therefore vessels and associated risks of unplanned hydrocarbon releases, cannot be completely eliminated.

Offshore refuelling is standard industry practice and oil pollution legislation (Protection of the Sea (Prevention of Pollution from Ships) Act 1983 and MARPOL Annex I) has been developed to safeguard against the risk of a hydrocarbon spill occurring during refuelling. Other hydrocarbon types such as HFO, IFO have specifically not been selected for this Activity (only diesel will be used in the Operational Area) to ensure potential environmental impacts are reduced to ALARP.

The combination of the standard prevention CMs (which reduce the likelihood of the event happening), and the spill response strategies (which may reduce the consequence) together reduce the overall hydrocarbon spill risk.

No additional controls have been identified and given the controls in place detailed above, the assessed residual risk for this impact is Low and cannot be reduced further. It is considered therefore that the impact of the activities conducted is reduced to ALARP.

In terms of spill response activities, Santos will implement oil spill response as specified within the OPEP. A detailed ALARP assessment on the adequacy of arrangements available to support spill response strategies and CMs is presented in the OPEP.

The North-west Marine Parks Network Management Plan states that actions required to respond to oil pollution incidents, including environmental monitoring and remediation, in connection with mining operations authorised under the OPGGS Act may be conducted in all zones of the marine parks identified with the EMBA (DNP, 2018a) without an authorisation issued by the Director, provided that the actions are taken in accordance with an EP that has been accepted by NOPSEMA, and the Director is notified in the event of oil pollution within a marine park, or where an oil spill response action must be taken within a marine park, so far as reasonably practicable, prior to response action being taken.

7.7.7 Acceptability evaluation

Is the risk ranked between Very Low to Medium?	Yes – residual risk is ranked as Low
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure, which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes – management consistent with OPGGS (E) R 2009 including safety case and WOMP. Santos has considered the values and sensitivities of the receiving environment, including, but not limited to: conservation values of the identified protection priorities (**Section 3**) relevant species recovery plans, conservation management plans and management actions, including but not limited to: + Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (TSSC, 2015d) + Recovery Plan for Marine Turtles in Australia (DoEE, 2017a) + Approved Conservation Advice for *Rhincodon typus* (whale shark) (TSSC, 2015a) + Conservation Management Plan for the Blue Whale, 2015 to 2025 (DoE, 2015b) + Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (TSSC, 2015c)

	+ Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (TSSC, 2015b) + Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) (DoE, 2014b) + Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013a) + Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015a).
Are risks and impacts consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environmental Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – During stakeholder consultation for the EP Addendum, Santos received a request from WAFIC seeking confirmation that the OPEP considered the following aspects (**Table 4-2**): + Baseline scientific data on aquatic organisms and the aquatic environment + Detailed post spill scientific monitoring of aquatic organism and aquatic environment + Communication strategy that considers the commercial fishing industry in the event of a spill event + Support to the commercial fishing industry with regards to traceability of fish products to manage tainting risks, if required. + Financial assistance to the commercial fishing industry in the event of a spill event. + Santos responded to WAFIC's request and confirmed: + The OPEP will include an overview of Santos' Scientific Monitoring Plan, which includes a description of the approach to collecting baseline data. + The OPEP will include an overview of the process for scientific monitoring post spills. + In the event of a major spill, notifications will be made if applicable to State and Commonwealth Government fisheries agencies, including the Australian Fisheries Management Authority and WA Department of Primary Industries and Regional Development (Fisheries). WAFIC is listed as a key

	stakeholder in Santos' communications register and would be contacted in the event of an oil spill. + There is a dedicated Scientific Monitoring Plan for Seafood Quality which aims to identify potential human health risks due to the presence of hydrocarbon concentrations in the flesh of targeted seafood species for consumption. + If any claims are received from parties who consider themselves affected by our activities, we would seek to respond to these claims in a timely and respectful manner. Santos considers the request closed.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

Given the CMs in place to prevent a vessel collision and refuelling incidents and the low frequency of significant volume diesel spills that occur in the industry, the likelihood of a loss of containment event during the activity is low. The risks from diesel spills are well understood and the activities will be managed in accordance with relevant legislation and standards. The CMs proposed are consistent with applicable actions described in the relevant Recovery Plans and Approved Conservation Advice and no stakeholder concerns have been raised regarding this aspect.

With the implementation of industry standard and activity-specific CMs to reduce the chance of a diesel spill event (and minimise impacts), the residual risk is assessed to be Low and ALARP. CMs will reduce the risk of impact from MDO spill to a level that is acceptable.

7.8 Minor Hydrocarbon Release

7.8.1 Description of event

Event	Causes for accident hydrocarbon releases (other than diesel release from a vessel collision or bunkering, and LOWC) include: + hydraulic fluids, lubricant oils and (stored) waste oils; + ROV failure (including oil seal, hydraulic system hose and quick disconnect system failures); + loss of primary containment (drums, tanks, intermediate bulk containers [IBCs], etc) due to handling, storage and dropped objects (e.g., swinging load during lifting activities); + vessel or MODU pipework failure or rupture, hydraulic hose failure, inadequate bunding; + lifting – dropped objects damaging diesel infrastructure (hoses, pipes, tanks, etc); and + formation fluids from flaring drop out during well testing. The MODU/vessels main engines and equipment such as pumps, cranes, winches, power packs and generators require MDO for fuel and a variety of hydraulic fluids and lubricating oils for efficient operation and maintenance of moving parts. These products are present within the equipment and also held in storage containers and tanks on the MODU and vessels. Small hydrocarbon leaks could occur from loss of primary containment due to handling, storage and dropped objects (during lifting activities). Volumes are likely to be small and limited to the volume of individual containers (e.g., IBC, 44-gallon drums) stored on the deck of vessels or the MODU. The credible spill for this scenario is considered to be the loss of an IBC (1 m^3) during transfer from a support vessel to the MODU or ISV. Equipment deployed overboard during drilling or installation activities (e.g., ROV operations) can result in unplanned discharges (of hydraulic fluids) directly to the marine environment due to equipment failure, equipment interactions with the vessel thrusters and/or accidental contact with subsea infrastructure. The largest credible hydrocarbon spill from ROV operations would be an accidental release of approximately 0.05 m^3 (50 L) of hydraulic fluid from the deployed ROV. Well testing is conducted to evaluate any hydrocarbon-bearing formations for possible flow characteristics and to clean the wellbore prior to production operations. Hydrocarbon flaring may be interrupted by pressure drops, incomplete combustion, or higher than anticipated drilling fluid content in the flaring system during well testing. As a result of flaring drop out, formation fluids may subsequently be discharged into the marine environment. Similarly, some flowback cushioning fluids may accidentally be released during well testing. Hydrocarbon spilt volumes due to drop out from flaring and well testing are difficult to estimate. Given the automatic and manual systems in place during flaring, the accidental release of hydrocarbon is expected to be low (less than 500 L). Base oil utilised during well testing is stored in pits on the MODU, in the event of structural failure during bunkering, there is the possibility of a release to the marine environment. Minor accidental loss of other hydrocarbon-based liquids (e.g., used lubricating oils, cooking oil, and hydraulic oil) to the marine environment could also occur via tank pipework failure or rupture, hydraulic hose failure, inadequate bunding and/or storage, insufficient fastening or inadequate handling which could result in impacts to water quality and hence sensitive environmental receptors.
Extent	The relative low volumes are expected to rapidly disperse into the marine environment. Below toxic/harmful threshold concentrations are expected to occur at short distances

	from the hydrocarbon release point. In the event of a worst-case spill, potential impacts beyond the operational areas are not expected.
Duration	Potentially toxic/harmful threshold concentrations limited to a very short period immediately following release.

7.8.2 Nature and scale of environmental impacts

Potential receptors: Physical environment (water and sediment quality, benthic habitats), threatened, migratory or local fauna (marine mammals, marine reptiles, sharks and rays, fish and birds), protected areas (Montebello AMP) and socio-economic receptors (commercial fishing).

Hydraulic fluids and lubricating fluids behave similarly to MDO when spilt in the marine environment (for information on MDO behaviour in the marine environment refer to **Section 7.7**). Hydraulic fluids are medium oils of light to moderate viscosity and have a relatively rapid spreading rate and, like diesel, will dissipate quickly, particularly in high sea states, although lubricating oils are more viscous and so the spreading rate of a spill of these oils would be slightly slower.

Physical environment

Minor volumes of hydrocarbons released to the marine environment may lead to contamination of the water column in the vicinity of the MODU and vessels. The potential impacts would most likely be highly localised and restricted to the immediate area surrounding the spill, with rapid dispersal to concentrations below impact thresholds likely to occur in the open ocean.

Due to the small volumes and expected rapid dispersal to concentrations below impact thresholds, impacts to water quality are not expected to cause flow-on effects to sediment quality or benthic habitats. There is no emergent or intertidal habitat that could be impacted by a surface spill and spilled hydrocarbons at minor volumes are unlikely to reach shorelines.

Threatened migratory or local fauna

The minor and short-term changes to water quality that may result are not predicted to impact on marine fauna (e.g., pelagic fish and sharks, marine mammals, marine reptiles and seabirds). As summarised in **Table 3-8**, the internesting BIAs for marine turtles, and BIAs for whales (migration and distribution) and whale shark (foraging) overlap the operational area, therefore these receptors may be present. A number of Recovery Plans and Conservation Advice for threatened and migratory species that may occur within the operational areas (**Table 3-9**) identify marine pollution and deteriorating water quality (chemical discharge) as a threat to the species.

Small hydrocarbon spills are unlikely to have an ecological effect on threatened or migratory fauna, given the small volumes that could be released, and the open ocean environment. Physical coating of marine fauna or lethal/sub-lethal toxicity effects from any accidentally released hydrocarbons, is considered unlikely given the expected low concentrations and short exposure times.

Protected areas

Although the drilling operational area overlaps a small portion of the Montebello AMP, significant impacts to the sensitivities and values of the AMP are not expected. As described above, impacts to water quality would most likely be highly localised and restricted to the immediate area surrounding the spill, with rapid dispersal to concentrations below impact thresholds likely to occur in the open ocean. Impacts to sediment quality and benthic habitats are not expected. Widespread ecological affects on threatened and migratory marine fauna are not expected.

Socio-economic receptors

Given the localised and temporary impacts of an unplanned hazardous liquid spill, any impact to commercial fishing, tourism and recreation activities is considered unlikely.

7.8.3 Environmental performance outcomes and control measures

The EPOs relating to this event include:

+ No loss of containment of hydrocarbon to the marine environment [ST-EPO-03].
+ No unplanned objects, emissions or discharges to sea or air [ST-EPO-04].
+ No injury or mortality to EPBC Act 1999 and WA Biodiversity Conservation Act 2016 listed fauna during activities [ST-EPO-05].

The control measures considered for this event are shown in **Table 7-18**, and EPSs and measurement criteria for the EPOs are described in **Table 8-2**.

Table 7-18: Control measure evaluation for minor release of hydrocarbons

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
Standard Controls				
ST-DC-CM-CM-002	Dropped object prevention procedures	Impacts to environment are reduced by preventing dropped objects and by retrieving dropped objects where possible. Minimises drop risk during MODU lifting operations. Ensures lifting equipment certified and inspected.	Personnel costs involved in implementing procedures and in incident reporting.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh costs.
ST-DC-CM-005 ST-IC-CM-033	Hazardous chemical management procedures	Reduces the risk of spills and leaks (discharges) to sea by controlling the storage, handling and clean-up.	Personnel cost associated with implementation of procedures and permanent or temporary storage areas.	**Adopted** – Benefits of ensuring procedures are followed and measures implemented outweigh costs.
ST-DC-CM-007	Chemical selection procedure	Reduced toxicity to marine environment	Potential additional cost and delays of	**Adopted –** Benefits of ensuring

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
ST-IC-CM-022		through ensuring only environmentally acceptable chemicals discharged to sea.	chemical substitution.	procedures are followed outweighs costs.
ST-DC-CM-008 ST-IC-CM-021	General chemical management procedures	Potential impacts to the environment are reduced through following correct procedures for the safe handling and storage of chemicals.	Personnel costs associated with ensuring procedures are in place and implemented during inspections.	**Adopted –** Benefits of ensuring procedures are followed and measures implemented outweigh the costs of personnel time.
ST-DC-CM-009 ST-IC-CM-039	Maritime Dangerous Goods Code	Dangerous goods managed in accordance with IMDG Code to reduce the risk of an environmental incident, such as an accidental release to sea or unintended chemical reaction.	Cost associated with implementation of code/procedure.	**Adopted –** Benefits of ensuring procedures are followed and measures implemented outweigh costs.
ST-DC-CM-013 ST-IC-CM-040	ROV inspection and maintenance procedures	Maintenance and pre-deployment inspection on ROV completed as scheduled to reduce the risk of hydraulic fluid releases to the marine environment.	Additional personnel costs of ensuring procedures in place and followed.	**Adopted –** Benefits of ensuring procedures are followed outweigh costs.
ST-DC-CM-016 ST-IC-CM-035	Accepted OPEP	Implements response plan to deal with an unplanned hydrocarbon spills quickly and efficiently in order to reduce impacts	Personnel and administrative costs associated with preparing documents, ongoing management (spill response exercises) and	**Adopted –** Regulatory requirement must be adopted..

Control Measure Reference No.	Control Measure	Environmental Benefit	Potential Cost/Issues	Evaluation
		to the marine environment.	implementation of OPEP.	
ST-DC-CM-017	Drilling and Completions Management Process	Well integrity control measures reduce the risk of unplanned discharges to the marine environment during well testing.	Cost associated with developing and implementing procedure.	**Adopted –** Benefits of ensuring procedures are followed outweighs costs.
ST-DC-CM-036	Well test procedures	Includes control measures that reduce the risk of hydrocarbons from entering the marine environment.	Cost associated with implementing procedures.	**Adopted –** Benefits of ensuring procedures are followed outweighs costs.
ST-IC-CM-041	Deck drainage control measures on ISV	Reduces the risk of spills and leaks (discharges) to sea through use of scupper plugs or equivalent deck drainage control measures available where chemicals and hydrocarbons are stored and frequently handled.	Additional personnel costs of ensuring procedures in place and followed.	**Adopted** – Benefits of ensuring procedures are followed outweigh costs.

7.8.4 Environmental impact assessment

Description	
Receptors	Physical environment (water and sediment quality, benthic habitats) Threatened, migratory or local fauna (marine mammals, marine reptiles, sharks, fish, rays and birds) Socio-economic receptors (tourism and recreation)
Consequence	I – Negligible

Description	
In the event of a minor hydrocarbon spill, the quantities would be limited to approximately 1 m^3 for the loss of the contents of an IBC, or 50 L for ROV hydraulic fluid. The small volumes, dilution and dispersion from natural weathering processes such as ocean currents are such that spills will be limited in area and duration. The number of receptors present at the activity location are expected to be limited to a small number of transient individuals. The susceptibility of marine fauna to hydrocarbons is dependent on hydrocarbon type and exposure duration; however, given that exposures would be limited in extent and duration, exposure to marine fauna from this hazard is considered to be low. The small volumes of worst-case discharges are such that, the impacts to receptors will decline rapidly with time and distance at the sea surface. Rapid dilution at depth would also result in the impacts to receptors declining rapidly with time and distance. Deteriorating water quality and marine pollution are identified as potential threats to a number of marine fauna species in relevant Recovery Plans and Conservation Advice (**Table 3-9**) and to MNES (DoE, 2013). With control measures in place, the activity will be conducted in a manner that reduces potential impacts to ALARP and an acceptable level. Toxic impacts are not expected to the benthic community due to the water depths. Near the sea surface, fish are able to detect and avoid contact with surface slicks and as a result, fish mortalities rarely occur in open waters from surface spills (Kennish, 1997; Scholz *et al*., 1992). Pelagic fish species are therefore generally not highly susceptible to impacts from hydrocarbon spills. In offshore waters near to the release point, pelagic fish are at risk of exposure to the more toxic aromatic components of the hydrocarbons. Pelagic fish in offshore waters are highly mobile and comprise species such as tunas, sharks and mackerel. Due to their mobility, it is unlikely that pelagic fish would be exposed to toxic components for long periods in this spill scenario. The more toxic components would also rapidly evaporate and concentrations would significantly diminish with distance from the spill site, limiting the potential area of impact. The potential minor hydrocarbon releases are not expected to significantly impact the receiving environment, including the values and sensitivities of the Montebello AMP, with control measures proposed to prevent releases and therefore the activity will be conducted in a manner that is considered acceptable. Given that a minor hydrocarbon spill would not result in a decreased population size at a local or regional scale or long term reduction to water and sediment quality it is expected that a spill of this nature would result in a Negligible (I) consequence.	
Likelihood	B - Unlikely
A small hydrocarbon liquid release has reduced likelihood due to a number of controls being in place, which include: the control measures in place to prevent spills the procedures in place to clean up a spill. Consequently, the likelihood of releasing minor volumes of hydrocarbons to the environment, is considered Unlikely (B).	
Residual Risk	The residual risk associated with this event is **Very Low**.

7.8.5 Demonstration of as low as reasonably practicable

Storage and use of hydraulic and lubricating oils/fluids for equipment and machinery, including for ROV operations, are required to undertake the activity, so their removal from the activity is not viable. Well testing is also likely to be required during the activity to evaluate the formation and clean the wellbore prior to production operations. A thorough set of control measures have been proposed to ensure the risks of minor hydrocarbons spills and leaks occurring and subsequent impacts are minimised. The resulting impacts to marine fauna that could potentially result from a spill of this size would be negligible, with potential impacts restricted to a small number of individuals within a localised area. Significant impacts to the values and sensitivities of the Montebello AMP are not expected. The assessed residual risk for this impact is low and cannot be reduced further. Therefore, it is considered that the impact of the activities conducted is ALARP.

7.8.6 Acceptability evaluation

Is the risk ranked between Very Low and Medium?	Yes – maximum minor hydrocarbon spill residual risk is ranked as Low.
Is further information required in the consequence assessment?	No – potential impacts and risks are well understood through the information available.
Are risks and impacts consistent with the principles of ecological sustainable development?	Yes – activity evaluated in accordance with Santos' Environmental Hazard Identification and Assessment Procedure which considers principles of ecologically sustainable development.
Are risks and impacts consistent with relevant legislation, international agreements and conventions, guidelines and codes of practice (including species recovery plans, threat abatement plans, conservation advice and Australian Marine Park zoning objectives)?	Yes – management consistent with SOLAS 1974 and *Navigation Act 2012*, Marine Order 91 (Marine pollution prevention – oil) and with relevant recovery plans and conservation advices for species that may occur in the operational areas (**Table 3-9**).
Are risks and impacts consistent with Santos' Environment, Health and Safety Policy?	Yes – aligns with Santos' Environment, Health and Safety Policy.
Are risks and impacts consistent with stakeholder expectations?	Yes – no concerns raised.
Are performance standards such that the impact or risk is considered to be ALARP?	Yes – see ALARP above.

With the control measures in place to prevent the accidental release of minor volumes of hydrocarbons, and potential social and environmental impacts and risk well understood and considered low, the environmental risk associated with a minor hydrocarbon release is considered acceptable.

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8 Implementation Strategy

OPGGS(E)R 2009 Requirements
Regulation 14(1)
The environment plan must contain an implementation strategy for the activity in accordance with this regulation.
Regulation 14(10)
The implementation strategy must comply with the Act, the regulations and any other environmental legislation applying to the activity.

The specific measures and arrangements that will be implemented in the event of an oil pollution emergency are detailed within the OPEP.

Stakeholder engagement is assessed separately for the requirements of the activities. Ongoing stakeholder management strategies are discussed in **Section 4**.

8.1 Environmental Management System

OPGGS(E)R 2009 Requirements
Regulation 14(3)
The implementation strategy must contain a description of the environmental management system for the activity, including specific measures to be used to ensure that, for the duration of the activity: a) the environmental impacts and risks of the activity continue to be identified and reduced to a level that is as low as reasonably practicable; and b) control measures detailed in the environment plan are effective in reducing the environmental impacts and risks of the activity to as low as reasonably practicable and an acceptable level; and c) environmental performance outcomes and standards set out in the environment plan are being met.

The Santos Health, Safety and Environmental Management System (HSEMS) exists to support its moral, professional and legal obligations to undertake work in a manner that does not cause harm to people or the environment. The HSEMS is a framework of policies, standards, processes, procedures, tools and control measures that, when used together by a properly resourced and competent organisation, ensure:

+ a common HSE approach is followed across the organisation;
+ HSE is proactively managed and maintained;
+ the mandatory requirements of HSE management are implemented and are auditable;
+ HSE management performance is measured and corrective actions are taken;
+ opportunities for improvement are recognised and implemented; and
+ workforce commitments are understood and demonstrated.

This implementation strategy is designed to meet the requirements of the EP Addendum which require that:

+ environmental impacts and risks continue to be identified for the duration of the activity and reduced to ALARP;

- control measures are effective in reducing environmental impacts and risks to ALARP and acceptable levels;
- environmental performance outcomes and standards set out in this EP Addendum are met;
- stakeholder consultation is maintained throughout the activity as appropriate.

8.2 Environmental Management Policy

Santos' Environment, Health and Safety Policy (**Appendix A**) clearly sets out Santos' strategic environmental objectives and the commitment of the management team to continuous environmental performance improvement. This EP Addendum has been prepared in accordance with the fundamentals of this policy. By accepting employment with Santos, each employee and contractor is made aware during the recruitment process that he or she is responsible for the application of this policy.

8.3 Hazard Identification, Risk and Impact Assessment and Controls

Hazards and associated environmental risks and impacts for the proposed activities have been systematically identified and assessed in this EP Addendum (refer to **Sections 6** and **7**). The control measures and environmental performance standards that will be implemented to manage the identified risks and impacts, and the environmental performance outcomes that will be achieved, are detailed below.

To ensure that environmental risks and impacts remain acceptable and ALARP during the activity and for the duration of this EP Addendum, hazards will continue to be identified, assessed and controlled as described in **Section 8.11** and **Section 8.12**.

Any new, or proposed amendment to a control measure, EPS or EPO will be managed in accordance with the Environment Management of Change Procedure (EA-91-IQ-10001) (**Section 8.11.2**).

Oil spill response control measures and environmental performance standards and outcomes are listed in the OPEP.

8.4 Environmental Performance Outcomes

To ensure environmental risks and impacts will be of an acceptable level, environmental performance outcomes for this EP Addendum have been defined and are listed in **Table 8-1** for planned activities and unplanned events, those relating to oil spill response are listed in the OPEP. These outcomes will be achieved by implementing the identified control measures to the defined environmental performance standards.

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Table 8-1: Environmental performance outcomes

Reference	Environmental Performance Outcomes
ST-EPO-01	Reduce impacts on other marine users through the provision of information to relevant stakeholders such that they are able to plan for their activities and avoid unexpected interference
ST-EPO-02	No introduction of marine pest species
ST-EPO-03	No loss of containment of hydrocarbon to the marine environment
ST-EPO-04	No unplanned objects, emissions or discharges to sea or air
ST-EPO-05	No injury or mortality to EPBC Act 1999 and WA Biodiversity Conservation Act 2016 listed fauna during activities
ST-EPO-06	Reduce impacts to air and water quality from planned discharges and emissions from the activities
ST-EPO-07	Seabed disturbance limited to planned activities and defined locations within the operational area
ST-EPO-08	Reduce impacts to marine fauna from lighting on vessels and MODU through limiting lighting to that required by safety and navigational lighting requirements

8.4.1 Control measures and performance standards

The control measures that will be used to manage identified environmental impacts and risks and the associated statements of performance required of the control measure (i.e., EPSs) are listed in **Table 8-2**. The naming convention of the control measure reference number in the table is related to and identifies the activity that the control measure will be implemented for. Control measures to be implemented for drilling and completions have the format ST-DC-CM-XXX, while control measures to be implemented for the subsea installation and pre-commissioning have the format ST-IC-CM-XXX.

Measurement criteria outlining how compliance with the control measure and the expected environmental performance could be evidenced are also listed.

All CMs and EPSs and associated measurement criteria relating to preparedness and response operations are contained within the Varanus Island Hub Operations OPEP (EA-60-RI-00186.02).

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Table 8-2: Control measures and environmental performance standards for the proposed activity

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
Spartan Development Drilling and Completions					
Procedure for interacting with marine fauna	ST-DC-CM-001	Vessel(s) comply with Santos' *Protected Marine Fauna Interaction and Sighting Procedure* (EA-91-11-00003) which ensures compliance with Part 8 of *Environment Protection and Biodiversity Regulations 2000* which includes controls for minimising the risk of collision with marine fauna.	ST-DC-CM-001-EPS-01	Conformance checked on receipt of marine fauna sighting datasheets.	ST-EPO-05
				Completed vessel statement of conformance.	
		Any vessel strikes with cetaceans will be reported in the National Ship Strike Database.	ST-DC-CM-001-EPS-02	Conformance checked on Santo's receipt of incident report.	
		Helicopter contractor procedures comply with Santos' Protected Marine Fauna Interaction and Sighting Procedure (EA 91 11 00003), which ensures compliance with Part 8 of the Environment Protection and Biodiversity Conservation Regulations 2000, which includes controls for minimising interaction with marine fauna.	ST-DC-CM-001-EPS-03	Helicopter contractor procedures align with Santos' Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003).	
Dropped object prevention procedures	ST-DC-CM--002	MODU Safety Case includes the following control measures for dropped objects that reduce the risk of objects entering the marine environment: + Lifting equipment certification and inspection. + Lifting crew competencies. + Heavy-lift procedures.	ST-DC-CM-002-EPS-01	NOPSEMA-accepted Safety Case.	ST-EPO-03 ST-EPO-04 ST-EPO-05
				Completed inspection checklist.	
				Details contained in incident documents.	

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		+ Preventative maintenance on cranes.			
		Lifting operations managed in accordance with MODU work instructions or procedures.	ST-DC-CM-002-EPS-02	MODU work instructions or procedures.	
		MODU objects dropped overboard are recovered to mitigate the environmental consequences from objects remaining in the marine environment, unless the environmental consequences are negligible or safety risks are disproportionate to the environmental consequences.	ST-DC-CM-002-EPS-03	Fate of dropped objects detailed in incident documents.	
MODU move procedure	ST-DC-CM-003	MODU move procedure contains a passage plan. No accidental contact with the seabed and subsea infrastructure during the MODU move.	ST-DC-CM-003-EPS-01	MODU move procedure. Details contained in incident documents.	ST-EPO-07
Waste (garbage) management procedure	ST-DC-CM-004	Waste management procedure implemented to reduce the risk of unplanned release of waste to sea. The procedure includes standards for: + bin types + lids and covers + waste segregation + bin storage.	ST-DC-CM-004-EPS-01	Completed inspection checklist	ST-EPO-04 ST-EPO-05 ST-EPO-06

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		No waste (garbage[3]) discharged to sea, unless the waste is food waste disposed in accordance with MARPOL Annex V.	ST-DC-CM-004-EPS-02	Completed garbage disposal record book or recording system.	
		Pursuant to MARPOL Annex V, placards displayed to notify personnel of waste disposal restrictions.	ST-DC-CM-004-EPS-03	Completed inspection checklist.	
Hazardous chemical[4] Management procedures	ST-DC-CM-005	For hazardous chemicals including hydrocarbons, the following standards apply to reduce the risk of an accidental release to sea: + Storage containers closed when the product is not being used. + Storage containers managed in a manner that provides for secondary containment in the event of a spill or leak. + Storage containers labelled with the technical product name as per the safety data sheet (SDS). + Spills and leaks to deck, excluding storage bunds and drip trays, immediately cleaned up.	ST-DC-CM-005-EPS-01	Completed inspection checklist.	ST-EPO-03 ST-EPO-04

[3] Garbage as defined by MARPOL Annex V and excludes waste generated as part of the 'drilling' process as described in these standards.

[4] Chemical in both liquid and solid form

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		+ Storage bunds and drip trays do not contain free flowing volumes of liquid. + Spill response equipment readily available.			
Deck cleaning product selection	ST-DC-CM-006	Deck cleaning products planned to be released to sea meet the criteria for not being harmful to the marine environment according to MARPOL Annex V.	ST-DC-CM-006-EPS-01	SDS and product supplier supplementary data as required. Completed inspection checklist.	ST-EPO-04 ST-EPO-06
Chemical selection procedure	ST-DC-CM-007	Chemicals planned for discharge to sea from the MODU are risk assessed as per the *Drilling Fluid and Chemical Selection in Drilling Activities Procedure* (EA-91-II-00007). This includes chemicals used in potable water systems.	ST-DC-CM-007-EPS-01	Completed Santos risk assessment.	ST-EPO-04 ST-EPO-06
		Firefighting foam used on board the MODU and vessels which may be discharged to sea during testing has been risk assessed as per Santos' *Drilling Fluid and Chemical Selection in Drilling Activities Procedure* (EA-91-II-00007).	ST-DC-CM-007-EPS-02	Completed Santos risk assessment.	
		Drilling, completions and cement chemicals potentially discharged to sea are Gold/Silver/D or E rated through OCNS, or PLONOR substances listed by OSPAR, or have a complete risk assessment as per Santos' *Drilling Fluid and Chemical Selection in Drilling Activities Procedure* (EA-91-II-00007) so that only environmentally acceptable products are used.	ST-DC-CM-007-EPS-03	Completed Santos risk assessment. Completed operational reports.	

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
General chemical management procedures	ST-DC-CM-008	SDS[5] available for all chemicals to aid in the process of hazard identification and chemical management.	ST-DC-CM-008-EPS-01	Completed inspection checklist.	ST-EPO-04 ST-EPO-06
		Chemicals managed in accordance with SDS in relation to safe handling and storage, spill response and emergency procedures, and disposal considerations.	ST-DC-CM-008-EPS-02	Completed inspection checklist.	
Maritime Dangerous Goods Code	ST-DC-CM-009	Dangerous goods managed in accordance with IMDG Code to reduce the risk of an environmental incident, such as an accidental release to sea or unintended chemical reaction.	ST-DC-CM-009-EPS-01	Completed Multimodal Dangerous Goods Form. Completed inspection checklist.	ST-EPO-04
Bulk liquid transfer procedure	ST-DC-CM-010	Bulk liquids transferred in accordance with the bulk transfer procedure to reduce the risk of a release to sea. The procedures will require: + Hose integrity: certified hoses will be used + hose flotation: bulk hoses in the water fitted with floatation collars + hose connections: hoses used for hydrocarbons fitted with hammer union connections at the MODU's manifold, self-sealing (dry-break) connections at the vessel end and self-sealing break-	ST-DC-CM-010-EPS-01	Completed procedural documents, for example work permits, job safety analysis forms, checklists, etc. Spill details contained in incident documentation.	ST-EPO-04

[5] Safety data sheet or material safety data sheet.

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		away connections when two or more hoses are joined together + valve alignment: a MODU supervisor checks that all valves are lined up correctly + tank venting: air vents for hydrocarbon storage tanks bunded if there is a risk of spill to deck + supervision: dedicated hose watch person while pumping bulk hydrocarbons + communications: constant radio communications between MODU control room and vessel + inventory control: MODU control room monitors tank fill levels + emergency shutdown available and tested before each transfer operation.			
Bulk solid transfer procedure	ST-DC-CM-011	Bulk solids transferred in accordance with bulk transfer procedures to reduce the risk of an unintentional[6] release to sea. The procedures includes standards for:	ST-DC-CM-011-EPS-01	Completed procedural documents, for example work permits, job safety analysis forms, checklists, etc.	ST-EPO-04 ST-EPO-06

[6] Tank venting and associated product loss is an intentional release to sea for safety reasons.

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		+ hose integrity: certified hoses will be used + hose flotation: bulk hoses in the water fitted with floatation collars + valve alignment: a MODU supervisor checks that all valves are lined up correctly + communications: constant radio communications between MODU control room and vessel + inventory control: MODU control room monitors tank fill levels or air vents watched to detect tank overfill + emergency shutdown available and tested before each transfer operation.		Spill details contained in incident documentation.	
MODU and support vessel spill response plans including pre-drilling source control plan	ST-DC-CM-012	MODU and support vessel have and implement a SOPEP, or SMPEP, pursuant to MARPOL Annex I.	ST-DC-CM-012-EPS-01	Approved SOPEP or SMPEP.	ST-EPO-04
		SOPEP or SMPEP spill response exercises conducted at least every three months to ensure personnel are prepared.	ST-DC-CM-012-EPS-02	Spill exercise records or evidence of a spill exercise in an operational report.	
		Prior to the drilling there will be a source control plan in place.	ST-DC-CM-012-EPS-03	Source control plan.	
ROV inspection and maintenance procedures	ST-DC-CM-013	Preventative maintenance on ROV completed as scheduled to reduce the risk of hydraulic fluid releases to sea.	ST-DC-CM-013-EPS-01	Maintenance records or evidence of maintenance in operational reports.	ST-EPO-04

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		ROV pre-deployment inspection completed to reduce the risk of hydraulic fluid releases to sea.	ST-DC-CM-013-EPS-02	Completed pre-deployment inspection checklist.	
Maritime notices	ST-DC-CM-014	Information provided to either AMSA, Department of Defence, AHO and/or nearest port authority on MODU arrival and departure so that the maritime industry is aware of petroleum activities.	ST-DC-CM-014-EPS-01	Transmittal records demonstrate notification of activity prior to the activity commencing.	ST-EPO-01
Support vessel	ST-DC-CM-015	At least one support vessel is available at all times to monitor the MODU 500 m exclusion zone to identify and communicate with any approaching third-party vessels.	ST-DC-CM-015-EPS-01	Daily Vessel Report.	ST-EPO-01 ST-EPO-05
		Support vessel(s) will be equipped with an automatic identification system (AIS) and radar.	ST-DC-CM-015-EPS-02	Completed inspection report or statement of conformance from vessel contractor.	
		Monitoring of surrounding marine environment is undertaken from vessel bridge.	ST-DC-CM-015-EPS-03	Bridge log or equivalent	
Accepted OPEP	ST-DC-CM-016	In the event of an oil spill to sea, the Santos OPEP requirements implemented to mitigate environmental impacts.	ST-DC-CM-016-EPS-01	Completed incident documentation.	ST-EPO-03
Drilling and Completions Management Process	ST-DC-CM-017	NOPSEMA-accepted WOMP includes control measures for well integrity, including: + measures for suspension in the event of a cyclone, that reduce the risk of an unplanned release of hydrocarbons; and +	ST-DC-CM-017-EPS-01	NOPSEMA-accepted WOMP.	ST-EPO-03 ST-EPO-04 ST-EPO-05

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		NOPSEMA accepted Safety Case includes control measures for well control that reduce the risk of an unplanned release of hydrocarbons.	ST-DC-CM-017-EPS-02	NOPSEMA-accepted Safety Case.	
		Santos Critical Acceptance Criteria for critical well operations and integrity aspects are achieved. Critical Acceptance Criteria will be selected based on the well objectives and Santos' Drilling and Completions Management Process technical standards, being: + location, rig moves and support + well control equipment + well barriers + drilling and completions fluids + surveying and trajectory control + casing, liner and tubing + cement + wellhead and production trees + completion components.	ST-DC-CM-017-EPS-03	Completed Critical Acceptance Criteria (CAC) in well program.	
Waste incineration	ST-DC-CM-019	Waste incineration managed in accordance with MARPOL Annex VI, except incineration within the 500 m exclusion zone shall not occur.	ST-DC-CM-019-EPS-01	Completed waste record book or recording system.	ST-EPO-04 ST-EPO-06
Fuel oil quality	ST-DC-CM-020	MARPOL-compliant (Marine Order 97) fuel oil (diesel) will be used during the activity.	ST-DC-CM-020-EPS-01	Fuel bunkering records and/or relevant purchase records.	ST-EPO-06

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		Intermediate fuel oil or heavy fuel oil will not be used during the activity.	ST-DC-CM-020-EPS-02		
Air pollution prevention certification	ST-DC-CM-021	Pursuant to MARPOL Annex VI, the MODU and vessels will maintain a current International Air Pollution Prevention Certificate, which certifies that measures to prevent ODs emissions, and reduce NOx, SOx, and incineration emissions during the activity are in place.	ST-DC-CM-021-EPS-01	Current international air pollution prevention certificate.	ST-EPO-04
Ozone-depleting substance handling procedures	ST-DC-CM-022	Ozone-depleting substances (ODS) managed in accordance with MARPOL Annex VI to reduce the risk of an accidental release of ODS to air.	ST-DC-CM-022-EPS-01	Completed ODS record book or recording system	ST-EPO-04
Santos stakeholder consultation strategy	ST-DC-CM-023	Santos will notify all relevant stakeholders listed, or as revised, in **Table 8-4** of relevant activity details prior to commencement, including activity timing, vessel movements, proposed cessation date and vessel details.	ST-DC-CM-023-EPS-01	Santos correspondence to relevant stakeholders.	ST-EPO-03 ST-EPO-01
		If the MODU departs and returns from an operational area, relevant maritime notices will be updated.	ST-DC-CM-023-EPS-02	Santos correspondence to relevant stakeholders.	
		All correspondence with external stakeholders is recorded.	ST-DC-CM-023-EPS-03	Saved consultation records.	
		Santos' Consultation Coordinator is contactable before, during and after completion of the planned activity to ensure stakeholder feedback is evaluated and considered during the operational activity phases.	ST-DC-CM-023-EPS-04	Consultation Coordinator contact details provided to relevant persons in all correspondence.	

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		Santos will not restrict commercial fishing access to an operational area and is committed to concurrent operations where safety of either vessel is not compromised.	ST-DC-CM-023-EPS-05	Incident records show nil incidents of complaints of restrictions to commercial fishing access to the operational area and show nil incidents of vessel safety being compromised by concurrent operations.	
Compliance with the Biosecurity Act 2015	ST-DC-CM-024	Vessels are managed to low risk in accordance with the Santos Invasive Marine Species Management Plan (EA-00-RI-10172) prior to movement or transit into or within the invasive marine species management zone, which requires: + assessment of applicable vessels using the IMSMP risk assessment + the management of immersible equipment to low risk.	ST-DC-CM-024-EPS-01	Completed risk assessment demonstrating MODU, equipment and vessels are 'low risk'.	ST-EPO-02
		Pursuant to the *Biosecurity Act 2015* and Australian Ballast Water Management Requirements 2017, support vessels carrying ballast water and engaged in international voyages shall manage ballast water so that marine pest species are not introduced.	ST-DC-CM-024-EPS-02	Records show Ballast Water Management is implemented. Completed ballast water record book or log is maintained.	
		Vessels and MODU receive entry clearance from DAWE (Seaports) as necessary (or as applicable to their location and movements).	ST-DC-CM-024-EPS-03	Records show a complete Questionnaire for Biosecurity Exemptions for Biosecurity Control Determination issued to Seaports at least one month in advance where practicable	

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
MODU identification system	ST-DC-CM-025	MODU has an Automatic Identification System (AIS) to aid in its detection at sea.	ST-DC-CM-025-EPS-01	Completed inspection report or statement of conformance supplied by MODU contractor.	ST-EPO-01
Anchoring	ST-DC-CM-028	No planned anchoring of the MODU within the operational area.	ST-DC-CM-028-EPS-01	MODU move report records no anchoring of the MODU within the operational area	ST-EPO-07
		No planned anchoring of support vessel(s) within the operational area.	ST-DC-CM-028-EPS-02	Daily vessel reports	
Anti-foulant system	ST-DC-CM-029	Vessel anti-foulant system maintained in compliance with *International Convention on the Control of Harmful Anti-fouling Systems on Ships*.	ST-DC-CM-029-EPS-01	Current International Anti-Fouling System Certificate.	ST-EPO-02
Sewage treatment system	ST-DC-CM-030	Pursuant to MARPOL Annex VI, MODU and support vessel(s) have a current International Sewage Pollution Prevention Certificate which certifies that required measures to reduce impacts from sewage disposal are in place (as applicable to vessel class).	ST-DC-CM-030-EPS-01	Current International Sewage Pollution Prevention Certificate.	ST-EPO-04 ST-EPO-06
		Sewage discharged in accordance with MARPOL Annex IV.	ST-DC-CM-030-EPS-02	Completed inspection checklist.	ST-EPO-06
		Preventive maintenance on sewage treatment equipment is completed as scheduled.	ST-DC-CM-028-EPS-03	Maintenance records.	ST-EPO-04
Oily water treatment system	ST-DC-CM-031	Oily mixtures (bilge water) only discharged to sea in accordance with MARPOL Annex I.	ST-DC-CM-031-EPS-01	Completed inspection checklist. Oil record book or log.	ST-EPO-04 ST-EPO-06
		Preventative maintenance on oil filtering equipment completed as scheduled.	ST-DC-CM-031-EPS-02	Maintenance records or evidence of maintenance in operational reports.	ST-EPO-04

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		Pursuant to MARPOL Annex I, a MODU and support vessel(s) will have an International Oil Pollution Prevention Certificate which certifies that required measures to reduce impacts of planned oil discharges are in place.	ST-DC-CM-031-EPS-03	Current International Oil Pollution Prevention Certificate.	ST-EPO-04 ST-EPO-06
Cuttings management system	ST-DC-CM-032	All well returns to the MODU are diverted to shale shakers, except if drilling with seawater. The recovered drilling fluid is recycled to the mud pits and separated drilled cuttings/solids diverted overboard. If drilling with seawater, cuttings/solids returned to the MODU are diverted overboard.	ST-DC-CM-032-EPS-01	Daily Mud Report.	ST-EPO-06
		The shale shakers are fitted with screens that meet API standards for solids removal particle size cut points.	ST-DC-CM-032-EPS-02	Daily Mud Report	
		Centrifuges are used as required to remove additional finer drilled cuttings/solids that are too small for the shale shakers to remove.	ST-DC-CM-032-EPS-03	Daily Mud Report.	
		Shale shakers are inspected by a dedicated shale shaker hand while drilling to ensure: + shakers are running and screens vibrating + shaker screens are not damaged or blinding.	ST-DC-CM-032-EPS-04	Daily Mud Report.	
		NAF is not used during the drilling activity.	ST-DC-CM-032-EPS-05	Completed operational reports.	
Inventory control procedure	ST-DC-CM-033	Only residual water-based fluid systems, brine, completion chemicals, cement and cement spacer within MODU mud pits and	ST-DC-CM-033-EPS-01	End of Well Report.	ST-EPO-04 ST-EPO-06

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		surface tanks that is no longer required will be diverted overboard.			
		Unusable inventories of bulk cement, drilling fluid solid additives, brine and drill water on-board the MODU managed according to the decision list in **Table 6-16**.	ST-DC-CM-033-EPS-02	End of Well Report. Completed decision log.	ST-EPO-04
Oil content measurement procedure	ST-DC-CM-034	All drilling-related oil content measurements and calculations will be made in accordance with the methods detailed in Santos' *Operational Guidelines for the use of Non-aqueous Drilling Fluids* (DR-91-ID-016).	ST-DC-CM-034-EPS-01	Completed operational reports.	ST-EPO-06
Lost-circulation material procedures	ST-CM-CM-035	Surface returns of hydrocarbon-based LCM will be contained for onshore disposal if the circulating material can be isolated; otherwise the material will be discharged directly to sea.	ST-DC-CM-035-EPS-01	Completed operational reports.	ST-EPO-06
Well test procedures	ST-DC-CM-036	NOPSEMA accepted MODU Safety Case Revision for well testing includes control measures that reduce the risk of hydrocarbons from entering the marine environment.	ST-DC-CM-036-EPS-01	NOPSEMA-accepted safety case revision for well testing.	ST-EPO-03 ST-EPO-04 ST-EPO-06
		Santos Well Test Program checklists completed to ensure safety and environmental control measures are implemented.	ST-DC-CM-036-EPS-02	Completed well test program checklist.	
		Burner pilots to remain ignited during a well test to reduce the risk of hydrocarbons being released to sea and air.	ST-DC-CM-036-EPS-03	Incident report of flare drop-out.	

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		Burner monitored by a dedicated flare watcher during a well test to identity and communicate an unplanned flare drop-out.	ST-DC-CM-036-EPS-04	Incident report of flare drop-out.	
		In the event of a flare drop-out or hydrocarbon being observed on the sea surface then liquid flaring, and if applicable the well test, shall cease and the event investigated and corrected before proceeding.	ST-DC-CM-036-EPS-05	Incident report of flare drop-out or unplanned hydrocarbon release.	
		During a well test, formation water and completion fluids containing hydrocarbons must be: + flared with hydrocarbons, or + stored in tanks on-board and shipped ashore for disposal, or + treated through an oil-water filtration system to reduce the oil in water to <30ppm concentration before being disposed to sea.	ST-DC-CM-036-EPS-06	Completed operational reports.	
		+ Oil-water filtration equipment will be: + designed to reduce oil-in-water to less than 30 ppm + calibrated prior to use + oil-in-water content monitored to assess the performance of the filtration equipment.	ST-DC-CM-036-EPS-07	Completed operational reports	

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
No fishing from MODU or support vessels	ST-DC-CM-037	Personnel are prohibited from recreational fishing activities on MODU or support vessels.	ST-DC-CM-037-EPS-01	Induction records confirm no fishing prohibition is communicated to all personnel.	ST-EPO-01
Petroleum Safety Zone (safety) established	ST-DC-CM-038	A 500 m PSZ is defined around the MODU during the activity.	ST-DC-CM-038-EPS-01	Notice to Mariners placed with AHO outlining PSZ and time frames of the activity.	ST-EPO-01 ST-EPO-03
Lighting will be used as required for safe work conditions and navigational purposes.	ST-DC-CM-039	Vessel/MODU navigation lighting and equipment is compliant with COLREGS/Marine Orders 30: Prevention of Collisions, and with Marine Orders 21: Safety of Navigation and Emergency Procedures.	ST-DC-CM-039-EPS-01	Vessel certification confirms compliance with applicable regulations.	ST-EPO-01 ST-EPO-03 ST-EPO-04 ST-EPO-05 ST-EPO-08
Seafarer certification	ST-DC-CM-040	Vessel crew are trained and competent, in accordance with Flag State regulations, to navigate vessels.	ST-DC-CM-040-EPS-01	Training records.	ST-EPO-01
Marine assurance standard	ST-DC-CM-041	Vessels selected and on-boarded in accordance with the *Offshore Marine Assurance Procedure* (SO-91-ZH-10001) to ensure contracted vessels are operated, maintained and manned in accordance with industry standards (for example, Marine Orders) and regulatory requirements (this EP) and the relevant Santos procedures mentioned in this EP.	ST-DC-CM-041-EPS-01	Completed i documentation in accordance with procedure.	ST-EPO-03
Refuelling and chemical transfer procedure	ST-DC-CM-042	All vessels/MODU that are involved in at sea bunkering or chemical transfer will have appropriate procedure in place to reduce risk of spill to sea which may include requirements, as appropriate for vessel size, such as:	ST-DC-CM-042-EPS-01	Audit Records. Inspection Records. Refuelling procedure.	ST-EPO-03

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		+ hose integrity: certified hoses will be used + hose floatation: bulk hoses in the water fitted with floatation collars + hose connections: hoses used for hydrocarbons fitted with self-sealing (dry-break) connections and self-sealing break-away connections when two or more hoses are joined together + valve alignment: a vessel supervisor checks that all valves are lined up correctly + tank venting: air vents for hydrocarbon storage tanks bunded if there is a risk of spill to deck + supervision: dedicated hose watch person while pumping bulk fuel + communications: constant radio communications between two vessels + inventory control: a vessel supervisor monitors tank fill levels + emergency shutdown: vessel emergency pumping stop tested before each transfer operation bunkering drill requirements.			
Recovery of all deployed equipment	ST-DC-CM-043	All equipment deployed during any activity will be recovered above the mudline at the	ST-DC-CM-043-EPS-01	Survey records	ST-EPO-07

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		end of each drilling campaign as per Section 572 of the OPGGS Act.			
MODU planned maintenance system (PMS)	ST-DC-CM-044	Documented maintenance program is in place for equipment on MODU that provides a status on the maintenance of equipment.	ST-DC-CM-044-01	Vessel daily/weekly records CMMS Records Vessel contractor written verification demonstrates compliance with PMS.	ST-EPO-03 ST-EPO-04 ST-EPO-05 ST-EPO-06
Vessel PMS to maintain vessel DP, engines and machinery.	ST-DC-CM-045	Documented maintenance program is in place for equipment on vessels that provides a status on the maintenance of equipment.	ST-DC-CM-045-01	Vessel daily/weekly records IMCA Common Marine Inspection Document (CMID) Vessel contractor written verification demonstrates compliance with PMS. CMMS records.	ST-EPO-04 ST-EPO-05 ST-EPO-06
Pre- campaign commencement assurance check	ST-DC-CM-046	Prior to each campaign commencement, an assurance check will be undertaken in accordance with Santos Environment Management of Change Procedure (EA-91-IQ-10001). This involves a documented review of the EP Addendum to ensure: + the activity details are current; + changes in legislation are identified; + stakeholder consultation has been completed and stakeholder concerns addressed; + potential impacts and risks are still relevant;	ST-DC-CM-046-EPS-01	Completed Assurance Check form.	ST-EPO-03

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		+ oil spill scenario is appropriate; + EPOs and EPSs are appropriate; + activity is acceptable and ALARP in accordance with the EP. A pre-campaign check will not be required prior to the first campaign under this EP Addendum if it is commenced within 12 months of EP acceptance.			
Quality control limits for Barite	ST-DC-CM-047	The contaminant limit concentrations in barite used for the drilling meets the below standard: + Mercury (Hg) – 1 mg/kg dry weight in stock barite Cadmium (Cd) – 3 mg/kg dry weight in stock barite	ST-DC-CM-047-EPS-001	Records show barite used for the drilling meets the below standard: + Mercury (Hg) – 1 mg/kg dry weight in stock barite Cadmium (Cd) – 3 mg/kg dry weight in stock barite	ST-EPO-06
		All barite is selected in accordance with API specifications which has limitations on all contaminant concentrations.	BD-CM-047-EPS-002	Mud reports show all mud is API standard	ST-EPO-06
Spartan Development Installation and Pre-commissioning					
Procedure for interacting with marine fauna	ST-IC-CM-001	Vessel(s) comply with Santos' *Protected Marine Fauna Interaction and Sighting Procedure* (EA-91-11-00003) which ensures compliance with Part 8 of *Environment Protection and Biodiversity Regulations 2000* which includes controls for minimising the risk of collision with marine fauna.	ST-IC-CM-001-EPS-01	Conformance checked on receipt of marine fauna sighting datasheets. Completed vessel statement of conformance.	ST-EPO-05

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		Any vessel strikes with cetaceans will be reported in the National Ship Strike Database.	ST-IC-CM-001-EPS-02	Conformance checked on Santo's receipt of incident report.	
		Helicopter contractor procedures comply with Santos' Protected Marine Fauna Interaction and Sighting Procedure (EA 91 11 00003), which ensures compliance with Part 8 of the Environment Protection and Biodiversity Conservation Regulations 2000, which includes controls for minimising interaction with marine fauna.	ST-IC-CM-001-EPS-03	Helicopter contractor procedures align with Santos' Protected Marine Fauna Interaction and Sighting Procedure (EA-91-11-00003).	
Vessel PMS to maintain vessel DP, engines and machinery.	ST-IC-CM-002	Documented maintenance program is in place for equipment on vessels that provides a status on the maintenance of equipment.	ST-IC-CM-002-01	Vessel daily/weekly records IMCA Common Marine Inspection Document (CMID) Vessel contractor written verification demonstrates compliance with PMS. CMMS records.	ST-EPO-04 ST-EPO-05 ST-EPO-06
Lighting will be used as required for safe work conditions and navigational purposes.	ST-IC-CM-003	Vessel/MODU navigation lighting and equipment is compliant with COLREGS/Marine Orders 30: Prevention of Collisions, and with Marine Orders 21: Safety of Navigation and Emergency Procedures.	ST-IC-CM-003-EPS-01	Vessel certification confirms compliance with applicable regulations.	ST-EPO-01 ST-EPO-03 ST-EPO-04 ST-EPO-05 ST-EPO-08
Waste incineration	ST-IC-CM-004	Waste incineration managed in accordance with MARPOL Annex VI, except incineration within the 500 m exclusion zone shall not occur.	ST-IC-CM-004-EPS-01	Completed waste record book or recording system.	ST-EPO-04 ST-EPO-06

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
Fuel oil quality	ST-IC-CM-005	MARPOL-compliant (Marine Order 97) fuel oil (diesel) will be used during the activity.	ST-IC-CM-005-EPS-01	Fuel bunkering records and/or relevant purchase records.	ST-EPO-06
		Intermediate fuel oil or heavy fuel oil will not be used during the activity.	ST-IC-CM-005-EPS-02		
Air pollution prevention certification	ST-IC-CM-006	Pursuant to MARPOL Annex VI, the MODU and vessels will maintain a current International Air Pollution Prevention Certificate, which certifies that measures to prevent OdS emissions, and reduce NOx, SOx, and incineration emissions during the activity are in place.	ST-IC-CM-006-EPS-01	Current international air pollution prevention certificate.	ST-EPO-04
Ozone-depleting substance handling procedures	ST-IC-CM-007	Ozone-depleting substances (ODS) managed in accordance with MARPOL Annex VI to reduce the risk of an accidental release of ODS to air.	ST-IC-CM-007-EPS-01	Completed ODS record book or recording system	ST-EPO-04
Pre- and post- installation seabed surveys	ST-IC-CM-008	Seabed survey of areas planned for structure installation completed prior to and after the installation activities.	ST-IC-CM-008-EPS-01	Completed survey reports with associated videos and/or photos.	ST-EPO-07
Installation procedures	ST-IC-CM-009	Use of acoustic positioning devices to accurately position structures.	ST-IC-CM-009-EPS-01	Santos endorsed installation procedure, inspections, test plans/check lists.	ST-EPO-07
Wet-storage	ST-IC-CM-010	All temporary equipment recovered from the seabed	ST-IC-CM-010-EPS-01	As built survey records	ST-EPO-07
Seafarer certification	ST-IC-CM-011	Vessel crew are trained and competent, in accordance with Flag State regulations, to navigate vessels.	ST-IC-CM-011-EPS-01	Training records.	ST-EPO-01
Santos stakeholder consultation strategy	ST-IC-CM-012	Santos will notify all relevant stakeholders listed, or as revised, in **Table 8-4** of relevant activity details prior to commencement,	ST-IC-CM-012-EPS-01	Santos correspondence to relevant stakeholders.	ST-EPO-03 ST-EPO-01

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		including activity timing, vessel movements, proposed cessation date and vessel details.			
		If the MODU departs and returns from an operational area, relevant maritime notices will be updated.	ST-IC-CM-012-EPS-02	Santos correspondence to relevant stakeholders.	
		All correspondence with external stakeholders is recorded.	ST-IC-CM-012-EPS-03	Saved consultation records.	
		Santos' Consultation Coordinator is contactable before, during and after completion of the planned activity to ensure stakeholder feedback is evaluated and considered during the operational activity phases.	ST-IC-CM-012-EPS-04	Consultation Coordinator contact details provided to relevant persons in all correspondence.	
		Santos will not restrict commercial fishing access to an operational area and is committed to concurrent operations where safety of either vessel is not compromised.	ST-IC-CM-012-EPS-05	Incident records show nil incidents of complaints of restrictions to commercial fishing access to the operational area and show nil incidents of vessel safety being compromised by concurrent operations.	
No fishing from MODU or support vessels	ST-IC-CM-013	Personnel are prohibited from recreational fishing activities on MODU or support vessels.	ST-IC-CM-013-EPS-01	Induction records confirm no fishing prohibition is communicated to all personnel.	ST-EPO-01
Maritime notices	ST-IC-CM-014	Information provided to either AMSA, Department of Defence, AHO and/or nearest port authority on MODU arrival and departure so that the maritime industry is aware of petroleum activities.	ST-IC-CM-014-EPS-01	Transmittal records demonstrate notification of activity prior to the activity commencing.	ST-EPO-01

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
ISV identification system	ST-IC-CM-015	ISV has an Automatic Identification System (AIS) to aid in its detection at sea.	ST-IC-CM-015-EPS-01	Completed inspection report or statement of conformance supplied by ISV contractor.	ST-EPO-01
Safety Exclusion Zone established	ST-IC-CM-016	A 500 m Safety Exclusion Zone is established around the ISV during the activity.	ST-IC-CM-016-EPS-01	Notice to Mariners placed with AHO outlining Safety Exclusion Zone and time frames of the activity.	ST-EPO-01 ST-EPO-03
Constant bridge watch on ISV	ST-IC-CM-017	Competent crew shall maintain constant bridge-watch.	ST-IC-CM-017-EPS-01	Vessel log of times and persons on watch and/or Crew training matrix and completed vessel statement of conformance verified by Santos Site Representative (CSR Weekly Checklist)	ST-EPO-01
		A visual and radar watch will be maintained on the vessel bridge at all times	ST-IC-CM-017-EPS-02	Vessel log of times and persons on watch verified by Santos Site Representative (CSR Weekly Checklist)	
ISV personnel inductions	ST-IC-CM-018	Induction materials reinforce to the Vessel Master the importance of marine communications in the event of any potential interactions with active commercial fishers.	ST-IC-CM-018-EPS-01	Induction records	ST-EPO-01
Waste (garbage) management procedure	ST-IC-CM-019	Waste management procedure implemented to reduce the risk of unplanned release of waste to sea. The procedure includes standards for: + bin types + lids and covers	ST-IC-CM-019-EPS-01	Completed inspection checklist	ST-EPO-04 ST-EPO-05 ST-EPO-06

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		+ waste segregation + bin storage.			
		No waste (garbage[7]) discharged to sea, unless the waste is food waste disposed in accordance with MARPOL Annex V.	ST-IC-CM-019-EPS-02	Completed garbage disposal record book or recording system.	
		Pursuant to MARPOL Annex V, placards displayed to notify personnel of waste disposal restrictions.	ST-IC-CM-019-EPS-03	Completed inspection checklist.	
Deck cleaning product selection	ST-IC-CM-020	Deck cleaning products planned to be released to sea meet the criteria for not being harmful to the marine environment according to MARPOL Annex V.	ST-IC-CM-020-EPS-01	SDS and product supplier supplementary data as required. Completed inspection checklist.	ST-EPO-04 ST-EPO-06
General chemical management procedures	ST-IC-CM-021	SDS[8] available for all chemicals to aid in the process of hazard identification and chemical management.	ST-IC-CM-021-EPS-01	Completed inspection checklist.	ST-EPO-04 ST-EPO-06
		Chemicals managed in accordance with SDS in relation to safe handling and storage, spill response and emergency procedures, and disposal considerations.	ST-IC-CM-021-EPS-02	Completed inspection checklist.	
Chemical selection procedure	ST-IC-CM-022	Chemicals planned for discharge to sea from the MODU are risk assessed as per the *Drilling Fluid and Chemical Selection in Drilling Activities Procedure* (EA-91-II-00007). This	ST-IC-CM-022-EPS-01	Completed Santos risk assessment.	ST-EPO-04 ST-EPO-06

[7] Garbage as defined by MARPOL Annex V and excludes waste generated as part of the ‘drilling’ process as described in these standards.

[8] Safety data sheet or material safety data sheet.

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		includes chemicals used in potable water systems.			
		Firefighting foam used on board the MODU and vessels which may be discharged to sea during testing has been risk assessed as per Santos' *Drilling Fluid and Chemical Selection in Drilling Activities Procedure* (EA-91-II-00007).	ST-IC-CM-022-EPS-02	Completed Santos risk assessment.	
		Drilling, completions and cement chemicals potentially discharged to sea are Gold/Silver/D or E rated through OCNS, or PLONOR substances listed by OSPAR, or have a complete risk assessment as per Santos' *Drilling Fluid and Chemical Selection in Drilling Activities Procedure* (EA-91-II-00007) so that only environmentally acceptable products are used.	ST-IC-CM-022-EPS-03	Completed Santos risk assessment. Completed operational reports.	
Sewage treatment system	ST-IC-CM-023	Pursuant to MARPOL Annex VI, MODU and support vessel(s) have a current International Sewage Pollution Prevention Certificate which certifies that required measures to reduce impacts from sewage disposal are in place (as applicable to vessel class).	ST-IC-CM-023-EPS-01	Current International Sewage Pollution Prevention Certificate.	DC-EPO-04 DC-EPO-06
		Sewage discharged in accordance with MARPOL Annex IV.	ST-IC-CM-023-EPS-02	Completed inspection checklist.	ST-EPO-06
		Preventive maintenance on sewage treatment equipment is completed as scheduled.	ST-IC-CM-023-EPS-03	Maintenance records.	ST-EPO-04
Oily water treatment system	ST-IC-CM-024	Oily mixtures (bilge water) only discharged to sea in accordance with MARPOL Annex I.	ST-IC-CM-024-EPS-01	Completed inspection checklist. Oil record book or log.	ST-EPO-04 ST-EPO-06

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		Preventative maintenance on oil filtering equipment completed as scheduled.	ST-IC-CM-024-EPS-02	Maintenance records or evidence of maintenance in operational reports.	ST-EPO-04
		Pursuant to MARPOL Annex I, a MODU and support vessel(s) will have an International Oil Pollution Prevention Certificate which certifies that required measures to reduce impacts of planned oil discharges are in place.	ST-IC-CM-024-EPS-03	Current International Oil Pollution Prevention Certificate.	ST-EPO-04 ST-EPO-06
Equipment pressure tested	ST-IC-CM-025	All new subsea infrastructure will undergo factory acceptance testing (FAT) to ensure strength (minimising the offshore testing required to only a system leak test).	ST-IC-CM-025-EPS-01	Pressure test certification of all equipment undergoing pressure.	ST-EPO-06
		Offshore leak testing will be conducted to ensure the integrity of joints between components.	ST-IC-CM-025-EPS-02	Installation log shows back seal testing of flowlines when connections are being made.	
Chemical dosage and volume	ST-IC-CM-026	Chemical dosage volume and concentration will be monitored during flooding	ST-IC-CM-026-EPS-01	Installation log shows compliance with maximum dosage concentration	ST-EPO-06
		Chemical dosage volume and concentration of the flowline will be confirmed prior to installation	ST-IC-CM-026-EPS-02		
ROV inspections during leak testing	ST-IC-CM-027	ROV inspection during leak test and hydrotest to identify leakage and trigger activity stop	ST-IC-CM-027-EPS-01	Records show ROV inspection during leak test and hydrotest activities and any instances of activity required to stop due to leaks.	ST-EPO-06
Flowline dewatering	ST-IC-CM-028	Flowline will only be dewatered back to the VI onshore facility, eliminating any marine discharges from dewatering the flowline.	ST-IC-CM-028-EPS-01	Records show flowline dewatered to VI onshore facility	ST-EPO-06

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
Dropped object prevention procedures	ST-IC-CM-CM-029	MODU Safety Case includes the following control measures for dropped objects that reduce the risk of objects entering the marine environment: + Lifting equipment certification and inspection. + Lifting crew competencies. + Heavy-lift procedures. + Preventative maintenance on cranes.	ST-IC-CM-029-EPS-01	NOPSEMA-accepted Safety Case. Completed inspection checklist. Details contained in incident documents.	ST-EPO-03 ST-EPO-04 ST-EPO-05
		Lifting operations managed in accordance with MODU work instructions or procedures.	ST-IC-CM-029-EPS-02	MODU work instructions or procedures.	
		MODU objects dropped overboard are recovered to mitigate the environmental consequences from objects remaining in the marine environment, unless the environmental consequences are negligible or safety risks are disproportionate to the environmental consequences.	ST-IC-CM-029-EPS-03	Fate of dropped objects detailed in incident documents.	
Lifting equipment maintenance	ST-IC-CM-030	SV safety case, accepted by NOPSEMA, includes the following control measures for dropped objects that reduce the risk of objects entering the marine environment: + Lifting equipment, maintenance, certification and inspection; + Lifting crew competencies; + Heavy-lift procedures; + Preventative maintenance on cranes; and	ST-IC-CM-030-EPS-01	NOPSEMA-accepted safety case	ST-EPO-04

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		+ Permit to work system for working within 500 m of subsea infrastructure.			
		Objects dropped overboard are recovered (if possible) to mitigate the environmental consequences from objects remaining in the marine environment, unless the environmental consequences are negligible, or safety risks are disproportionate to the environmental consequences.	ST-IC-CM-030-EPS-02	Fate of dropped objects detailed in incident documents	
Compliance with the Biosecurity Act 2015	ST-IC-CM-031	Vessels are managed to low risk in accordance with the Santos Invasive Marine Species Management Plan (EA-00-RI-10172) prior to movement or transit into or within the invasive marine species management zone, which requires: + assessment of applicable vessels using the IMSMP risk assessment + the management of immersible equipment to low risk.	ST-IC-CM-031-EPS-01	Completed risk assessment demonstrating MODU, equipment and vessels are 'low risk'.	ST-EPO-02
		Pursuant to the *Biosecurity Act 2015* and Australian Ballast Water Management Requirements 2017, support vessels carrying ballast water and engaged in international voyages shall manage ballast water so that marine pest species are not introduced.	ST-IC-CM-031-EPS-02	Records show Ballast Water Management is implemented. Completed ballast water record book or log is maintained.	
		Vessels and MODU receive entry clearance from DAWE (Seaports) as necessary (or as applicable to their location and movements).	ST-IC-CM-031-EPS-03	Records show a complete Questionnaire for Biosecurity Exemptions for Biosecurity Control Determination issued	

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
				to Seaports at least one month in advance where practicable	
Anti-foulant system	ST-IC-CM-032	Vessel anti-foulant system maintained in compliance with *International Convention on the Control of Harmful Anti-fouling Systems on Ships*.	ST-IC-CM-032-EPS-01	Current International Anti-Fouling System Certificate.	ST-EPO-02
Hazardous chemical[9] Management procedures	ST-IC-CM-033	For hazardous chemicals including hydrocarbons, the following standards apply to reduce the risk of an accidental release to sea: + Storage containers closed when the product is not being used. + Storage containers managed in a manner that provides for secondary containment in the event of a spill or leak. + Storage containers labelled with the technical product name as per the safety data sheet (SDS). + Spills and leaks to deck, excluding storage bunds and drip trays, immediately cleaned up. + Storage bunds and drip trays do not contain free flowing volumes of liquid.	ST-IC-CM-033-EPS-01	Completed inspection checklist.	ST-EPO-03 ST-EPO-04

[9] Chemical in both liquid and solid form

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		+ Spill response equipment readily available.			
MODU and support vessel spill response plans including pre-drilling source control plan	ST-IC-CM-034	ISV and support vessels have and implement a SOPEP, or SMPEP, pursuant to MARPOL Annex I.	ST-IC-CM-034-EPS-01	Approved SOPEP or SMPEP.	ST-EPO-04
		SOPEP or SMPEP spill response exercises conducted at least every three months to ensure personnel are prepared.	ST-IC-CM-034-EPS-02	Spill exercise records or evidence of a spill exercise in an operational report.	
		Prior to the drilling there will be a source control plan in place.	ST-IC-CM-0354-EPS-03	Source control plan.	
Accepted OPEP	ST-IC-CM-035	In the event of an oil spill to sea, the Santos OPEP requirements implemented to mitigate environmental impacts.	ST-IC-CM-035-EPS-01	Completed incident documentation.	ST-EPO-03
Marine assurance standard	ST-IC-CM-036	Vessels selected and on-boarded in accordance with the *Offshore Marine Assurance Procedure* (SO-91-ZH-10001) to ensure contracted vessels are operated, maintained and manned in accordance with industry standards (for example, Marine Orders) and regulatory requirements (this EP) and the relevant Santos procedures mentioned in this EP.	ST-IC-CM-036-EPS-01	Completed documentation in accordance with procedure.	ST-EPO-03
Refuelling and chemical transfer procedure	ST-IC-CM-037	All vessels that are involved in at sea bunkering or chemical transfer will have appropriate procedure in place to reduce risk of spill to sea which may include requirements, as appropriate for vessel size, such as:	ST-IC-CM-037-EPS-01	Audit Records. Inspection Records. Refuelling procedure.	ST-EPO-03

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		+ hose integrity: certified hoses will be used + hose floatation: bulk hoses in the water fitted with floatation collars + hose connections: hoses used for hydrocarbons fitted with self-sealing (dry-break) connections and self-sealing break-away connections when two or more hoses are joined together + valve alignment: a vessel supervisor checks that all valves are lined up correctly + tank venting: air vents for hydrocarbon storage tanks bunded if there is a risk of spill to deck + supervision: dedicated hose watch person while pumping bulk fuel + communications: constant radio communications between two vessels + inventory control: a vessel supervisor monitors tank fill levels + emergency shutdown: vessel emergency pumping stop tested before each transfer operation bunkering drill requirements.			
Dynamic positioning system	ST-IC-CM-038	Dynamic Positioning (DP) equipment design, redundancy, equipment maintenance and operation in accordance with the IMCA	ST-IC-CM-038-EPS-01	Completed inspection checklist	ST-EPO-03

Control Measure	Control Measure Reference No.	Environmental Performance Standard	EPS Reference No.	Measurement Criteria	EPO Reference No. (Table 8-1)
		Guideline for the Design and Operation of Dynamically Positioned Vessels			
		DP trials to ensure correct operation.	ST-IC-CM-039-EPS-02	Vessel log of DP trials	
Maritime Dangerous Goods Code	ST-IC-CM-039	Dangerous goods managed in accordance with IMDG Code to reduce the risk of an environmental incident, such as an accidental release to sea or unintended chemical reaction.	ST-IC-CM-039-EPS-01	Completed Multimodal Dangerous Goods Form.	ST-EPO-04
				Completed inspection checklist.	
ROV inspection and maintenance procedures	ST-IC-CM-040	Preventative maintenance on ROV completed as scheduled to reduce the risk of hydraulic fluid releases to sea.	ST-IC-CM-040-EPS-01	Maintenance records or evidence of maintenance in operational reports.	ST-EPO-04
		ROV pre-deployment inspection completed to reduce the risk of hydraulic fluid releases to sea.	ST-IC-CM-040-EPS-02	Completed pre-deployment inspection checklist.	
Deck drainage control measures on ISV	ST-IC-CM-041	Scupper plugs or equivalent deck drainage control measures available where chemicals and hydrocarbons are stored and frequently handled.	ST-IC-CM-041-EPS-01	Weekly inspection checklist	ST-EPO-04

8.5 Leadership, Accountability and Responsibility

OPGGS(E)R 2009 Requirements
Regulation 14(4)
The implementation strategy must establish a clear chain of command, setting out the roles and responsibilities of personnel in relation to the implementation, management and review of the environment plan, including during emergencies or potential emergencies.

While Santos' Chief Executive Officer has the overall accountability for the implementation of the Santos HSEMS and Environment, Health and Safety Policy, Santos' Manager – Offshore Drilling and Completions, is accountable for ensuring implementation, management and review of this EP Addendum.

The effective implementation of this EP Addendum requires collaboration and cooperation among Santos and its contractors. The chain of command and accountabilities of personnel in relation to the implementation, management and review of the EP Addendum is outlined in **Table 8-3**. It is also outlined in the OPEP for oil spill response.

Table 8-3: Chain of command, key leadership roles and responsibilities

Role	Responsibilities
Drilling Personnel	
Manager – Offshore Drilling & Completions	+ ensures Santos' policies and standards are adhered to and communicated to all employees and contractors; + promotes HSE as a core value integral with how Santos does its business; + empowers personnel to 'stop-the-job' due to HSE concerns; + provides resources for HSE management; + ensures a high level of HSE performance and drives improvement opportunities; + ensures emergency response plans are in place; + maintains communication with company personnel, government agencies and the media; + approves MoC documents, if acceptable and ALARP; and + ensures the annual HSE improvement plan is completed.
Santos Drilling Superintendent	+ ensures conformance with environmental performance outcomes and standards in the EP; + delegates HSE responsibility and informs these personnel of their responsibilities under the EP; + empowers personnel to `stop-the-job' due to HSE concerns; + ensures HSE incidents are reported, investigated, corrected and communicated; + ensures MODU meets quarantine requirements to operate in Australian waters; + ensures HSE inspections and audits are completed and corrective actions implemented; + reviews MoC documents; and + ensures personnel on the MODU have the necessary qualifications, training and/or supervision.

Role	Responsibilities
Santos Supervisors/ MODU Offshore Installation Manager/Vessel Masters	Has overall responsibility for: + implementation and compliance with relevant environmental legislative requirements, EP commitments and operational procedures on the vessel; + maintaining clear communication with personnel on board; + communicating hazards and risks to the workforce; + monitoring daily activities on the vessel/MODU to ensure that the relevant environmental legislative requirements, EP commitments and operational procedures are being followed; + maintaining vessels/MODU to all regulatory and class requirements; + maintaining their vessel/MODU in a state of preparedness for emergency response; and + reporting environmental incidents to PIC and ensuring follow-up actions are performed.
Drilling Company Site Representative	Has responsibility for: + implementing EP commitments; + ensuring personnel competency; + ensuring compliance with procedures and work instructions; + being site focal point for onshore/offshore communications; + reporting all incidents and potential hazards; + leading site-based incident response; and + implementing corrective actions from environmental incidents and audits.
Santos HSE Team Leader, Drilling and Completions	Has overall responsibility for: + provide advice to ensure compliance with the Santos Environment Health and Safety Policy and this EP; + providing operational HSE oversight and advice; + facilitating the development and implementation of environmental management of change documents; + ensuring EP-required reporting is accurate and timely; + ensuring environmental incidents are appropriately investigated; + ensuring that appropriate enforcement mechanisms to prevent breaches of this EP Addendum are implemented; and + providing advice to ensure environmental incident reporting meets regulatory requirements (as outlined in the EP) and the Santos internal incident reporting and investigation procedure.
Installation and pre-commissioning Personnel	

Role	Responsibilities
Manager Integrated Projects	+ ensures Santos policies and standards are adhered to and communicated to all employees and contractors; + promotes HSE as a core value integral with how Santos does its business; + empowers personnel to 'stop-the-job' due to HSE concerns; + provides resources for HSE management; + ensures a high level of HSE performance and drives improvement opportunities; + ensures emergency response plans are in place; + maintains communication with company personnel, government agencies and the media; and + approves MoC documents, if acceptable and ALARP.
Vessel master	Has overall responsibility for: + implementation and compliance with relevant environmental legislative requirements, EP commitments and operational procedures on the vessel; + maintaining clear communication with personnel on board; + communicating hazards and risks to the workforce; + monitoring daily activities on the vessel to ensure that the relevant environmental legislative requirements, EP commitments and operational procedures are being followed; + maintaining vessels to all regulatory and class requirements; + maintaining their vessel in a state of preparedness for emergency response; and + reporting environmental incidents to Santos and ensuring follow-up actions are carried out.
ISV Company Site Representative	Has responsibility for: + implementing EP commitments; + ensuring personnel competency; + ensuring compliance with procedures and work instructions; + being site focal point for onshore/offshore communications; + reporting all incidents and potential hazards; + leading site-based incident response; and + implementing corrective actions from environmental incidents and audits.
Integrated Project HSE Lead	Has overall responsibility for: + ensuring incident preparedness and response arrangements meet Santos and regulatory requirements; + approving the OPEP; and + providing ongoing resources to maintain compliance with the OPEP and other Santos incident response requirements.
Support Personnel	
Santos Marine Superintendent	+ ensures conformance with environmental performance outcomes and standards in the EP;

Role	Responsibilities
	+ delegates HSE responsibility and informs these personnel of their responsibilities under the EP; + empowers personnel to `stop-the-job' due to HSE concerns; + ensures HSE incidents are reported, investigated, corrected and communicated; + ensure vessels meet quarantine requirements to operate in Australian waters; + ensures HSE inspections and audits are completed and corrective actions implemented; + reviews MoC documents; and + ensures personnel on the vessels have the necessary qualifications, training and/or supervision.
Santos HSE Manager	Has overall responsibility for: + ensuring incident preparedness and response arrangements meet Santos and regulatory requirements; + approving the OPEP; and + providing ongoing resources to maintain compliance with the OPEP and other Santos incident response requirements.
Senior Stakeholder Adviser	+ ensures relevant stakeholders are identified throughout the life of the EP; + maintains a stakeholder contact and information database; + maintains a Stakeholder Notification Log specific to the EP; + maintains records of all stakeholder correspondence specific to the EP; + prior to commencement of the activity and on advice of HSE Team Lead, provides a notification to all relevant stakeholders listed, or as revised, in Table 8 4. The notification will include information on activity timing, vessel movements and vessel details; + on advice of HSE Team Lead, provide cessation notifications to relevant stakeholders identified in **Table 8-4**; + is available before, during and after the activity to ensure opportunities for stakeholders to provide feedback are available; and + prepares and distributes quarterly consultation updates to relevant stakeholders.

Role	Responsibilities
Santos HSE Coordinator(s)	+ ensures the EP Addendum is managed and reviewed: monitors conformance with EPOs and EPSs, and the implementation strategy in the EP Addendum; + prepares, maintains and distributes the environmental compliance register; + completes regular HSE reports, inspections and audits; + completes HSE inductions and promotes general awareness; + collates HSE data and records; + contributes to HSE incident management and investigations; + provides operational HSE oversight and advice; + facilitates the development and implementation of MoC documents; + provides incident reports, compliance reports and notifications to NOPSEMA; + ensures stakeholder consultation and communication requirements have been fulfilled; and + ensures subcontractors are communicated the EP Addendum requirements.
HSE Team Lead – Security and Emergency Response	Has overall responsibility for: + overarching incident and crisis management responsibility; + managing the Crisis Management Team and IMT personnel training program; + reviewing and assessing competencies for Crisis Management Team, IMT, and field-based Incident Response Team members; + managing the Duty roster system for Crisis Management Team and IMT personnel; and + managing the maintenance and readiness of incident response resources and equipment.
Senior Oil Spill Response Advisor	Has overall responsibility for: + providing upfront and ongoing guidance, framework, and direction on preparation of this OPEP; + developing and maintaining arrangements and contracts for incident response support from third-parties; + developing and defining objectives, strategies and tactical plans for response preparedness defined in this OPEP and IRP; and + undertaking assurance activities on arrangements outlined within the OPEP.

8.6 Workforce Training and Competency

OPGGS(E)R 2009 Requirements
Regulation 14(5)
The implementation strategy must include measures to ensure that each employee or contractor working on, or in connection with, the activity is aware of his or her responsibilities in relation to the environment plan, including during emergencies or potential emergencies, and has the appropriate competencies and training.

This section describes the mechanisms that will be in place so that each employee and contractor is aware of his or her responsibilities in relation to the EP Addendum and has appropriate training and competencies.

8.6.1 Activity inductions

All personnel on the MODU, ISV and support vessels will complete an induction that will include a component addressing their EP responsibilities. Induction attendance records for all personnel will be maintained. Inductions will include information on:

+ Santos' Environment, Health and Safety Policy;
+ regulatory regime (NOPSEMA regulations);
+ EPBC Act Policy Statement 2.1 and how it applies to the activity;
+ operating environment (e.g., nearby protected marine areas, sensitive environmental periods);
+ interaction with other marine users (i.e., topic to reinforce the importance of marine communications regarding any potential interactions with active commercial fishing);
+ activities with highest risk (e.g., invasive marine species and hydrocarbon releases);
+ EP commitments (e.g., **Table 8-1** and **Table 8-2**);
+ incident reporting and notifications;
+ regulatory compliance reporting;
+ management of change process for changes to EP activities; and
+ oil pollution emergency response (e.g., OPEP requirements).

8.6.2 Training and competency

All members of the workforce on the MODU, ISV and vessels will complete relevant training and hold qualifications and certificates for their role. Santos and its contractors are individually responsible for ensuring that their personnel are qualified and trained. The systems, procedures and responsible persons will vary and will be managed through the use of online databases, staff on boarding process and training departments, etc.

Personnel qualification and training records will be sampled before and/or during an activity. Such checks will be performed during the procurement process, facility acceptance testing, inductions, crew change, and operational inspections and audits.

8.6.3 Workforce involvement and communication

Daily operational meetings will be held at which HSE will be a standing agenda item. It is a requirement that supervisors attend daily operational meetings and that all personnel attend daily toolbox or pre-shift meetings. Toolbox or pre-shift meetings will be held to plan jobs and discuss work tasks, including HSE risks and their controls.

HSE performance will be monitored and reported during the activity, and performance metrics (such as the number of environmental incidents) will be regularly communicated to the workforce. Workforce involvement and environmental awareness will also be promoted by encouraging offshore personnel to report marine fauna sightings and marine pollution (for example, oil on water, dropped objects).

8.7 Asset Management and Maintenance

Ongoing operations and maintenance of infrastructure installed as part of the Spartan Development will be performed consistent with the existing operational and maintenance processes and procedures (refer to Sections 2.6 and 2.7 of the VI Hub Operations EP for Commonwealth Waters (EA-60-RI-10003)).

8.8 Emergency Preparedness and Response

OPGGS(E)R 2009 Requirements
Regulation 14(8)
The implementation strategy must contain an oil pollution emergency plan and provide for updating the plan.

The MODU, ISV and support vessels are required to have and implement incident response plans, such as an emergency response plan and SMPEP or SOPEP. Regular incident response drills and exercises (for example, as defined in an emergency response plan, SMPEP or SOPEP) are performed to refresh the crew in using equipment and implementing incident response procedures.

Santos will implement the activity OPEP (EA-60-RI-00186.02) in the event of a hydrocarbon spill. The OPEP details how Santos will prepare and respond to a spill event and meets the requirement of the OPGGS(E)R 2009.

8.9 Incident Reporting, Investigation and Follow-up

OPGGSR 2009 Requirements
Regulation 14(2)
The implementation strategy must: (a) state when the titleholder will report to the Regulator in relation to the titleholder's environmental performance for the activity; and (b) provide that the interval between reports will not be more than 1 year. Note: Regulation 26C requires a titleholder to report on environmental performance in accordance with the timetable set out in the environment plan.
Regulation 14(7)
The implementation strategy must provide for sufficient monitoring of, and maintaining a quantitative record of, emissions and discharges (whether occurring during normal operations or otherwise), such that the record can be used to assess whether the environmental performance outcomes and standards in the environment plan are being met.

All personnel will be informed through inductions and daily operational meetings of their duty to report HSE incidents and hazards. Reported HSE incidents and hazards will be shared during daily operational meetings and will be documented in the incident management systems as appropriate. HSE incidents will be investigated using root cause analysis.

Environmental recordable and reportable incidents will be reported to NOPSEMA as required, in accordance with Table 8 4. The incident reporting requirements will be provided to all crew on board the facilities and support vessels with special attention to the reporting time frames to provide for accurate and timely reporting.

For the purposes of this activity, in accordance with OPGGS(E) Regulations:

- a recordable incident, for an activity, means a breach of an EPO or EPS, in the EP Addendum that applies to the activity, that is not a reportable incident; and
- a reportable incident, for an activity, means an incident relating to the activity that has caused, or has the potential to cause, moderate to significant environmental damage.

For the purposes of this EP Addendum, a reportable incident is an incident that is assessed to have an environmental consequence of moderate or higher in accordance with the Santos environmental impact and risk assessment process outlined in **Section 5**. Of the planned and unplanned events assessed within this EP, the following were identified to have a potential consequence level of Moderate or higher if the event were to occur and would therefore be a reportable incident:

- introduction of invasive marine species (Moderate);
- hydrocarbon release (surface and subsurface) from LOWC (Major); and
- hydrocarbon release (marine diesel oil) (Moderate).

8.10 Reporting and Notifications

OPGGSR 2009 Requirements
Regulation 14(2)
The implementation strategy must: (a) state when the titleholder will report to the Regulator in relation to the titleholder's environmental performance for the activity; and (b) provide that the interval between reports will not be more than 1 year.
Regulation 14(7)
The implementation strategy must provide for sufficient monitoring of, and maintaining a quantitative record of, emissions and discharges (whether occurring during normal operations or otherwise), such that the record can be used to assess whether the environmental performance outcomes and standards in the environment plan are being met.

8.10.1 Notifications and compliance reporting

Regulatory, other notification and compliance reporting requirements are summarised in **Table 8-4**.

Table 8-4: Activity notification and reporting requirements

Initiation	Required Information	Timing	Type	Recipient
Before the Activity				
AHO Notification – as requested by Defence and AMSA during consultation.	Pre-start notification.	At least four weeks before the activity commences where practicable.	Written	AHO at datacentre@hydro.gov.au
DMIRS notification requirement requested during consultation	Pre-start notification.	At least two weeks before the activity commences where practicable	Written	DMIRS petroleum.environment@dmirs.wa.gov.au
OPGGS(E) Regulation 29 & 30 – Notifications NOPSEMA must be notified that the activity is to commence.	Complete NOPSEMA's Regulation 29 Start or End of Activity Notification form prior to each campaign.	At least ten days before the activity commences.	Written	NOPSEMA
AMSA JRCC Notification – as requested by AMSA during consultation.	Pre-start notification.	24 to 48 hrs prior to activity commencement.	Written	AMSA's JRCC rccaus@amsa.gov.au

Initiation	Required Information	Timing	Type	Recipient
Director of National Parks notification The DNP has requested notification from Santos when the EP is accepted by NOPSEMA; and at least 10 days prior to all activities occurring within the Montebello AMP (excluding vessel transiting)	Acceptance of EP notification Pre-start notification	Upon NOPSEMA acceptance of this EP Addendum At least 10 days prior to the activity commencement in the Montebello AMP	Written Written	DNP marineparks@awe.gov.au DNP marineparks@awe.gov.au
DoD notification The DoD has requested notification from Santos at least four weeks prior to the commencement of activities.	Pre-start notification	At least 4 weeks prior to activity commencing	Written	offshore.petroleum@defence.gov.au
During the Activity				

Initiation	Required Information	Timing	Type	Recipient
OPGGS(E) Regulation 26B – Recordable Incidents NOPSEMA must be notified of a breach of an EPO or EPS, in the environment plan that applies to the activity that is not a reportable incident.	Complete NOPSEMA's Recordable Environmental Incident Monthly Report form.	The report must be submitted as soon as practicable after the end of the calendar month, and in any case, not later than 15 days after the end of the calendar month.	Written	NOPSEMA
OPGGS(E) Regulation 16(c), 26 & 26A – Reportable Incident NOPSEMA must be notified of any reportable incidents. For the purposes of Regulation 16(c), a reportable incident is defined as: + An incident relating to the activity that	The oral notification must contain: + all material facts and circumstances concerning the reportable incident known or by reasonable search or enquiry could be found out + any action taken to avoid or mitigate any adverse environmental impacts of the reportable incident + the corrective action that has been taken, or is proposed to be taken, to stop, control or remedy the reportable incident.	As soon as practicable, and in any case not later than two hours after the first occurrence of a reportable incident, or if the incident was not detected at the time of the first occurrence, at the time of becoming aware of the reportable incident.	Oral	NOPSEMA
	A written record of the oral notification must be submitted. The written record is not required to include anything that was not included in the oral notification.	As soon as practicable after the oral notification.	Written	NOPSEMA National Offshore Petroleum Titles Administrator

Initiation	Required Information	Timing	Type	Recipient
has caused, or has the potential to cause, moderate to significant environmental damage.	A written report must contain: + all material facts and circumstances concerning the reportable incident known or by reasonable search or enquiry could be found out + any action taken to avoid or mitigate any adverse environmental impacts of the reportable incident + the corrective action that has been taken, or is proposed to be taken, to stop, control or remedy the reportable incident + the action that has been taken, or is proposed to be taken, to prevent a similar incident occurring in the future. Consider reporting using NOPSEMA's Report of an Accident, Dangerous Occurrence or Environmental Incident form.	Must be submitted as soon as practicable, and in any case not later than three days after the first occurrence of the reportable incident unless NOPSEMA specifies otherwise. Same report to be submitted to within seven days after giving the written report to NOPSEMA.	Written	NOPSEMA National Offshore Petroleum Titles Administrator
OPGGS(E) Regulation 26C –Environmental Performance NOPSEMA must be notified of the environmental performance at the intervals provided for in the EP.	Report must contain sufficient information to determine whether or not environmental performance outcomes and standards in the EP Addendum have been met.	A detailed environmental performance report will be submitted within three months of submission of Regulation 29(2).	Written	NOPSEMA
AMSA Reporting	Any changes to the intended operations.	As soon as practicable.	Written	AMSA's JRCC rccaus@amsa.gov.au

Initiation	Required Information	Timing	Type	Recipient
Under the MoU between Santos and AMSA and as requested by AMSA during consultation	Titleholder agrees to notify AMSA of any marine pollution incident[10].	Within two hours of incident.	Oral	AMSA
	POLREP and SITREP available online (refer OPEP).	POLREP as requested by AMSA following verbal notification. SITREP as requested by AMSA within 24 hours of request.	Written	AMSA
AHO Notification – as requested by Defence and AMSA during consultation.	Any changes to the intended operations	As soon as practicable.	Written	AHO at datacentre@hydro.gov.au
Santos' commitment to include activity in Quarterly Consultation Update until activity ends.	The Quarterly Consultation Update will include the activity. This consultation will cease once the activity has ended.	Quarterly.	Written	The Quarterly Consultation Update is circulated to a broad group of Santos stakeholders, including many of the stakeholders identified in **Section 4**.

[10] For clarity and consistency across Santos regulatory reporting requirements Santos will meet the requirement of reporting marine oil pollution by reporting oil spills assessed to have an environmental consequence of moderate or higher in accordance with Santos environmental impact and risk assessment process outlined in **Section 5**.

Initiation	Required Information	Timing	Type	Recipient
Director of National Parks Reporting Notification of the event of oil pollution within a marine park or where an oil spill response action must be taken within a marine park; or if any changes to intended operations (requested through consultation).	The 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 as soon as possible. Notification should be provided to the 24-hour Marine Compliance Duty Officer on 0419 293 465. The notification should include: + titleholder details + time and location of the incident (including name of marine park likely to be affected) + proposed response arrangements as per the OPEP (such as dispersant, containment) + confirmation of providing access to relevant monitoring and evaluation reports when available + contact details for the response coordinator. Note that the DNP may request daily or weekly Situation Reports, depending on the scale and severity of the pollution incident.	So far as reasonably practicable prior to response action being written.	Oral and written	Director of National Parks
	+ Notify if details regarding the activity change and result in an overlap with or new impact to a marine park.	As soon as practicable.	Written	DNP: marineparks@awe.gov.au
DPIRD Reporting If marine pests or disease are suspected this must be reported to DPIRD.	Notification of any suspected marine pests or diseases including any organism listed in the Western Australian Prevention List for Introduced Marine Pests and any other non-endemic organism that demonstrates invasive characteristics.	Within 24 hours.	Oral	DPIRD FishWatch

Initiation	Required Information	Timing	Type	Recipient
DAWE Reporting + Any harm or mortality to EPBC Act-listed threatened marine fauna. + Marine Fauna Sighting Data.	Notification of any harm or mortality to an EPBC listed species of marine fauna whether attributable to the activity or not.	Within seven days to EPBC.permits@environment.gov.au	Written	DAWE
	Marine fauna sighting data recorded in the marine fauna sighting database.	As soon as practicable, in any case no later than three months of the end of the activity.	Written	DAWE
Any harm or mortality to fauna listed as threatened under the WA Biodiversity Conservation Act 2016.	Notification of any harm or mortality to fauna listed as a threatened species under the WA Biodiversity Conservation Act 2016 as a result of Santos activities.	A fauna report will be submitted to DBCA within seven days to fauna@dbca.wa.gov.au.	Written	DBCA
Australian Marine Mammal Centre Reporting Any ship strike incident with cetaceans will also be reported to the National Ship Strike database.	Ship strike report provided to the Australian Marine Mammal Centre: https://data.marinemammals.gov.au/report/shipstrike.	As soon as practicable.	Written	DAWE

Initiation	Required Information	Timing	Type	Recipient
Department of Biodiversity, Conservation and Attractions Reporting Impacts to marine mammals or turtles in reserves.	Notification of any incidence of entanglement, boat collisions and stranding of marine mammals in the reserves and any incident of turtle mortality and incidents of entanglement in the reserves as detailed in the Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves.	Within 48 hours.	Written	DBCA
Department of Biodiversity, Conservation and Attractions Reporting Notification of the event of a hydrocarbon release.	Notification of actual or impending spillage.	As soon as practicable.	Oral or Written	DBCA Pilbara regional office
Department of Transport Reporting All actual or impending MOP incidents that are in, or may impact, State waters resulting from an offshore petroleum activity.	Notification of actual or impending spillage, release or escape of oil or an oily mixture that is capable of causing loss of life, injury to a person or damage to the health of a person, property or the environment	Within two hours.	Oral	DoT
	WA DoT POLREP and SITREP available online (refer OPEP).	As requested by DoT following verbal notification.	Written	DoT
End of Activity				

Initiation	Required Information	Timing	Type	Recipient
OPGGS(E) Regulation 29 – Notifications NOPSEMA must be notified that the activity is completed.	Complete NOPSEMA's Regulation 29 Start or End of Activity Notification form for both notifications.	Within ten days after cessation of each campaign.	Written	NOPSEMA
Director of National Parks Reporting The DNP has requested notification form Santos at the conclusion of activities within the Montebello AMP	Activity Cessation Notification	Within ten days after cessation of activities in the Montebello AMP	Written	DNP marineparks@awe.gov.au
AHO AMSA JRCC DMIRS	Activity Cessation Notification.	Within ten days after cessation of each campaign.	Written	AHO: datacentre@hydro.gov.au AMSA's JRCC: rccaus@amsa.gov.au DAWE: Petroleum&Fisheries@agriculture.gov.au DBCA: EMBAdmin@dbca.wa.gov.au DMIRS: petroleum.environment@dmirs.wa.gov.au PPA: shipping@pilbaraports.com.au
Commercial fishers notification - requested during consultation	Activity Cessation Notification provided to relevant commercial fishing stakeholders, as agreed with WAFIC or relevant industry body:	Within ten days after cessation of each campaign.	Written	WAFIC oilandgas@wafic.org.au

Initiation	Required Information	Timing	Type	Recipient
OPGGS(E) Regulation 14(2) & 26C – Environmental Performance NOPSEMA must be notified of the environmental performance of the activity.	Report must contain sufficient information to determine whether or not environmental performance outcomes and standards in the EP Addendum have been met.	An environmental performance report will be submitted within three months of completion of each campaign	Written	NOPSEMA
OPGGS(E) Regulation 25A EP ends when titleholder notifies completion and the Regulator accepts the notification. NOPSEMA must be notified that the activity has ended and all EP obligations have been completed	Notification advising NOPSEMA of end of all activities to which the EP Addendum relates and that all obligations have been completed.	Within six months of the final Regulation 29 (2) notification.	Written	NOPSEMA

8.10.2 Monitoring and recording emissions and discharges

OPGGS(E)R 2009 Requirements
Regulation 10A(e)
Includes an appropriate implementation strategy and monitoring, recording and reporting arrangements.
Regulation 14 (7)
The implementation strategy must provide for sufficient monitoring of, and maintaining a quantitative record of, emissions and discharges (whether occurring during normal operations or otherwise), such that the record can be used to assess whether the environmental performance outcomes and standards in the environment plan are being met.

Vessel-based discharges to the marine environment, associated with this activity will be recorded and controlled in accordance with requirements under relevant marine orders.

Santos and vessel contractors will maintain records so that emissions and discharges can be determined or estimated. Such records will be maintained for a period of five years. Contractors are required to make these records available upon request. Santos records discharges or emissions (where practicable), to the environment as described in **Table 8-5**.

Table 8-5: Monitoring methods for emissions and discharges

Discharge/emission	Parameter	Quantitative Record	Recording frequency
Chemicals (discharged to marine environment as per **Section 6.7**)	Volume	Chemical Risk Assessment Volumes used will be estimated based on known inventories	For every chemical use with a fate to the marine environment
Oily water	Volume and location	Oil Record Book* or equivalent report	For every discharge
Garbage (including food scraps)	Volume and location	Garbage Record Book*	For every discharge
Sewage	Volume and location	Sewage Record Book*	For every discharge
Ballast water	Volume and location	Ballast water record book or log**	For every discharge
Unplanned discharge of solid objects	Volume	Incident report	For every discharge
Unplanned discharge of hazardous liquids	Volume	Incident report	For every discharge
Unplanned hydrocarbon release	Volume	Incident report	For every discharge

**Maintained as per vessel class in accordance with relevant Marine Orders.*

*** Maintained as per Australian Ballast Water Management Requirements 2017.*

8.11 Document Management

8.11.1 Information management and document control

This EP Addendum, as well as approved management of change documents, are controlled documents and current versions will be available on Santos' intranet. Santos contractors are also required to maintain current versions of these documents.

Environmental performance outcomes and standards will be measured based on the measurement criteria listed in **Table 8-2**. Such records will be maintained for a period of five years. Contractors are required to make these records available upon request.

8.11.2 Management of change

The MoC process provides a systematic approach to initiate, assess, document, approve, communicate and implement changes to EPs and OPEPs.

The MoC process considers Regulations 7, 8 and 17 of the OPGGS(E)R 2009 and determines if a proposed change can proceed and the manner in which it can proceed. The MoC procedure will determine whether a revision of the EP Addendum is required and whether that revision is to be submitted to NOPSEMA. For a change to proceed, the associated environmental impacts and risks must be demonstrated to be acceptable and ALARP. Additional stakeholder consultation may be required, depending on the nature and scale of the change. Additional information about the MoC process is provided in **Figure 8-1**.

The MoC procedure also allows for the assessment of new information that may become available after EP acceptance, such as new management plans for AMPs, new recovery plans or conservation advice for species, and changes to the EPBC Protected Matters Search results. If a review identifies new information, this is treated as a "Change that has an impact on EP", and the MoC process is followed accordingly.

Accepted MoCs become part of the in-force EP or OPEP, are tracked on a register and are made available on Santos' intranet. Where appropriate, the EP Addendum compliance register will be updated so that CM or EPS changes are communicated to the workforce and implemented. Any MoC will be distributed to the management people identified in **Table 8-3** (excluding the Chief Executive Officer and Directors), and the most relevant management position will ensure the MoC is communicated and implemented, which may include crew meetings, briefings or communications as appropriate for the change.

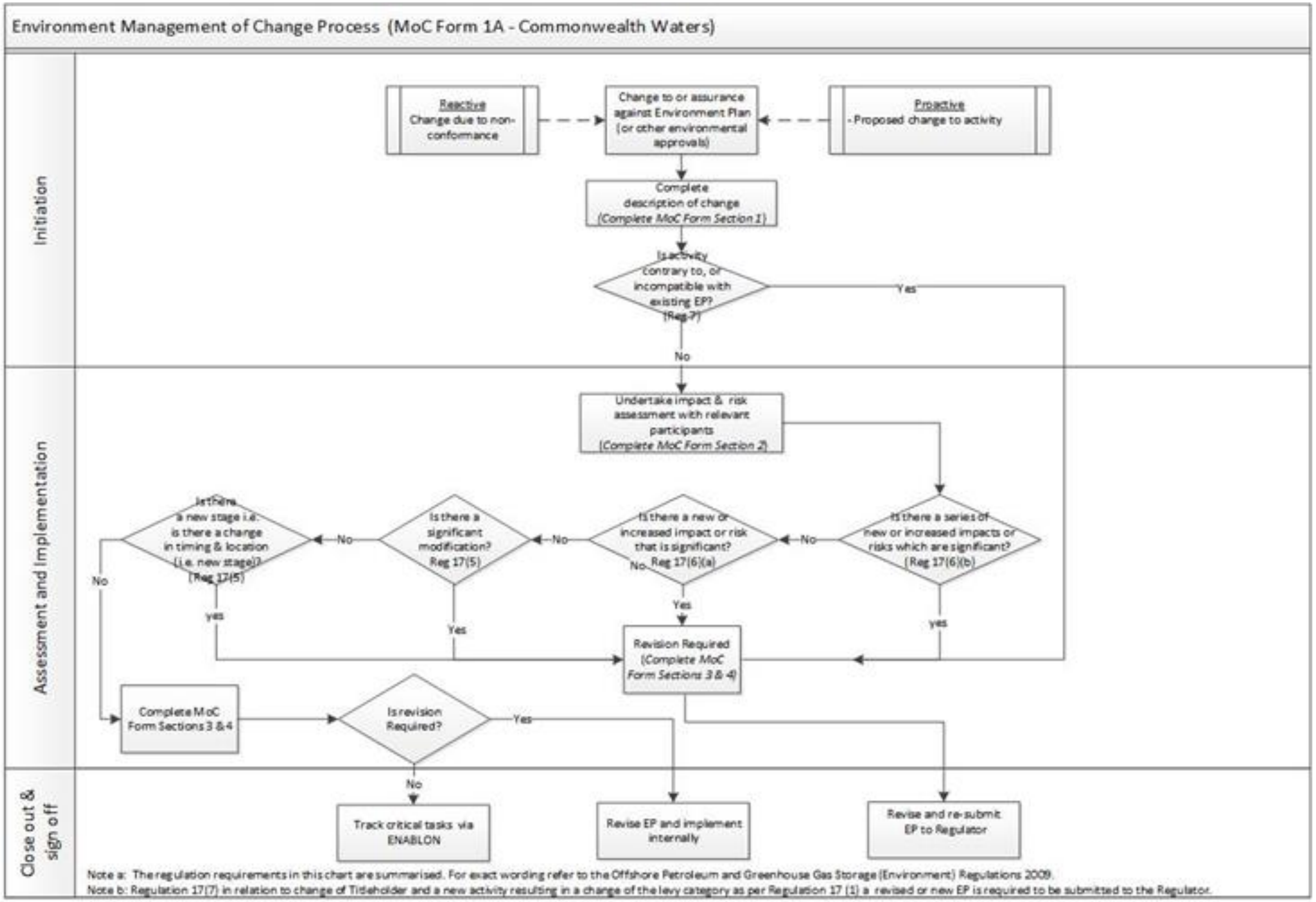

Figure 8-1: Environment management of change process

8.11.3 Reviews

This EP Addendum has assessed impacts and risk across the both operational areas, during any time of the year, for planned and unplanned events given the nature of the 24/7 operations.

It is recognised that the over the validity of this EP Addendum things may change, such as:

+ Legislation;
+ businesses conditions, activities, systems, processes and people;
+ industry practices;
+ science and technology; and
+ societal and stakeholder expectations.

To ensure Santos maintains up-to-date knowledge of the industry, legislation and conservation advice, the following tasks are undertaken:

+ maintain membership of APPEA (Australian Petroleum Production & Exploration Association), which provides a mechanism for communicating potential changes in legislation, industry practice and other issues that may affect EP implementation to relevant personnel in Santos;
+ undertake annual spill response exercises to check spill response arrangements and capability are adequate;
+ identify stakeholders prior to the activity commencing under this EP Addendum via the mechanisms outlined in **Section 4**;
+ review the Values and Sensitivities within the EMBA which includes completing a new EPBC Protected Matters Search, reviewing **Appendix C** against relevant legislation to capture and review any relevant updates and incorporate as required, and reviewing any recently known published relevant scientific papers;
+ subscribe to various regulator updates; and
+ have regular liaison meetings with Regulators

Through maintenance of up to date knowledge, these changes are identified. If the changes have an impact on the activity or risks described and assessed in this EP Addendum, the EP Addendum will be reviewed and any changes required documented in accordance with Santos' MoC procedure (**Section 8.11.2**).

8.12 Audits and inspections

OPGGS(E)R 2009 Requirements
Regulation 14(6)
The implementation strategy must provide for sufficient monitoring, recording, audit, management of nonconformance and review of the titleholder's environmental performance and the implementation strategy to ensure that the environmental performance outcomes and standards in the environment plan are being met.

8.12.1 Audits

Santos audit plans and schedules are reviewed and updated at the beginning of each calendar year and cover all Santos facilities and activities. Santos' audit schedule may be amended to accommodate operational priorities, activity risk, personnel availability or high audit demand during certain periods (for example, regulatory audits, contractor audits). Santos will determine if a vessel audit is required following contract award and vessel confirmation.

Audits will be undertaken in a manner consistent with Santos' Management Standard for Assurance SMS MS15.

Audit scope typically includes a selection of CMs and EPSs and EPOs. However, audits may also include other parts of the EP.

Audits findings may include opportunities for improvement and non-conformances. Audit non-conformances are managed as described in **Section 8.12.3**.

8.12.2 Inspections

During an activity, HSE inspections (desktop or vessel based) will be conducted at least once during the activity to identify hazards, incidents and EP non-conformances. These inspections will also check compliance against all the EPOs and EPSs of this EP Addendum (**Table 8-2**) and inform end of activity reporting (**Table 8-4**). Any in field opportunities for improvement or corrective actions will be discussed during the inspection with the Vessel Master or Offshore Installation Manager.

8.12.3 Non-conformance management

EP non-conformances will be addressed and resolved by a systematic corrective action process as outlined in Santos' Management Standard for Assurance (MS15) and the Assurance Procedure (ST01). Non conformances arising from audits and inspections will be entered into Santos' incident and action tracking management system (i.e., 'HSE Toolbox). Once entered, corrective actions, time frames and responsible persons (including action owners and event validators) will be assigned. Corrective action 'close out' will be monitored using a management escalation process.

8.12.4 Continuous improvement

For this EP Addendum, continuous improvement will be driven by the list below, and may result in a review of the EP Addendum with changes applied in accordance with **Section 8.11.2**:

+ improvements identified from the review of business-level HSE key performance indicators;
+ actions arising from Santos and departmental HSE improvement plans;
+ corrective actions and feedback from HSE audits and inspections, incident investigations and after action reviews;
+ opportunities for improvement and changes identified during pre-activity reviews and MoC documents; and
+ actions taken to address concerns and issues raised during the ongoing stakeholder management process (**Section 4**).

Identified continuous improvement opportunities will be assessed in accordance with the MoC process to ensure any potential changes to this EP, or OPEP, are managed in accordance with the OPGGS(E)R 2009 and in a controlled manner.

9 References

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Appendix A – Santos Environment, Health and Safety Policy

Environmental Management

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Policy

Our commitment

We share the community's concern for the proper care and custody of our environment for present and future generations. At Santos protecting the environment and valuing cultural heritage are an integral part of the way we do business.

Our objective is to implement best environmental practices wherever practical to do so. We are committed to demonstrating leadership in environmental management and ensuring that our actions are performed in a manner which has acceptable impact on the land, sea and air.

We will comply with all applicable environmental legislation and regulations relevant to our business.

We will promote continuous improvement in energy efficiency, greenhouse gas emission reduction and innovation to reduce our carbon footprint and energy use.

Our actions

Wherever we operate we will:

+ Maintain open community and government consultation regarding our activities and our environmental performance
+ Educate, train and encourage our workforce to conduct activities in an environmentally responsible manner
+ Identify, assess and control risks to the environment and the surrounding community in order to manage the potential for unacceptable pollution and impacts
+ Develop and implement systems to manage all activities which have the potential to affect the surrounding natural environment
+ Measure our environmental performance and set targets for continual improvement; and
+ Conduct monitoring of the surrounding natural environment thereby contributing to knowledge of natural systems and enabling any impacts to be detected.

Governance

This policy has been reviewed and endorsed by the Santos WA Energy Holdings Board of Directors and management who foresee benefits in, and take responsibility for, its successful implementation.

By accepting employment with Santos, each employee and contractor acknowledges that they are responsible for the application of this policy.

K. T. Gallagher

Kevin Gallagher
Managing Director & CEO

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Appendix B – Legislative Framework

Australian Legislation

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
Aboriginal and Torres Strait Islander Heritage Protection Act 1984	This Act provides for the preservation and protection from injury or desecration areas and objects that are of significance to Aboriginal people, under which the Minister may make a declaration to protect such areas and objects. The Act also requires the discovery of Aboriginal remains to be reported to the Minister.	Yes	Commonwealth – Department of Agriculture, Water and the Environment	There are no known sites of Aboriginal Heritage Significance within the operational area, but there are within the EMBA. This Act would only apply to the activity if there was a discovery of Aboriginal remains, which is not considered likely to occur given the off-shore location of the activity.	**Section 3.2.3 -** Protected/significant areas
Australian Ballast Water Requirements, Version 7	Australian Ballast Water Management Requirements outline the mandatory ballast water management requirements to reduce the risk of introducing harmful aquatic organisms into Australia's marine environment through ballast water from international vessels. These requirements are enforceable under the *Biosecurity Act 2015*.	Yes	Commonwealth – Department of Agriculture and Water Resources	Potential internationally sourced vessel operating in Australian Waters which could have the potential for introduction of Invasive Marine Species and potential ballast water exchange.	**Section 7.2** – Introduction of invasive marine species
Australian Heritage Council Act 2003	This Act identifies areas of heritage value listed on the Register of the National Estate and sets up the Australian Heritage Council and its functions.	Yes	Australian Heritage Council	There are a number of national heritage places found on the National Heritage List, within the EMBA, as identified by the Act.	**Section 3.2.3** – Protected/significant areas
Australian Maritime Safety Authority Act	This Act specifies that AMSA's role includes protection of the marine environment from pollution from ships and	Yes	AMSA	This Act applies to the use of any vessel associated with operations, and is relevant to	**Section 7.7** – Hydrocarbon spill – marine diesel oil

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
1990 (AMSA Act)	other environmental damage caused by shipping. AMSA is responsible for administering the Marine Order in Commonwealth Waters. This Act facilitates international cooperation and mutual assistance in preparing and responding to a major oil spill incident and encourages countries to develop and maintain an adequate capability to deal with oil pollution emergencies. Requirements are given effect through AMSA. AMSA is the lead agency for responding to oil spills in the marine environment and is responsible for the Australian National Plan for Maritime Environmental Emergencies.			the activity in regards to the unplanned pollution from ships.	
Aquatic Resources Management Act 2016	This Act will be the primary legislation used to manage fishing, aquaculture, pearling and aquatic resources in Western Australia. The Act was scheduled for commencement on 1 January 2019; however, this has been deferred while an amendment to the Act is progressed.	Yes	Department of Primary Industries and Regional Development	Vessel movements have the potential to introduce invasive marine species (IMS). This Act was considered during development of the Santos IMS Management Zone and IMS Management Plan (EA-00-RI-10172).	**Section 7.2 -** Introduction of invasive marine species
Marine Orders	Marine Orders (MO) are subordinate rules made pursuant to the *Navigation Act 2012* and *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* affecting the maritime industry. They are a means of implementing Australia's international maritime obligations by giving effect to international conventions in Australian law.	Yes	AMSA	Vessel movements, safety, discharges and emissions	**Section 6 and 7**– Planned and unplanned events

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Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
Maritime Powers Act 2013	Protects the heritage values of shipwrecks and relics for shipwrecks over 75 years. It is an offence to interfere with a shipwreck covered by this Act. Available historic shipwreck locations covered by international conventions enacted by this legislation have been identified and assessed (as applicable) within this EP.	No	The Department of Immigration and Border Protection	This Act applies to the shipwrecks (over 75 years old) within the EMBA. There is no planned interaction or interference with shipwrecks, and any unplanned impacts is only expected to affect the surface waters.	N/A
Biosecurity Act 2015 Biosecurity Regulations 2016	This Act provides the Commonwealth with powers to take measures of quarantine, and implement related programs as are necessary, to prevent the introduction of any plant, animal, organism or matter that could contain anything that could threaten Australia's native flora and fauna or natural environment. The Commonwealth's powers include powers of entry, seizure, detention and disposal. This Act includes mandatory controls on the use of seawater as ballast in ships and the declaration of sea vessels voyaging out of and into Commonwealth Waters. The Regulations stipulate that all information regarding the voyage of the vessel and the ballast water is declared correctly to the quarantine officers.	Yes	Commonwealth – Department of Agriculture and Water Resources	This Act applies to all internationally sources vessels operating in Australian Waters which could have the potential for the introduction of IMS and potential ballast water exchange.	**Section 7.2** – Introduction of IMS
Corporations Act 2001	This Act is the principal legislation regulating matters of Australian companies, such as the formation and operation of	Yes	Commonwealth – Australian Securities and	The titleholder has provided ACN details within the meaning of the Act.	**Section 1.5**

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	companies, duties of officers, takeovers and fundraising.		Investments Commission		
Environment Protection and Biodiversity Conservation Act 1999 EPBC Amendment Regulations 2006	NOPSEMA is the sole assessor for offshore petroleum activities in Commonwealth water (as of 28 February 2014). Under the new arrangements, environmental protection will be met through NOPSEMA's decision-making processes. This Act is the Australian Government's key piece of environmental legislation. The Act focuses on protecting MNES. AMP Management Plans were also developed under this Act.	Yes	Commonwealth – Department of Agriculture, Water and the Environment	This Act applies to all aspects of the activity that have the potential to impact MNES. Appropriate environmental approvals will be sought from NOPSEMA for all operations (this EP) which outlines compliance with the relevant regulations and plans under the Act. Where activities have existing approvals under the Act, these will continue to apply.	**Section 6.1** – Noise emissions **Section 6.2** – Light emissions **Section 6.6**– Operational discharges **Section 6.7** – Drilling and cement discharges **Section 6.8** – Planned chemical and hydraulic fluid discharges **Section 7.6, 7.7** and 7.8 – Hydrocarbon release **Section 7.3** – Marine fauna interaction
Underwater Cultural Heritage Act 2018	This Act replaces the *Historic Shipwrecks Act 1976*, and extends protection to other wrecks such as submerged aircraft and human remains. It also increases penalties applicable to damaged sites. The Act came into effect on 1 July 2019.	Yes		No planned interaction or interference to shipwrecks. Potential impact could be due to a hydrocarbon spill but the credible spill is to surface, and therefore shipwrecks are highly unlikely to be impacted. Numerous shipwrecks identified within EMBA.	**Section 7.6, 7.7** and 7.8 – Hydrocarbon release

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
National Greenhouse and Energy Reporting Act 2007	Introduces a single national reporting framework for the reporting and dissemination of information about greenhouse gas emissions, greenhouse gas projects and energy use and production of corporations.	Yes	Commonwealth – Department of Agriculture, Water and the Environment Climate Change Authority	This Act applies to the atmospheric emissions through combustion engine use to operate the vessels and MODU associated with the activity. Implementation of the Act will reduce the impact of GHG emissions associated with vessel use for the installation and pre-commissioning activity, through compliance with MARPOL Annex VI (Marine Order Part 97: Marine Pollution Prevention – Air Pollution), and require the use of low sulphur fuel.	**Section 6.3** – Atmospheric emissions
Maritime Legislation Amendment (Prevention of Air Pollution from Ships) Act 2007	This Act implements the requirements of MARPOL 73/78 Annex VI for shipping in Commonwealth Waters.	Yes	Commonwealth, Department of Infrastructure and Regional Development.	Implementation of this Act reduces the impact of GHG emissions associated with vessel use for the installation and pre-commissioning activity, through compliance with MARPOL Annex VI (Marine Order Part 97: Marine Pollution Prevention – Air Pollution), and require the use of low sulphur fuel.	**Section 6.3** – Atmospheric emissions
Marine Safety (Domestic Commercial	This Act is a single regulatory framework for the certification, construction, equipment, design and operation of	Yes	Commonwealth – Australian	All vessel movements associated with the activity will be governed by AMSA marine	**Section 6.5**– Interaction with other marine users

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
Vessel) National Law Act 2012	domestic commercial vessels inside Australia's exclusive economic zone.		Maritime Safety Authority	safety regulations under the Act.	**Section 7.7 –** Hydrocarbon spill – marine diesel oil
Navigation Act 2012	An Act regulating navigation and shipping including SOLAS. A number of Marine Orders enacted under this Act apply directly to offshore petroleum exploration and production activities: + Marine Order 21: Safety and Emergency Arrangements + Marine Order 27: Safety of Navigation and Radio Equipment + Marine Order 30: Prevention of collisions + Marine Order 58: Safe Management of Vessels + Marine Order 70 – Seafarer Certification.	Yes	AMSA (operational) Department of Infrastructure and Regional Development Minister for Infrastructure and Regional Development	All vessel movements associated with the activity will be governed by marine safety regulations and Marine Orders under the Act.	**Section 6.5**– Interaction with other marine users **Section 7.7 –** Hydrocarbon spill – marine diesel oil
Offshore Petroleum and Greenhouse Gas Storage Act 2006 Offshore Petroleum and Greenhouse Gas Storage (Environment)	Petroleum exploration and development activities in Australia's offshore areas are subject to the environmental requirements specified in the OPGGS Act and associated Regulations. The OPGGS Act contains a broad requirement for titleholders to operate in accordance with "good oil-field practice". Specific environmental provisions relating to work practices essentially require operators to control and prevent the escape of wastes and petroleum.	Yes	NOPSEMA	The activity involves cessation of production activities, which is a petroleum activity regulated by NOPSEMA under this Act.	**Section 6**– Risk Assessments for Planned Events **Section 7**– Risk Assessments for Unplanned Events

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
Regulations 2009	The Act also requires that activities are carried out in a manner that does not unduly interfere with other rights or interests, including the conservation of the resources of the sea and sea-bed, such as fishing or shipping. In some cases, where there are particular environmental sensitivities or multiple use issues it may be necessary to apply special conditions to an exploration permit area. The holder of a petroleum title must maintain adequate insurance against expenses or liabilities arising from activities in the title, including expenses relating to clean-up or other remedying of the effects of the escape of petroleum. The OPGGS Environment Regulations provide an objective based regime for the management of environmental performance for Australian offshore petroleum exploration and production activities in areas of Commonwealth jurisdiction. Key objectives of the Environment Regulations include: + to ensure operations are carried out in a way that is consistent with the principles of ecologically sustainable development + to adopt best practice to achieve agreed environment protection standards in industry operations				

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	+ to encourage industry to continuously improve its environmental performance.				
Ozone Protection and Synthetic Greenhouse Gas Management Act 1989	Regulates the manufacture, importation and use of ozone depleting substances (typically used in fire-fighting equipment and refrigerants). Applicable to the handling of any ODS.	Yes	Commonwealth – Department of Agriculture, Water and the Environment	The activity does not include import, export or manufacture activities of ODS. This Act applies where ODS is found on vessel refrigeration systems; however, this is a rare occurrence.	**Section 6.3** – Atmospheric emissions
Protection of the Sea (Powers of Intervention) Act 1981 Protection of the Sea (Powers of Intervention) Regulations 1983	The Act authorises the Commonwealth to take measures for the purpose of protecting the sea from pollution by oil and other noxious substances discharged from ships and provides legal immunity for persons acting under an AMSA direction.	Yes	Commonwealth – Department of Infrastructure and Regional Development	This Act applies to vessel discharges and movements associated with the activity. The Act is relevant to the extent that Santos will comply with MARPOL through the following relevant Marine Orders relating to marine pollution prevention have been put in place to give effect to relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78: + Marine Order 91: Marine Pollution Prevention – Oil + Marine Order 93: Marine Pollution Prevention – Noxious Liquid Substances	**Section 6.5** – Interaction with other marine users **Section 6.6–** Planned operational discharges **Section 7.4** to **7.8 –** Unplanned hydrocarbon and non-hydrocarbon/ chemical spills **Section 7.2 –** Introduction of IMS

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
				+ Marine Order 94: Marine Pollution Prevention – Packaged Harmful Substances + Marine Order 95: Marine Pollution Prevention – Garbage + Marine Order 96: Marine Pollution Prevention – Sewage.	
Protection of the Sea (Prevention of Pollution from Ships) Act 1983 Protection of the Sea (Prevention of Pollution from Ships) (Orders) Regulations 1994	This Act relates to the protection of the sea from pollution by oil and other harmful substances discharged from ships. This Act disallows any harmful discharge of sewage, oil and noxious substances into the sea and sets the requirements for a shipboard waste management plan. The following Marine Orders relating to marine pollution prevention have been put in place to give effect to relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78: + Marine Order 91: Marine Pollution Prevention – Oil + Marine Order 93: Marine Pollution Prevention – Noxious Liquid Substances + Marine Order 94: Marine Pollution Prevention – Packaged Harmful Substances	Yes	Commonwealth – Department of Infrastructure and Regional Development	This Act applies to vessel discharges and movements associated with the activity. The Act is relevant to the extent that Santos will comply with MARPOL through the following relevant Marine Orders relating to marine pollution prevention have been put in place to give effect to relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78: + Marine Order 91: Marine Pollution Prevention – Oil + Marine Order 93: Marine Pollution Prevention – Noxious Liquid Substances	**Section 6.5** – Interaction with other marine users **Section 6.6–** Planned operational discharges **Section 7.4** to **7.8 –** Unplanned hydrocarbon and non-hydrocarbon/ chemical spills **Section 7.2 –** Introduction of IMS

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
	+ Marine Order 95: Marine Pollution Prevention – Garbage + Marine Order 96: Marine Pollution Prevention – Sewage + Marine Order 97: Marine Pollution Prevention – Air Pollution.			+ Marine Order 94: Marine Pollution Prevention – Packaged Harmful Substances + Marine Order 95: Marine Pollution Prevention – Garbage + Marine Order 96: Marine Pollution Prevention – Sewage.	
Protection of the Sea (Civil Liability of Bunker Oil Pollution Damage) Act 2008	This Act implements the requirements for the International Convention on Civil Liability for Bunker Oil Pollution Damage.	Yes	AMSA	This Act applies to diesel refuelling which may be undertaken at sea as part of the activity. Compliance with the Act reduces the risk of bunker oil pollution.	**Section 7.7** – Hydrocarbon spill – marine diesel oil
Protection of the Sea (Harmful Antifouling Systems) Act 2006	This Act relates to the protection of the sea from the effects of harmful anti-fouling systems. It prohibits the use of harmful organotins in ant-fouling paints used on ships. This is enacted by Marine Order 98 (Marine Pollution – Anti-fouling Systems) 2013.	Yes	Commonwealth, Department of Infrastructure and Regional Development and AMSA	This Act applies to vessel movements in Australian Waters associated with the activity. Vessels are required to have biofouling systems in place to prevent introduction of IMS/harmful impact on Australian biodiversity. This is enacted by Marine Order 98 (Marine Pollution – Anti-fouling Systems) 2013.	**Section 7.2** – Introduction of IMS

Commonwealth Legislation	Summary	Relevant to activity?	Administering Authority	Relevant aspects of the activity	EP Section
State Legislation					
Fish Resources Management Act 1994 *Fish Resources Management Regulations 1995*	This Act establishes a framework for management of fishery resources and is the nominated lead agency responsible for implementing Western Australian marine biosecurity management requirements through implementation of the *Fish Resources Management Act 1994* (FRMA 1994) and associated regulations.	Yes	Department of Primary Industries and Regional Development	Introduction of invasive marine species.	**Section 7.2** – Introduction of invasive marine species

International Agreements and Conventions

International Agreements and Conventions	Summary	Relevant to Activity?	Relevant Aspects	EP Section
1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972	Implemented in WA *Marine (Sea Dumping) Act* and *Environmental Protection (Sea Dumping) Act 1981.*	Yes	Sewage, grey water, and putrescible wastes generated from support vessels and MODU. Deck drainage/deck wash-down, cooling, brine, ballast and bilge water from support vessels. Hydraulic fluid released by valve operation on subsea infrastructure. Various discharges from planned maintenance activities.	**Section 6.6** – Operational discharges
Agreement Between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and Their	This agreement recognises the special international concern for the protection of migratory birds and birds in danger of extinction that migrate between Australia and	Yes	Only relevant in so far as the credible spill scenario may result in impact to migratory seabirds foraging in area.	**7.6** to **7.8 –** Unplanned hydrocarbon spills

International Agreements and Conventions	Summary	Relevant to Activity?	Relevant Aspects	EP Section
Environment 1974 (commonly referred to as the Japan Australia Migratory Bird Agreement or JAMBA)	Japan. Implemented in EPBC Act 1999.			
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 1986 (commonly referred to as the China Australia Migratory Bird Agreement or CAMBA)	This agreement recognises the special international concern for the protection of migratory birds and birds in danger of extinction that migrate between Australia and China. Implemented in EPBC Act 1999.	Yes	Only relevant in so far as the credible spill scenario may result in impact to migratory seabirds foraging in area.	**7.6** to **7.8 –** Unplanned hydrocarbon spills
Convention for the Control of Transboundary Movements of Hazardous Wastes and Their Disposal 1989 (Basel Convention)	This convention deals with the transboundary movement of hazardous wastes, particularly by sea. Implemented in *Hazardous Waste (Regulation of Exports and Imports) Act 1989.*	No	Activity does not involve transboundary movement of hazardous wastes.	N/A
United Nations Convention on Biological Diversity -1992	An international treaty to sustain life on earth.	Yes	Relevant only insofar as the activity may interact with MNES (threatened and migratory species) protected under the EPBC Act.	**Section 6.1** – Noise emissions **Section 6.2**– Light emissions **Section 6.4** – Seabed and benthic habitat disturbance **Section 7.3 –** Interaction with marine fauna **Section 7.4** to **7.8** – Unplanned releases

International Agreements and Conventions	Summary	Relevant to Activity?	Relevant Aspects	EP Section
Convention on Oil Pollution Preparedness, Response and Co-operation 1990 (OPRC 90)	This convention comprises national arrangements for responding to oil pollution incidents from ships, offshore oil facilities, sea ports and oil handling. The convention recognises that in the event of pollution incident, prompt and effective action is essential.	Yes	In the event that worse-case credible spill scenarios may enact a national arrangement for response.	**Section 7.6** to **7.8 –** Unplanned hydrocarbon spills **Section 6.9–** Spill response operations
Convention on the Conservation of Migratory Species of Wild Animals 1979 (Bonn Convention)	The Bonn Convention aims to improve the status of all threatened migratory species through national action and international agreements between range states of particular groups of species.	Yes	Only relevant in so far as the credible spill scenario may result in impact to MNES protected migratory species.	**Section 7.6** to **7.8 –** Unplanned hydrocarbon spills **Section 6.9–** Spill response operations
International Convention for the Establishment of an International Fund for Compensation for Oil Pollution Damage (Fund 92)	This convention ensures compensation is provided for damage caused by oil pollution.	No	Relevant to oil tankers, not supply or support vessels.	N/A

International Agreements and Conventions	Summary	Relevant to Activity?	Relevant Aspects	EP Section
International Convention for the Prevention of Pollution from Ships 1973/1978 (MARPOL 73/78)	This Convention and Protocol (together known as MARPOL 73/78) build on earlier conventions in the same area. MARPOL is concerned with operational discharges of pollutants from ships. It contains six Annexes, dealing respectively with oil, noxious liquid substances, harmful packaged substances, sewage, garbage and air pollution. Detailed rules are laid out as to the extent to which (if at all) such substances can be released in different sea areas. The legislation giving effect to MARPOL in Australia is the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*, the *Navigation Act 2012* and several Parts of Marine Orders made under this legislation.	Yes	Already dealt with through the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983* – refer to legislation table.	N/A
International Convention for the Safety of Life at Sea 1974	This convention is generally regarded as the most important of all international treaties concerning the safety of merchant ships Implemented in the *Air Navigation Act 1920.*	Yes	Only relevant in so far as SOLAS relates to safety aspects of the activity, such as navigation aids which reduce potential for vessel collision and hydrocarbon release to the environment.	**Section 6.5**– Interaction with other marine users
International Convention on Civil Liability for oil pollution damage (1969)	This convention provides a mechanism for ensuring the payment of compensation for oil pollution damage.	No	Relevant to oil tankers.	N/A

International Agreements and Conventions	Summary	Relevant to Activity?	Relevant Aspects	EP Section
International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Convention) 2004	The IMO has been addressing the problem of invasive marine species in ship's ballast water since the 1980s. Ballast water and sediments guidelines were adopted in 1991 and the ballast water convention was adopted in 2004. Recent accession by Finland has triggered the final entry into force of these international requirements. As a result, the International Convention for the Control and Management of Ships Ballast Water and Sediment will enter into force on 8th September 2017 (IMO Briefing 22 2016). It aims to prevent the spread of harmful aquatic organisms from one region to another, by establishing standards and procedures for the management and control of ships' ballast water and sediments. Ballast Water Management systems must be approved by the Administration in accordance with this IMO Guidelines.	Yes	Potential internationally sourced vessel operating in Australian Waters which could have the potential for introduction of Invasive Marine Species and potential ballast water exchange.	**Section 7.2** – Introduction of invasive marine species

International Agreements and Conventions	Summary	Relevant to Activity?	Relevant Aspects	EP Section
United Nations Convention on the Law of the Sea (UNCLOS) (1982)	Part XII of the convention sets up a general legal framework for marine environment protection. The convention imposes obligations on State Parties to prevent, reduce and control marine pollution from the various major pollution sources, including pollution from land, from the atmosphere, from vessels and from dumping (Articles 207 to 212). Subsequent articles provide a regime for the enforcement of national marine pollution laws in the many different situations that can arise. Australia signed the agreement relating to the implementation of Part XI of the Convention in 1982, and UNCLOS in 1994.	Yes	Only relevant to the extent that Santos will comply with MARPOL through the following relevant Marine Orders relating to marine pollution prevention have been put in place to give effect to relevant regulations of Annexes I, II, III, IV, V and VI of MARPOL 73/78: + Marine Order 91: Marine Pollution Prevention – Oil + Marine Order 93: Marine Pollution Prevention – Noxious Liquid Substances + Marine Order 94: Marine Pollution Prevention – Packaged Harmful Substances + Marine Order 95: Marine Pollution Prevention – Garbage + Marine Order 96: Marine Pollution Prevention – Sewage + Marine Order 97: Marine Pollution Prevention – Air Pollution.	**Section 6.6**– Operational discharges **Section 7.4** to **7.8** – Unplanned releases **Section 7.2** – Introduction of invasive marine species
United Nations Framework Convention on Climate Change (1992)	The objective of the convention is to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous interference with the climate system. Australia ratified the convention in December 1992 and it	Yes	Only relevant to the extent that to reduce impact of GHG emissions associated with vessel use, Santos will comply with MARPOL Annex VI (Marine Orders Part 97: Marine Pollution Prevention – Air Pollution) and require the use of low sulphur fuel.	**Section 6.3** – Atmospheric emissions

International Agreements and Conventions	Summary	Relevant to Activity?	Relevant Aspects	EP Section
	came into force on 21 December 1993.		The MODU and support vessels will use diesel, which is a low sulphur fuel.	

Appendix C – Values and Sensitivities of the Marine and Coastal Environment

EA-00-RI-10062

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Values and Sensitivities of the Marine and Coastal Environment

PROJECT / FACILITY	All
REVIEW INTERVAL (MONTHS)	12 Months
SAFETY CRITICAL DOCUMENT	NO

Rev	Owner	Reviewer/s *Managerial/Technical/Site*	Approver
	Environmental Approvals Coordinator	Environmental Approvals Coordinator	Team Leader- Regulatory Approvals
7	Joanna Edwards	Annette McGovern	Daniel Thompson

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Rev	Rev Date	Author / Editor	Amendment
A	13/0520/14	Oceanica	Technical review
B	13/05/2014	Oceanica	Editorial review
0	30/0720/14	EG/GG	Final
1	30/12/2014	GG	Updated
2	28/07/2016	Jacobs	Updated
3	28/11/2017	Jacobs	Updated
3.1	11/12/2018	Jacobs	Issued for technical review
4	17/12/2018	Jacobs	Issued for use
4.1	09/01/2019	Jacobs	Issued for technical review
5	14/02/2019	Santos	Issued for use
5.1	15/01/2020	CDM Smith	Issued for technical review
6	19/03/2020	CDM Smith	Issued for use
6A	15/11/2020	Astron	Issued Technical review
7	30/11/2020	Astron	Issued for use

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Appendices

1. Introduction

Santos WA Energy Limited (Santos) is the titleholder of multiple petroleum titles for exploration, development and operational activities located in marine waters off north-western Western Australia. This document describes the existing environment that may be affected (EMBA) by these petroleum activities and includes details of the relevant values and sensitivities of that environment as required by the Commonwealth *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* and State *Western Australian Petroleum (Submerged Lands) (Environment) Regulations 2012.*

The EMBA represents the largest possible spatial extent that could be contacted by the worst-case spill event modelled for Santos activities to date (loss of well control event from drilling an exploration well at Phoenix South). The EMBA encompasses the full range of environmental receptors that might be contacted by surface and subsurface hydrocarbons in the highly unlikely event of a worst case oil spill from Santos's activities. The low hydrocarbon exposure values as defined in NOPSEMA's '*Environmental Bulletin – Oil Spill Modelling*' (April 2019), are used as a predictive tool to set the outer boundaries of the EMBA.

This document describes the values and sensitivities of the marine environment based on the modelling results for the low hydrocarbon exposure values for the surface hydrocarbons and the entrained hydrocarbons from a loss of well control event at Phoenix South 2, as loss of control from this well has the largest spatial spill extent of all Santos' activities.

This document is informed by a search of the protected matters search tool (PMST) provided by the Department of Agriculture, Water and the Environment (DAWE) (previously the Department of the Environment and Energy (DoEE) (dated 10/11/2020 and provided in **Appendix A**), as well as published scientific literature and studies where applicable. Descriptions of all fauna are provided, with a focus on protected species that are threatened and migratory. The PMST is performed annually and any changes from this updated search are detailed in a change register (**Appendix B**). This document is then reviewed annually and updated accordingly.

1.1 Geographical Extent

The EMBA, includes the coastal waters and shoreline habitats of Western Australia (WA), encompassing the south of WA and the Northern Territory (NT) border in the north (**Appendix A**). This area largely approximates the Commonwealth North-West Marine Region (NWMR), the South-West Marine Region (SWMR) and the North Marine Region (NMR). Based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) Version 4.0, there are 14 bioregions that occur within the EMBA. These bioregions are based on fish, benthic habitat and oceanographic data (IMCRA v. 4.0). Where relevant, the physical, biological and social environments within the EMBA are discussed with reference to the IMCRA Provincial Bioregions. The provinces of most relevance (**Figure 1-1**) are:

North-west Marine Region

+ Northwest Shelf Transition;
+ Timor Province;
+ Northwest Transition;
+ Northwest Province;
+ Northwest Shelf Province;
+ Central Western Transition;
+ Central Western Shelf Transition; and
+ Central Western Shelf Province.

South-west Marine Region

- Central Western Province;
- Southwest Shelf Transition;
- Southwest Transition; and
- Southwest Shelf Province; and
- Southern Province,

North Marine Region

- Northwest Shelf Transition (as above).

Other IMCRA 4.0 bioregions of interest include: Christmas Island Province.

The international waters of south west Indonesia and Timor-Leste (in part) are also included in the EMBA and described where relevant throughout this document.

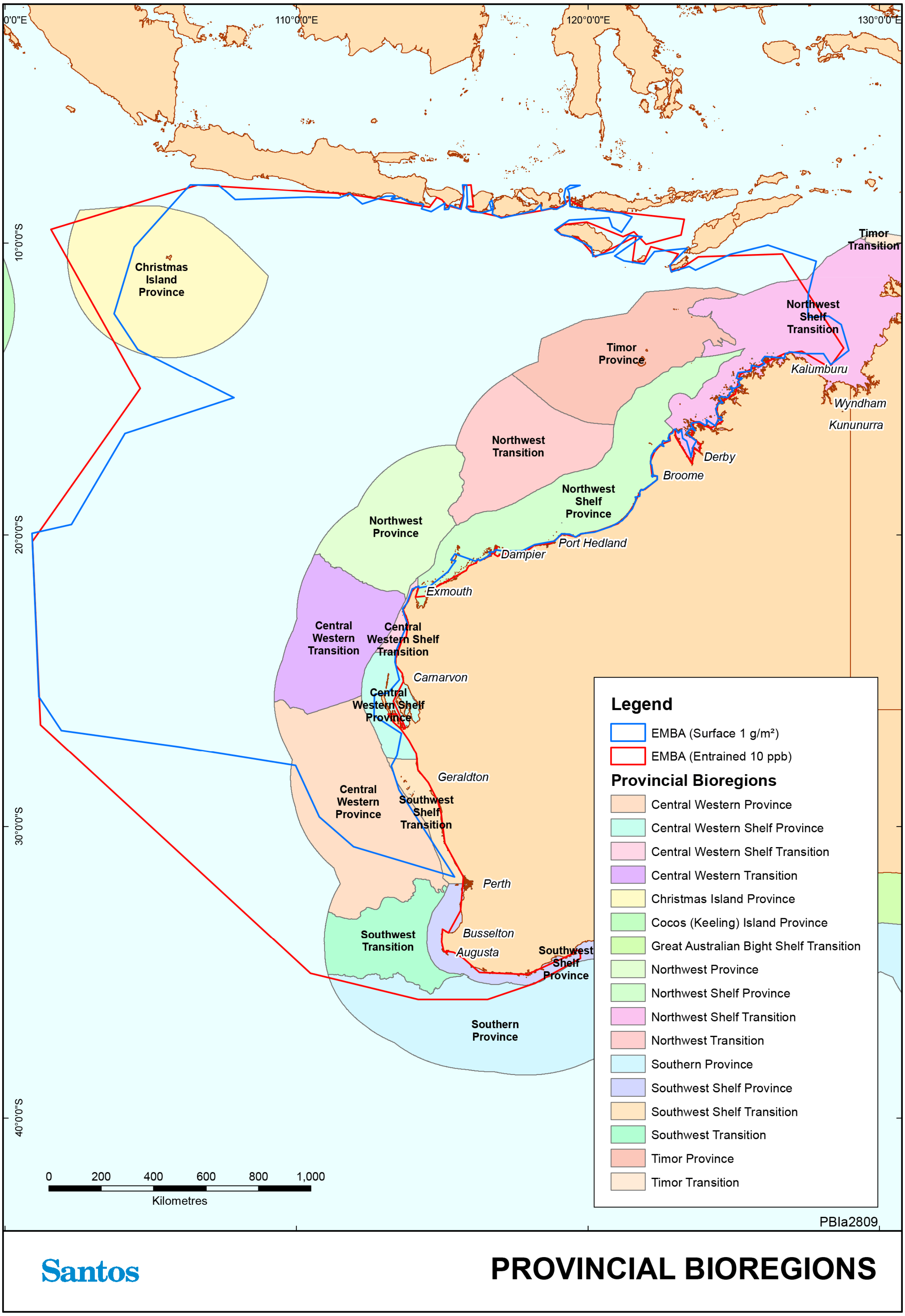


Figure 1-1: EMBA within IMCRA 4.0 Provincial Bioregions

2. Physical Environment

2.1 Geomorphology

2.1.1 Formation History

Approximately 550–160 million years ago, northern and western parts of Australia formed part of the northern margin of Gondwana. About 300 million years ago, crustal stretching, rifting and breakup initiated development of an extensive basin that became the site for deposition of sediments (Baker *et al*. 2008 in Department of the Environment, Heritage, Water and the Arts (DEWHA) 2008a). Approximately 135 million years ago the continent broke up resulting in the separation of greater India and Australia. Ocean spreading associated with the continental break-up resulted in the creation of the Argo and Cuvier abyssal plains. Subsidence of the rifted margin resulted in the formation of the Exmouth and Scott plateaux and the Rowley Terrace. The narrow shelf south of North West Cape was formed approximately 130 million years ago as a result of the separation of India and seafloor spreading (Baker *et al*. 2008 in DEWHA 2008a).

The South-west region has been relatively stable throughout its recent geological past. This has shaped a continental shelf that has high wave exposure and is punctuated with coastal features such as island groups and fringing coastal reefs providing sheltered habitats for marine communities (2008a).

2.1.2 Present Day Geological Features

The EMBA consists of five major landform features: continental shelf, continental slope, continental rise, Exmouth plateau and abyssal plain. The majority of the area consists of either continental shelf or continental slope (DEWHA 2008a).

Limited surveys have shown that the continental slope in the EMBA comprises diverse geological features such as canyons, plateaux, terraces, ridges, reefs, banks and shoals (DEWHA (2008)) (**Figure 2-1** and **Figure 2-2**). These features are significant in that over half of the total area of banks and shoals across Australia's entire marine jurisdiction occurs in the Commonwealth waters from the South Australian border to the Northern Territory border, as well as 39% of terraces and 56% of deeps, holes and valleys (DEWHA 2008a).

An important characteristic of the EMBA is the significant narrowing of the continental shelf around North West Cape from the broad continental shelf in the north (**Figure 2-3**). For example, in the Joseph Bonaparte Gulf (at the NT boundary), the continental shelf is around 400 km wide, whereas at North West Cape the shelf is only 7 km wide – the narrowest of anywhere on the Australian continental margin (DEWHA 2008a). Shelf width affects oceanography with flow on effects to productivity and ecosystem functioning.

The continental shelf north of Cape Leveque is characterised by a rimmed ramp where the waters over the outer margins of the shelf (approximately 50 to 100 m waters depth) are shallower than the middle portions (up to 150 m water depth). The rim at its outer edge is the site of a number of coral reefs including Ashmore, Cartier, Scott and Seringapatam (DEWHA 2008a).

The Indonesian archipelago lies between the Pacific and Indian oceans, and bridges the continents of Asia and Australia. The archipelago is divided into several shallow shelves and deep-sea basins.

2.1.3 Southwest Shelf Province

The Southwest Shelf Province consists of an area of narrow continental shelf from Rottnest to Point Dempster. For the purposes of this document (EMBA), the northern and western limits of the bioregion are the main focus because it is this portion that falls within the EMBA, which are an extension of the seafloor described in the Southwest Shelf Transition (below). It includes features such as limestone ridges, depressions defining an inshore lagoon and a relatively smooth inner shelf plain that meets the South Bank Ridge on the outer shelf, and islands providing important habitat, such as Rottnest Island. The shelf progressively broadens to form the relatively sheltered waters of Geographe Bay before narrowing once again at Cape Mentelle.

2.1.4 Southwest Shelf Transition

The Southwest Shelf Transition is a nearshore bioregion that covers the area of continental shelf from Perth to Busselton, and extends out to the edge of the shelf. This bioregion consists of a narrow continental shelf, ranging from approximately 40–80 km wide. It includes a series of complex nearshore ridges and depressions that form inshore lagoons, a smooth inner shelf plain, a series of offshore ridges and a steep, narrow outer shelf. The near-shore ridges are formed by eroded limestone reefs and pinnacles that stand 10–20 m above the seafloor. The edge of the inner shelf plain is marked by a series of broken offshore ridges that extend north to the northern limits of the bioregion, where they emerge to support the tropical carbonate reef growth of the Houtman Abrolhos Islands.

2.1.5 Southwest Transition

The Southwest Transition is an offshore deep-water bioregion with a submerged continental fragment as its dominant seafloor feature – the Naturaliste Plateau. The Plateau extends across an area of 90,000 km^2 of which only 29,825 km^2 is within Commonwealth waters. It is located west of Cape Leeuwin and Cape Naturaliste in water depths ranging from 2,000–5,000 m. It is relatively flat with a slight northward dip, and has steep southern and western sides and a more gently sloping northern side. The Plateau is separated from the Australian continent by the Naturaliste Trough and two offshore terraces on the continental slope (average depth 780 m). Submarine canyons incise the northern parts of the slope and parts of the Naturaliste Plateau.

2.1.6 Southern Province

The Southern Province is the largest bioregion within Australia's waters stretching from the shelf break south of Kangaroo Island to the southern edge of the Naturaliste Plateau. The bioregion includes the deepest ocean areas within the Australian Exclusive Economic Zone (approximately 5,900 m maximum water depth) and consists of a long continental slope incised by numerous well-developed submarine canyons. Several key ecological features are present within the EMBA and include the Albany Canyons Group, the Ceduna and Eyre Terraces (covering approximately 147,150 km^2) and the Diamantina Fracture Zone.

2.1.7 Sediments

Terrestrial environments are not a major source of sediment in the area and terrigenous sediments tend to be confined to the inner shelf (generally less than 100 m water depth), particularly in areas adjacent to rivers. Sediments in the area generally become finer with increasing water depth, ranging from sand and gravels on the shelf to mud on the slope and abyssal plain. Joseph Bonaparte Gulf is an exception to this pattern, as sediments with high mud content extend across the inner and mid shelf within the Gulf, graduating to sands and gravels in the Bonaparte Depression.

The distribution and resuspension of sediments on the inner shelf is strongly influenced by the strength of tides across the continental shelf as well as episodic events such as cyclones. Further offshore, on the mid to outer shelf and on the slope itself, sediment movement is primarily influenced by ocean currents and internal tides. Internal tides describe the tidal movement across a slope of water stratified by marked differences in density. Internal tides cause resuspension and net down-slope deposition of sediments on the North West Shelf (DEWHA 2008a).

Surveys conducted over the North West Shelf indicate that similar sediments occur extensively over this geographic region, but with spatial variation in the grain size and origin of the surface sediments.

The ecology of the southwest is also greatly influenced by the lack of river discharge into the Region. The few significant rivers adjacent to the Region flow intermittently and their overall discharge is low. The low discharge of rivers and the generally low rate of biological productivity also results in low turbidity (suspended sediments), making the waters of the Region relatively clear (McLoughlin & Young 1985). Surface sediments in the area are predominantly composed of skeletal remains of marine fauna, with lenses of weathered sands (McLoughlin & Young 1985).

Several geomorphic formations have been associated with Key Ecological Features (DEWHA 2008a) and these are discussed in **Section 10**.

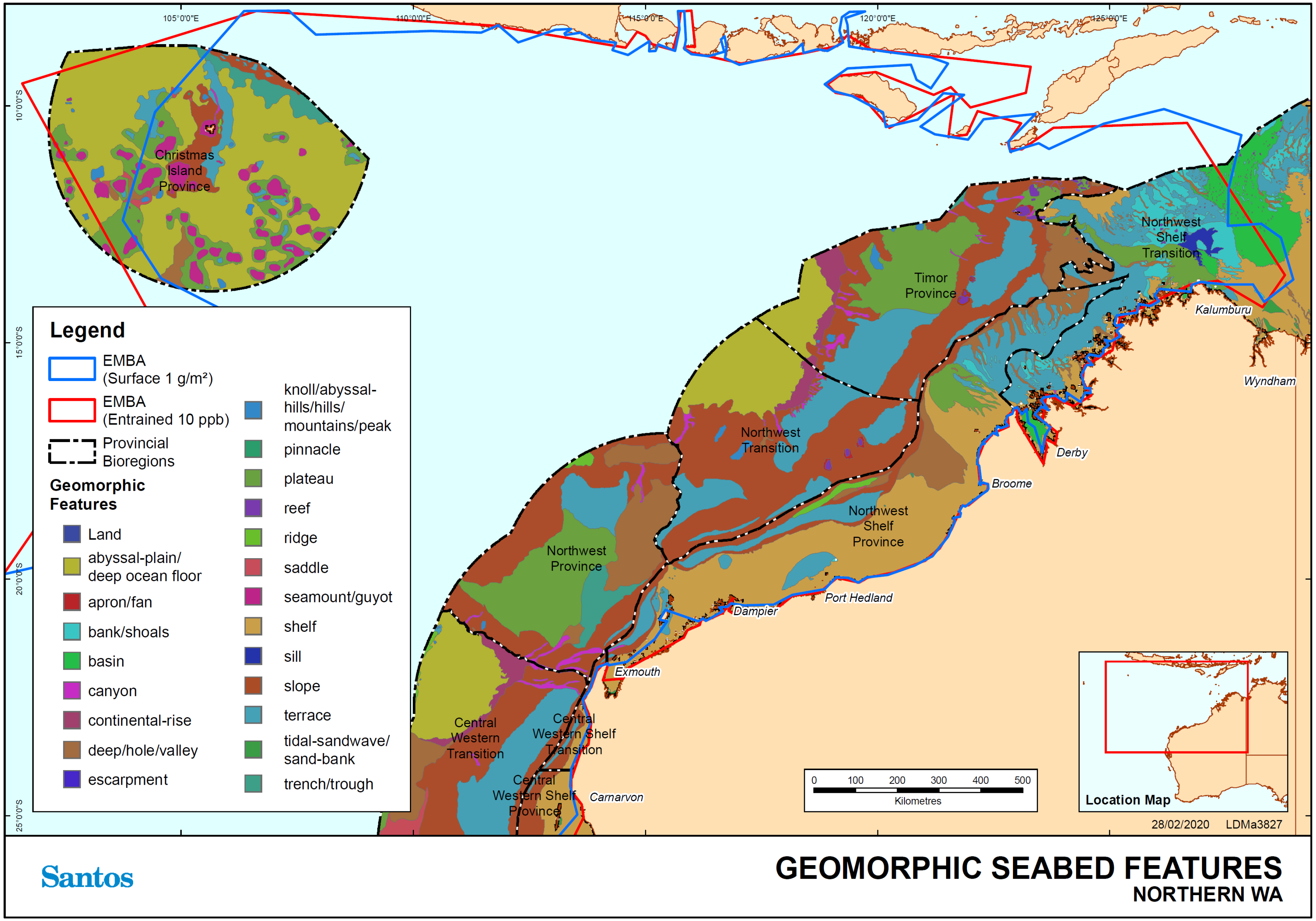


Figure 2-1: Geomorphic/seafloor features of Northern WA

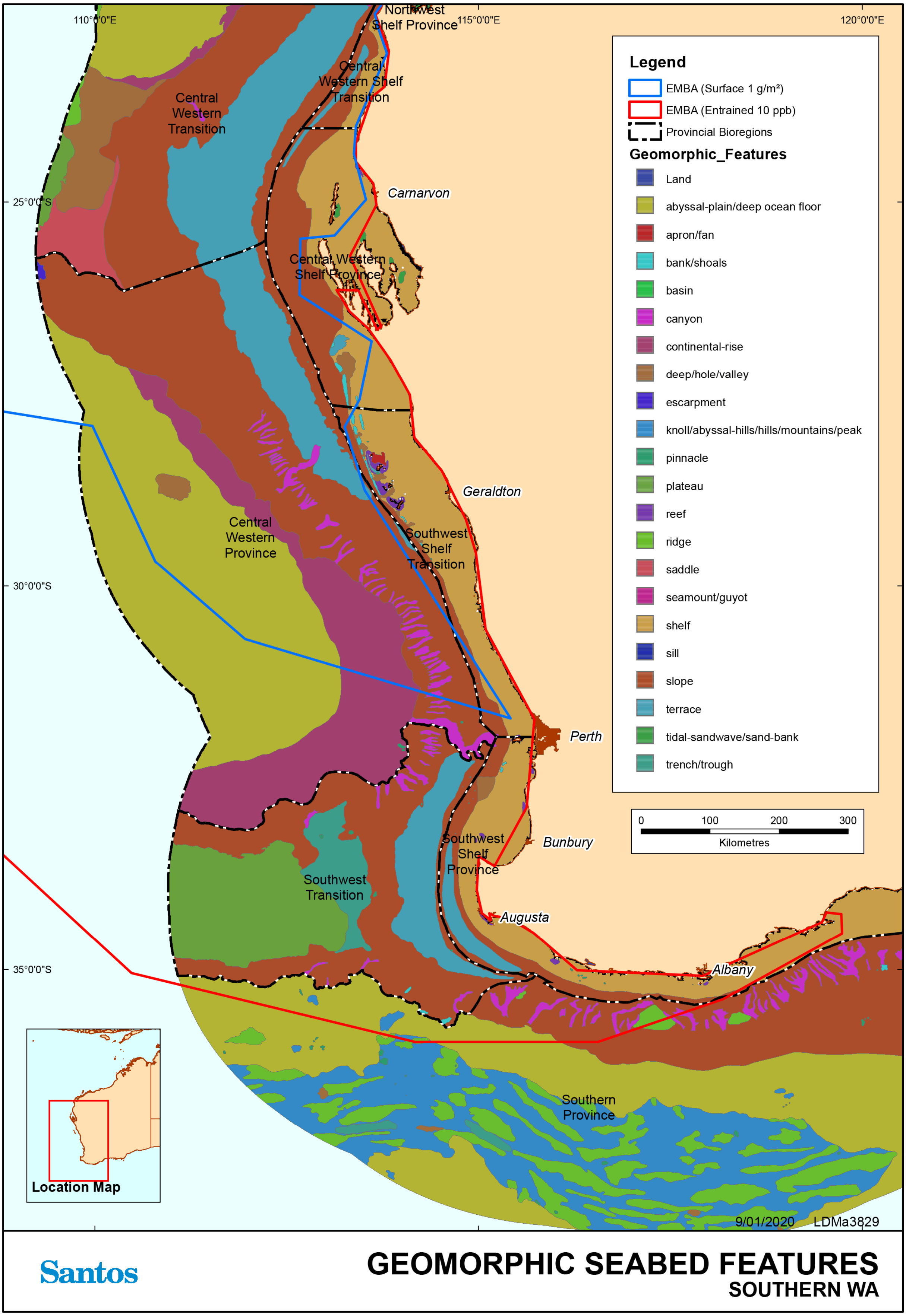


Figure 2-2: Geomorphic/seafloor features of Southern WA

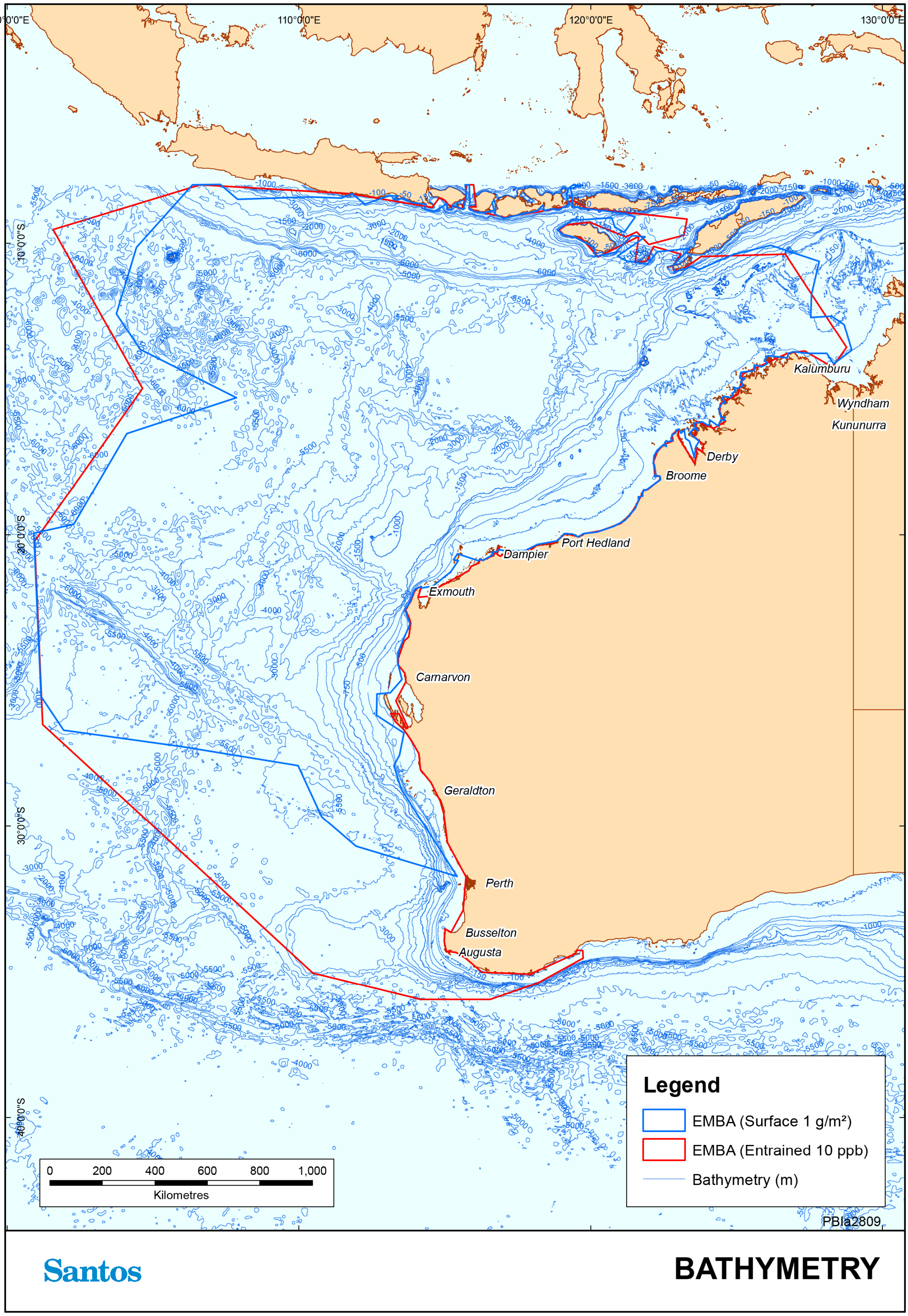


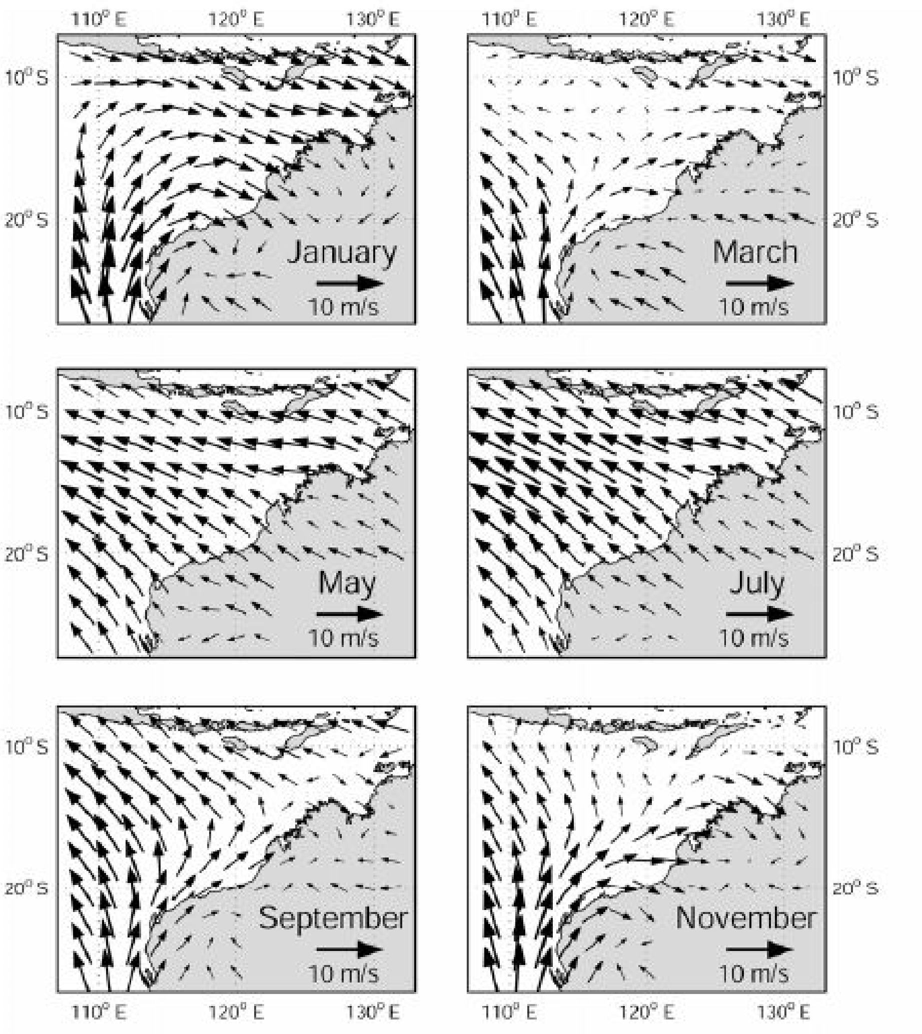
Figure 2-3: Bathymetry of the EMBA

2.2 Climate

Waters in northern Western Australia predominantly lie in the arid tropics, experiencing high summer temperatures and periodic tropical cyclones in summer. Rainfall in the region is low, although intense rainfall may occur during the passage of summer tropical cyclones and thunderstorms (Condie *et al.* 2006). Mean air temperatures range from a minimum of 11°C in winter to a maximum of 36°C in summer (Condie *et al.* 2006). Due to the arid climate, daytime visibility in the area is generally greater than 5 nautical miles (SSE 1991).

The summer and winter seasons fall into the periods September–March and May–July, respectively. Winters are characterised by clear skies, fine weather, predominantly strong east to southeast winds and infrequent rain (calculated from NCEP-NCAR dataset measured from 1982 to1999; Condie *et al.* 2006; **Figure 2-4**).

Summer winds are more variable, with strong south-westerlies dominating. Transitional wind periods, during which either pattern may predominate, can be experienced in April–May and September of each year.



Calculated from NCEP-NCAR dataset measured from 1982 to 1999. Source: Condie *et al*. (2006)

Figure 2-4: Seasonally averaged winds at 10 m above mean sea level

Tropical cyclones generate the most significant storm conditions in the area (SSE 1993). These clockwise-spiralling storms have generated wind speeds 50–120 knots (SSE 1991). Tropical cyclones develop in the eastern Indian Ocean, and the Timor and Arafura Seas during the summer months. Three to four cyclones per year are typical, with the official cyclone season being November through to April (Bureau of Meteorology

(BoM) 2013). In Indonesia, the main variable in climate is not temperature or pressure, but rainfall, which varies greatly by month and place, ranging from 997 millimetres (mm) to 4,927 mm.

Waters in the southwest and southern Western Australia experience a Mediterranean style climate that is characterised by cool, wet winters and hot, dry summers. In winter, wind patterns are characterised by a prevailing westerly wind stream. This enables winter cold fronts and strong westerly winds to regularly penetrate the south-west, with cold fronts crossing the coast every week or so. Apart from the passage of storms, typically lasting one day or less, the weather is otherwise mild in winter with winds variable and relatively weak. In summer, cold fronts rarely penetrate into the south of the state with any strength and hot easterly winds prevail.

2.3 Oceanography

Major drivers of marine ecosystems include ocean currents, tides, waves, temperature and salinity. The dominant offshore sea surface current is the Leeuwin Current (**Figure 2-5**), which carries warm tropical water south along the edge of Western Australia's continental shelf, reaching its peak strength in winter and becoming weaker and more variable in summer (Condie *et al.* 2006). The current is typically located seaward of the shelf break (200 m isobath) and is a narrow, surface current, extending to a depth of 150 m (BHPB 2005, Woodside 2005) and a width of 50–100 km (DEWHA 2008a). The formation of meanders and eddies are also a feature of the Leeuwin Current and a number of eddies occur south of Shark Bay (DEWHA 2008a). The strength of the Leeuwin Current is influenced by seasonal variability in the pressure gradient (DEWHA 2008a). The Holloway Current is the prevailing seasonal current, travelling south-west along the north West Australian coast in winter and north-east in summer (Brewer et al. 2007).

The Indonesian Throughflow is the other important current influencing the upper 200 m of the outer North West Shelf (Woodside 2005). This current brings warm and relatively fresh water to the region from the western Pacific via the Indonesian Archipelago (**Figure 2-5**). Modelling undertaken by Woodside and Commonwealth Scientific and Industrial Research Organisation (CSIRO) Marine and Atmospheric Research indicates that significant east–west flows occur across the North West Shelf to the north of the North West Cape, possibly linking water masses in the area (Woodside 2005, Condie *et al.* 2006).

Currents in the coastal zone and over the inner to mid-shelf are largely driven by tides and winds, whereas offshore, over the continental shelf, slope and rise are influenced by large scale regional circulation (DEWHA 2008a).

The nearshore Ningaloo Current flows northwards opposite to the Leeuwin Current, along the outside of the Ningaloo Reef and across the inner shelf from September to mid-April (BHPB 2005, Woodside 2005). The nearshore Capes Current, which is to the south of the Ningaloo Current, is a seasonal current that appears strongest between Cape Leeuwin and Cape Naturaliste, in the southwest of Western Australia (Pearce and Pattiaratchi 1999). Strong northwards winds between November and March slow the Leeuwin Current and increase the strength of the Capes Current. Localised upwelling is also known to occur in the area (Pearce and Pattiaratchi 1999).

Tides increase in amplitude from south to north, corresponding with the increasing width of the shelf (Holloway 1983). Tides in the area are generally semi-diurnal (i.e. two high tides and two low tides per day) with a spring/neap cycle. The northern area experiences some of the largest tides in the world. In the Kimberley, the daily tidal range is up to 10 m during spring tides and less than 3 m during some neap tides. Mid-shelf tidal currents are predicted to have average speeds of approximately 0.25 knots during neap tides and up to 0.5 knots during spring tides (NSR 1995, WNI 1995).

The wave climate in the northwest is composed of locally-generated wind waves (seas) and swells that are propagated from distant areas (WNI 1995). In summer the seas typically approach from the west and southwest, while in winter the seas typically approach from the south and east. Mean sea wave heights are typically less than 1 m and peak heights of less than 2 m are experienced in all months of the year (WNI 1995).

Indonesian waters, especially the eastern part of the archipelago, play an important role in the global water mass transport system, in which warm water at the surface conveys heat to the deeper cold water in what is known as the great ocean conveyor belt (refer **Figure 2-5**). The eastern archipelago is the only place in the

Pacific Ocean that connects with the Indian Ocean at lower latitudes. The water mass transport from the Pacific to the Indian Ocean through various channels in Indonesia is called Arlindo (Arus Lintas Indonesia), also known as the Indonesian Throughflow (ADB 2014). Surface currents in Indonesian waters are more strongly influenced by circulation from the Pacific Ocean than from the Indian Ocean. The currents are also greatly influenced by the winds of the prevailing monsoon.

Average swell heights are low, around 0.4–0.6 m in all months. The greatest exposure to swells is from the west (SSE 1993). Tropical cyclones have generated significant swell heights of up to 5 m in this area, although the predicted frequency of swells exceeding 2 m is less than 5% (WNI 1996). In the open ocean, sustained winds result in wind-forced currents of approximately 3% of the wind speed (Holloway & Nye 1985).

Tides in the South West Capes area are mixed (i.e. diurnal and semi-diurnal) and generally less than one metre, with a typical daily range of about 0.7 m during spring tides and about 0.5 m during neap tides. Tides of this magnitude produce weak currents compared to wind and wave driven flows (Hill & Ryan 2002 cited in Department of Environment and Conservation (DEC) 2013).

Waters on the continental shelf are usually thermally-stratified, with a marked change in water density at approximately 20 m (SSE 1993). Surface temperatures vary annually, being warmest in March (32°C) and coolest in August (19°C). Vertical gradients are related to the seasonality of sea surface temperatures, and are greatest during the warm-water season (SSE 1991). Near-bottom water temperature on the North West Shelf is approximately 23°C, with no discernible seasonal variation.

Salinity is relatively uniform at 34–35 ppt throughout the water column and across the North West Shelf. Due to the low rainfall there is little freshwater run-off from the adjacent mainland (Blaber *et al*. 1985).

Pronounced shifts in water column characteristics can occur following the passage of tropical cyclones (McKinnon *et al*. 2003). Changes in water temperature and salinity characteristics can result from changes in local heating and evaporation following the southward movement of warmer water due to southward-moving cyclones, and can have flow-on effects to primary and secondary productivity (McKinnon *et al*. 2003).

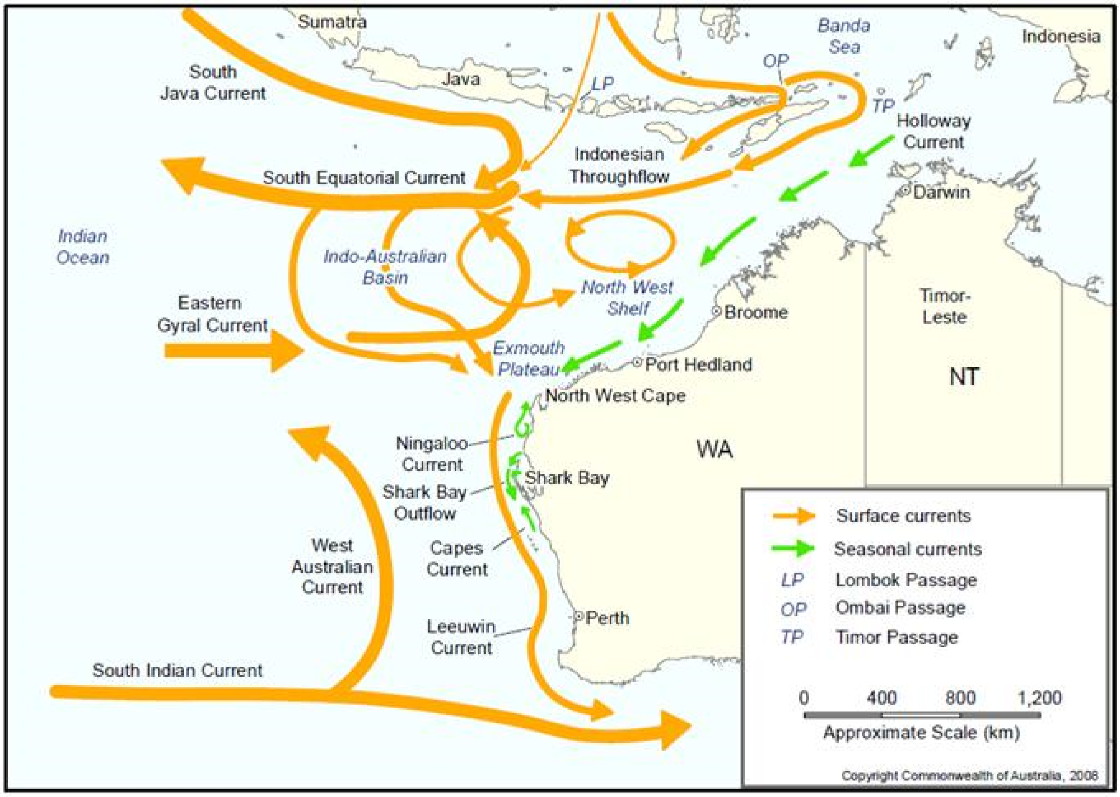


Figure 2-5: Surface currents in WA

Source: DEWHA (2008b)

3. Benthic and Pelagic Habitats

Benthic habitats are defined as those subtidal habitats lying below the lowest astronomical tide (LAT). The benthic habitats within waters in the EMBA lie at depths ranging from LAT down to more than 6,000 m at Argo and Cuvier abyssal plains (DEWHA 2008a, 2008b).

Benthic habitats are partially driven by light availability. Primary producers (photosynthetic corals, seagrasses and macroalgae) are limited to the photic zone, whereas benthic invertebrates including filter feeding communities may be found in deeper waters. The depth of the photic zone varies spatially and temporally and is predominantly dependent on the volumes of suspended material in the water column. The photic zone in the offshore Pilbara is approximately 70 m whereas in oceanic waters in the northwest and coastal waters of the southwest the photic zone may extend to 120 m (DEWHA 2008b).

The following section broadly categorises benthic habitats as four biological communities; coral, seagrasses, macroalgae and non-coral benthic invertebrates. These communities are discussed in terms of the 14 IMCRA v. 4.0 bioregions. Some broad scale benthic habitat mapping exists for the Northwest and Central Western Shelf Provinces and this is shown in **Figure 3-1**.

3.1 Coral Reefs

Corals are both primary producers and filter feeders and thus play a role in the provision of food to marine fauna and in nutrient recycling to support ecosystem functioning (Conservation and Land Management (CALM) & Marine Parks and Reserves Authority (MPRA) 2005a).

Corals create settlement substrate and shelter for marine flora and fauna. Studies have shown that declines in the abundance, or even marked changes in species composition of corals, has a marked impact on the biodiversity and productivity of coral reef habitats (Pratchett *et al*. 2008). As part of the reef building process, scleractinian corals are also important for protection of coastlines through accumulation and cementation of sediments and dissipation of wave energy (CALM & MPRA 2005a).

The waters in the EMBA contain extensive coral communities. Coral reefs in the area fall into two general groups: the fringing reefs around coastal islands and the mainland shore; and large platform reefs, banks and shelf-edge atolls offshore (Woodside 2011). The distribution of corals in area is governed by the availability of hard substrate for attachment and light availability.

Coral reefs are dynamic environments that regularly undergo cycles of disturbance and recovery. Depending on how frequent and severe the disturbances are, recovery can take a few years or more than a decade. Disturbances can include bleaching, cyclones and disease outbreaks (Australian Institute of Marine Science (AIMS) 2011).

Corals in the northwest and central provinces have experienced bleaching events and subsequent recovery. Bleaching is the process where symbiotic algae are expelled from the coral tissue, often leading to the death of the colony. Causes of bleaching include high temperatures (Scott Reef; 1998), anoxic conditions (Bill's Bay; 2008) or smothering (Waples & Hollander 2008, Gilmour et al. 2013). Coral susceptibility to bleaching and their ability to recover is an important consideration in the context of potential anthropogenic impacts.

Four bioregions (Northwest Province, Northwest Transition, Central Western Province and Central Western Shelf Transition) lie in deep waters below the photic zone. Two bioregions (Southwest Transition and Southwest Shelf Province) occur in waters that are too cold to support tropical coral reefs species. Photosynthetic corals are not present in either of these locations and hence these bioregions are not discussed further.

3.1.1 Southwest Shelf Transition

The coral reefs of the Houtman Abrolhos Islands are the most southern extensive coral community along the west coast. Smaller localised pockets do occur as far south as Rottnest Island and even extend to Cape Naturaliste in the Southwest Shelf Province. The reefs around the Abrolhos Islands comprise 211 known species of corals and all but two of the coral species are tropical (Department of Fisheries (DoF) 2012). The greatest diversity and density of corals is found on the reef slopes, shallow reef perimeters and lagoon patch reefs in the more sheltered northern and eastern sides of each of the three limestone platforms that support the island groups (DoF 2012).

3.1.2 Central Western Shelf Province

The Central Western Shelf Province occurs on the continental shelf between Coral Bay and Busselton and is generally flat with depths ranging from 0–100 m. The province includes Shark Bay and Bernier, Dorre and Dirk Hartog Islands.

Studies at Shark Bay recorded 80 species of coral (Marsh 1990). The study determined that salinity and seasonal temperature gradients restrict the distribution of corals to areas that have normal salinity in the western half of the Bay, a few species occur in the metahaline waters but none in the hyper saline areas (Marsh 1990). The eastern shores of Bernier, Dorre and Dirk Hartog Islands provide the most favourable habitats for coral growth due to shelter, and water with relatively small salinity and temperature fluctuations. Some sections of these islands support prolific coral growth (up to 100% cover) both in the sheltered leeward and exposed areas. This bioregion is a transitional zone between the predominantly tropical flora and fauna of the north and temperate flora and fauna further south (CALM & NPNCA 1996).

3.1.3 Central Western Shelf Transition

A significant proportion of this bioregion is covered by the Ningaloo Reef. The Ningaloo Reef is unique in that it is the largest fringing reef in Australia and is the only large reef found on the western side of a continent in the southern hemisphere.

A 300 km section of the coast, from Red Bluff to North West Cape and extending to Bundegi in Exmouth Gulf, is included in the Ningaloo Marine Park. Ningaloo Reef supports variable lagoonal, intertidal and subtidal coral communities along its length. Ningaloo Reef is characterised by a high diversity of hard corals with at least 217 species representing 54 genera of hermatypic (reef building) corals recorded to date (Veron & Marsh 1988). The most diverse coral communities are found in the shallow relatively clear water, high energy environment of the fringing barrier reef and low energy lagoonal areas to the west of North West Cape (CALM & MPRA 2005a).

Coral diversity reduces with increasing depth, and corals are uncommon at depths greater than 40 m (Waples & Hollander 2008). At depths between 20 and 30 m hard corals have been found to be more dominant in the northern areas of the Ningaloo Marine Park, whereas in southern areas other sessile invertebrates such as sponges, are more prevalent (Waples & Hollander 2008).

3.1.4 Northwest Transition

This bioregion lies mostly over the continental slope and the abyssal plain in deep waters that preclude photosynthetic coral growth (DEWHA 2008a). However, in contrast with the surrounding area, the Rowley Shoals are three distinct reef systems (Mermaid, Clerke and Imperieuse Reefs) approximately 30–40 km apart that rise vertically to the surface from depths of between 500 and 700 m. The marine reef fauna of the Rowley Shoals is considered to be exceptionally rich and diverse, including species typical of the oceanic coral reef communities of the Indo-West Pacific. As many of these species are not found in the inshore tropical waters of northern Australia, such populations are of regional significance (DEWHA 2008a).

A 1993 survey at Mermaid Reef recorded 214 species of scleractinian corals (Done *et al*. 1994). Since 1997, mean coral cover has increased through periods of impact and recovery from cyclones, reaching the highest (71%) on record in 2017 (Gilmour *et al.* 2019). The survey found that coral assemblages of the Rowley Shoals are broadly comparable to those found on the reefs of the outer Great Barrier Reef and in the Coral Sea. While the coral fauna is similar to Scott Reef, it differs considerably from that of north-western Australia (Veron 1986). Veron (1986) notes that the clear water of the Rowley Shoals allows coral communities to exist over a great range of depths, while the strong wave action on the outer coral slopes and the wide tidal range result in distinct patterns of zonation.

3.1.5 Northwest Shelf Province

This province contains numerous small coastal islands in addition to larger archipelago and offshore island groups. Many of these features are surrounded by shallow waters with small barrier and fringing reefs that support coral communities. Key areas recognised for coral communities in this bioregion are discussed below.

The Dampier Archipelago supports coral reefs in shallow waters near islands and submerged pinnacles. The most significant coral reefs have formed along the seaward slopes of Delambre Island, Hamersley Shoal, Sailfish Reef, Kendrew Island and north-west Enderby Island (CALM & MPRA 2005). Field trips in the Dampier Archipelago between 1972 and 1998 recorded 229 species of corals from 57 genera (Griffith 2004). Surveys of the Dampier Port and inner Mermaid Sound recorded approximately 120 coral species from 43 genera (Blakeway & Radford 2005) with coral reefs dominated by acroporids and pocilloporids. The greatest coral cover (up to 70%) was recorded in the eastern half of the archipelago (Wells *et al*. 2003).

The Montebello, Lowendal and Barrow Islands include 315 islands associated with extensive coral reefs, the most significant of which occur in the sheltered waters on the eastern side of the islands. Examples of these significant reefs include Dugong Reef, Batman Reef and reefs along the Lowendal Shelf (DEC & MPRA 2007a). Dominant corals include acroporids and poritids, with greater than 70% cover recorded for some areas (Chevron 2010). Subtidal coral reef communities around the islands are highly diverse, with at least 150 species of hard corals recorded from fringing and patch coral reef areas (DEC & MPRA 2007a).

Coral distribution near the mainland is restricted by lack of light due to natural turbidity. Corals may exist as sparse coral colonies in some locations, rather than extensive coral communities. Within Exmouth Gulf, coral communities are less common but are present on fringing reefs surrounding islands, as solitary corals distributed across areas of hard substrate, or on larger isolated patch reefs.

An epibenthic dredge survey of nearshore areas north of Broome identified 14 species of hard corals from six families (Keesing *et al*. 2011). Limited coral surveys conducted at Broome (15 species) and the Lacepede Islands (ten species) (Veron & Marsh 1988) suggest the species diversity in this locality may be low. However, low species diversity observed during the dredge survey may reflect the limited sampling frequency, limited depth range (11–23 m) or inadequate sampling in habitats considered favourable for the proliferation of hard corals (hard substrate). In contrast, other surveys of nearshore locations in the region have recorded much higher levels of species diversity. Veron and Marsh (1988) stated that 102 species of hard corals have been recorded from the Kimberley coast and nearshore reefs and Cairns (1998) recorded 87 species of azooxanthellate hard coral species from north-western Australian waters.

3.1.6 Timor Province

Although water depths in this province are generally deep (200 m to almost 6,000 m) there are several reefs and islands that are regarded as biodiversity hotspots (DEWHA 2008a).

Ashmore Reef, Cartier Island, Hibernia, Scott and Seringapatam Reefs are areas of enhanced local biological productivity, within an area of relatively unproductive waters. Ashmore Reef National Nature Reserve supports one of the greatest number of coral species of any reef off the West Australian coast, with 255 species of reef-building corals in 56 genera (Veron 1993). Taxonomic revisions and additional surveys have resulted in a net increase in species numbers to 275 (Griffith 1997, Ceccarelli *et al*. 2011). Species are typical of the Indo-pacific region and none are unique or considered endemic. However, 41 species (15% of the total hard coral species at the site) are listed as vulnerable on the IUCN Red List (IUCN 2019). In 1998, hard coral covered an area of around 717 ha at Ashmore Reef. The majority of hard corals occur in the deep lagoon (265 ha) and shallow reef top (315 ha) with small areas in the shallow lagoons, and reef edge/slope habitats (Skewes *et al*. 1999a). The soft, non-reef building corals are less well studied at Ashmore Reef than the hard corals (Hale & Butcher 2013). In 1986, 39 soft coral taxa were recorded within the Ashmore Reef, including the vulnerable blue coral (*Heliopora coerulea*) which was moderately common on the reef flats (Marsh 1993). In 1998, the total cover of soft coral at Ashmore Reef was 323 ha and *Sarcophyton* spp. was the dominant taxa covering around 19 ha in total (Skewes *et al*. 1999b, Hale & Butcher 2013).

The species composition of all the hard coral reefs in the bioregion is very similar and reflects strong links with Indo-West Pacific fauna, largely as a result of the dispersal of coral spawn via regional currents. The reefs and islands in this bioregion are thought to be important biological stepping-stones between centres of biodiversity in the Indo–Pacific and reef ecosystems further south (DEWHA 2008a).

Seringapatam Reef is a regionally important scleractinian coral reef as it has a high biodiversity, which is comparable to Ningaloo Reef. Results from the Western Australian Museum (WAM) survey in 2006 noted 159 species of scleractinian corals with a hard coral cover of approximately 16% (WAM 2009). The dominant benthic habitats of the reef were observed to include hard and soft corals (Heyward et al. 2013 cited in ConocoPhillips 2018).

Scott Reef consists of two reefs, North Scott Reef and South Scott Reef, which are separated by a deep (400–700 m) channel. North Scott Reef is an annular reef which encloses a lagoon that is connected to the ocean. South Scott Reef is a crescent-shaped reef which forms an arc and partially encloses another lagoon. Light penetration at Scott reef is high due to low turbidity. Light penetration depths to the deeper part of South Reef Lagoon are in excess of 50m with corals able to survive at depths of up to 70 m (Woodside Energy Limited *et al.* 2010).

Hibernia Reef consists of an approximately oval-shaped reef, with large areas of the reef becoming exposed at low tide. Hibernia Reef is also characterised by a deep central lagoon and drying sand flats.

There are a number of shoals and banks in the NMR and NWMR. Relatively few studies have been undertaken of these features with the majority of the understanding derived from the Big Bank Shoals study (Heyward *et al*. 1997), PTTEP surveys initiated in response to the Montara incident (Heyward *et al*. 2010; Heyward *et al.* 2011) and ConocoPhillips baseline surveys undertaken to support the Barossa Area Development (Heyward *et al.* 2017). The PTTEP surveys completed at Ashmore, Cartier and Seringapatam Reefs were undertaken during a coral bleaching disturbance likely to be attributed to regional thermal stress indicated by both *in situ* and satellite based data for the region. The condition of the reefs communities was consistent with previous surveys within the area and did not indicate any disturbance from the Montara incident (Heyward *et al*. 2010; Heyward *et al.* 2012).

In general, the submerged features are characterised by abrupt bathymetry, rising steeply from the surrounding outer continental shelf at depths of 100 m–200 m. The shoals and banks tend to flatten at depths of 40-50 m, with horizontal plateau areas of several square kilometres generally present at 20-30 m depths (Heyward *et al*. 2010). The shoals and banks support a diverse and varied range of benthic communities, including algae, reef-building soft corals, hard corals and filter-feeders (Heyward *et al.* 1997, Heyward *et al.* 2012). The plateau areas were dominated by benthic primary producer habitat, with interspersed areas of sand and rubble patches (Heyward *et al*. 2012).

3.1.7 Northwest Shelf Transition

Coral communities of the Northwest Shelf Transition have historically not been well studied. However, based on the scale of reef development and the diversity of coral species recorded through limited surveys, it is highly likely that further surveys will demonstrate that the Kimberley contains a coral reef province of global significance (Masini *et al*. 2009).

Coral reefs in the province include fringing reefs around coastal islands and some mainland shores. Development of coral communities in inshore areas is limited due to persistent high turbidity. Known examples of coral reefs in the bioregion are given below, however further mapping is required.

Benthic habitat surveys at Adele and Long Islands in 2009 and 2010 revealed extensive development of hard and soft coral communities (Richards *et al*. 2013). Scleractinian coral communities at Adele Island were diverse, supporting 176 species in intertidal and subtidal areas up to 14 m depth. At Long Island approximately 200 species of scleractinian corals were recorded in intertidal and subtidal areas. These surveys also identified two significant and unique habitats; a zone of mixed corallith and rhodolith habitat at Adele Island and an Organ Pipe Coral habitat zone with unusually high benthic cover at Long Island (Richards *et al*. 2013).

Studies by DBCA and the LNG industry indicate that fringing and emergent coral reefs are well developed in the Heyward island group, around islands in the Bonaparte Archipelago, and off mainland shores of Cape Voltaire and Cape Bougainville. Surveys by INPEX of Maret, Bethier and Montalivet islands, which were largely restricted to the intertidal zone, have recorded 280 species of coral from at least 55 genera, making the Kimberley Bioregion the most coral-diverse area in WA (INPEX 2008).

Montgomery Reef has been identified as a key feature in the area. Montgomery Reef is a huge submerged rock platform covering approximately 400 km^2. Corals occur in the subtidal area around Montgomery Reef, and in the many rock pools on the platform where there is shaded from the sun by algae or rock ledges (DEWHA 2008a). A survey of benthic habitats at Montgomery Reef was conducted in 2009 by AIMS but a literature search found no published results from this survey (AIMS 2014).

Browse Island is surrounded by a minor fringing coral reef. Assemblages at Browse Island are characteristic of coral platform reefs throughout the Indo-West Pacific region, particularly Cartier Island. Coral diversity was greatest on the reef faces and shallow lagoons but these areas were of very limited extent (URS 2010a).

Hard corals have been recorded at Echuca Shoals but the community was low in both species richness and abundance (URS 2010a). The presence of occasional large outcrops suggests that larger coral structures have occurred previously and may still occur elsewhere on the shoal (RPS Environmental 2008).

3.1.8 International Waters

Important areas outside of the IMCRA bioregions include:

Christmas Island

Fringing coral reefs around Christmas Island are relatively simple with 88 coral species previously identified which are identified to support and over 600 fish species (Director of National Parks 2012).

Indonesia (west)

Indonesia has an estimated 75,000 km^2 coral reef ecosystem distributed throughout the archipelago (Tomascik et al. 1997 cited in Hutumo & Moosa 2005). Fringing reefs are the most common reef types with scleractinian corals as being the most dominant and important group. 452 species of hermatypic scleractinian coral were collected from Indonesian waters by Tomascik et al. (1997 cited in Hutumo & Moosa 2005), a study presented by Suharsono (2004 cited in Hutumo & Moosa 2005), indicated that 590 species of scleractinian corals exist in Indonesian waters. Acropora, Montipora and Porites are the most important reef building corals in Indonesia.

The Lesser Sunda Ecoregion encompasses the chain of islands and surrounding waters from Bali, Indonesia to Timor-Leste. This region contains suitable habitat for corals on shallow water substrates formed by limestone and lava flows and is thought to contain more than 500 species of scleractinian reef-building corals (DeVantier *et al.* 2008). Coral species composition is influenced by regional and local scale seasonal upwellings that typically occur from April to May each year on the southern side of the islands. The ecoregion is considered important for coral endemism, particularly the areas of Bali-Lombok, Komodo and East Flores. Fringing coral reefs tend to be less developed on the southern, more exposed shorelines (Wilson *et al.* 2011).

Timor-Leste

See **Section 3.1.6** for a description of habitat typical of shoals and banks in the Timor Sea.

3.2 Seagrasses

Seagrasses are biologically important for four reasons:

1. As sources of primary production;
2. As habitat for juvenile and adult fauna such as invertebrates and fish;
3. As a food resource; and
4. For their ability to attenuate water movement and trap sediment (Masini *et al*. 2009).

Twenty-five species of seagrass have been recorded in WA, the highest diversity in the world (Masini *et al*. 2009). Waters extending from Busselton to the NT border support predominantly tropical species although temperate species are also found, particularly between Busselton and Exmouth (Walker 1987). One species, *Cymodocea angustata*, is endemic to WA (Department of Parks and Wildlife (DPAW) 2013).

The main seagrasses of the region are small, ephemeral species that grow on soft sediments and have a seed bank in the surficial sediments that allows them to recover quickly from disturbance (Walker 1989). Small, ephemeral species of seagrass tend to form mixed associations with macroalgae (CALM & MPRA 2005, DEC & MPRA 2007a, BHPBIO 2011) and usually covers less than 5% of the substrate (BHPBIO 2011, van Keulen & Langdon 2011).

Areas occupied by seagrass vary markedly both seasonally and interannually and it is not clear why some areas of suitable substrate will support seagrass in one year but not the next. It appears that recruitment to what may otherwise be suitable substrate is haphazard, lending weight to the descriptions of these seagrass communities as ephemeral (CALM & MPRA 2005, DEC & MPRA 2007a).

Two bioregions (Northwest Province and Central Western Transition) lie entirely in deep waters below the photic zone. Seagrasses are not present hence these bioregions are not discussed further.

3.2.1 Southwest Shelf Province

Geographe Bay is a large relatively sheltered area with that supports extensive beds of tropical and temperate seagrass that have a high diversity of species and endemism (DEWHA 2008a). They are thought to account for about 80% of benthic primary production in the area. These seagrass beds provide important nursery habitat for many shelf species that use the shallow seagrass habitat as nursery grounds for several years before moving out over the shelf to their adult feeding grounds along the shelf break.

The Geographe Bay seagrass meadows are among the most extensive temperate seagrass communities on the west coast (MPRSWG 1994 cited in DEC 2013), and include 10 species from five genera (*Amphibolis, Posidonia, Halophila, Heterozostera* and *Thalassodendron*). Geographe Bay is dominated by stands of the narrowleaf tape-weed (*Posidonia sinuosa*) that covers approximately 70% of Geographe Bay. It has smaller areas of *Posidonia angustifolia*, *Amphibolis griffithii*, *A. antarctica* and minor species, which have irregular distributions both spatially and temporally (Lord 1995 cited in DEC 2013). *Thalassodendron pachyrhizum*, *Posidonia* spp. and *Amphibolis* spp. are also found in depths of between 27 and 45 m (Walker *et al*. 1994 cited in DEC 2013).

3.2.2 Southwest Shelf Transition

Species diversity of seagrasses in this bioregion is the highest in the world, with 14 species occurring (DEWHA 2008a). In total, 10 seagrass species have been recorded at the Abrolhos ranging from small, delicate species to larger, more robust types that grow in large meadows (DoF 2012). Small paddle-weeds grow in protected lagoon areas or deep waters between the islands, such as Goss Passage and the larger species may be found growing on reef as well as in sandy areas (DoF 2012). *Thalassodendron pachyrhizum*, which is encountered growing on the exposed reef crest area, has been recorded at a number of the island groups. There are also two species of wire-weed (*Amphibolis* species), endemic to southern Australia, found at the Abrolhos (DoF 2012). The most abundant seagrass is *Amphibolis antarctica*, while *Amphibolis griffithii* appears to be restricted to bays such as Turtle Bay in the Wallabi Group.

The larger ribbon-weeds (*Posidonia* species) grow in sheltered bays and lagoons where the sand cover is deeper and more stable (e.g. Turtle Bay, the Gap, East Wallabi Island, the lagoon on the west side of West Wallabi Islands and around North Island) (DoF 2012).

Nine species of seagrass are found in the Perth region, including at Rottnest Island where *Amphibolis* thrives in clear waters overlying limestone rock (Amalfi 2006). Seagrasses are a major component of the ecosystem on the Rottnest Shelf, thriving in waters ranging in depth from intertidal to 45m (Amalfi 2006). All of the seagrass species identified with the exception of *Syringodium isoetifolium* and *H. ovalis* are endemic to temperate areas of southern Australia (Amalfi 2006). At Rocky Bay, on the north side of the island where it is protected from big swells and strong south to south-westerly winds, a mix of dense seagrass meadow consisting of *Amphibolis* and *Posidonia* thrive. The meadows around Rottnest Island serve as nurseries for juveniles of many fish species, and are home to species such as the cobbler and long-headed flathead (Amalfi 2006).

3.2.3 Central Western Shelf Province

Shark Bay contains the largest reported seagrass meadows in the world (approximately 4,000 km^2), as well as some of the most species-rich seagrass assemblages (Walker *et al.* 1989). Twelve species of seagrass are found in the Bay with the dominant species being *Amphibolis antarctica*. Seagrass is a fundamental component of biological processes in Shark Bay; it has modified the physical, chemical and biological characteristics of the Bay and provides food, habitat and nursery grounds for many species (CALM & National Parks and Nature Conservation Authority (NPNCA) 1996).

An inshore survey of benthic habitats near Busselton recorded dense coverage of *Amphibolis* spp. on limestone pavement. *Halophila* spp., *Heterozostera* spp. and *Syringodium isoetifolium* were recorded on sandy substrates (DoF 2007).

3.2.4 Central Western Shelf Transition

Nine species of seagrasses have been found throughout Ningaloo Reef (van Keulen & Langdon 2011). Some delineation of temperate and tropical species exists; however, several species were found throughout the Ningaloo Reef. Halophila ovalis was the most commonly found seagrass at Ningaloo and was generally found growing in sandy patches between coral bomboras. *Amphibolis antarctica* is a large meadow forming species that has been found growing in large clumps in Bateman Bay, north of Coral Bay (van Keulen & Langdon 2011).

3.2.5 Northwest Transition

The Rowley Shoals provide the only suitable shallow substrate for seagrasses in this predominantly deep bioregion. Sparse seagrass is found within subtidal coral reef communities of the Rowley Shoals but is not a major habitat type. Two species of seagrass, *Thalassia hemprichii* and *Halophila ovalis*, have been recorded at Mermaid Reef (Huisman *et al*. 2009). Earlier studies at Mermaid and Imperieuse Reef recorded the above two species and a third species; *Thalassodendron ciliatum* (Walker & Prince 1987).

3.2.6 Northwest Shelf Province

In the Northwest Shelf Province, seagrasses are present but sparsely distributed to depths of approximately 30 m (LEC & Astron 1993, URS 2009, CALM 2005a). The abundance and distribution of tropical (and subtropical) seagrass species can vary greatly due to seasonal changes in water quality (turbidity, light penetration) and conditions (wave action, temperature), with biomass tending to peak in summer (Lanyon & March 1995).

Studies between Quondong and Coulomb Points north of Broome identified seagrass communities of *Halophila* spp. patchily distributed across large areas, from the lower intertidal and out to a depth of approximately 20 m (DEC 2008, Fry *et al*. 2008). Similarly, *Halophila decipiens* was the only seagrass collected from epibenthic dredge studies at five localities near Broome from Gourdon Bay to Packer Island (Keesing *et al.* 2011).

Roebuck Bay is located south of Broome and includes large areas of intertidal mudflats. Extensive seagrass meadows occur in the northern regions of Roebuck Bay and are dominated by *Halophila ovalis* and *Halodule uninervis*. *Halophila minor* and *Halodule pinifolia* have also been reported at this location (Prince 1986, Walker & Prince 1987, Seagrass-Watch 2019).

In the Dampier Archipelago seagrass occurs in the larger bays and sheltered flats of the area (CALM & MPRA 2005). Six species of seagrass, including three Halophila species, have been recorded on the subtidal soft sediment habitats (CALM & MPRA 2005). Seagrasses do not form extensive meadows within the proposed reserves, but rather form interspersed seagrass/macroalgal beds. The largest areas of seagrass are found between Keast and Legendre islands, and between West Intercourse Island and Cape Preston (CALM & MPRA 2005).

Surveys near Onslow found that *Halophila* spp. were the most widespread of the seagrasses in that region. Seagrasses were found to be generally sparsely distributed (<10% cover), occurring in small patches within larger areas of suitable substrate. Small areas of higher (>50%) seagrass cover occurred in shallow clear water areas but were not common (URS 2009, URS 2010b, Chevron 2010).

Similarly, in the Montebello/Barrow Islands Marine Conservation Reserves, seagrasses appear not to form extensive meadows but are sparsely interspersed between macroalgae. Seven seagrass species have been recorded in the Reserves (DEC & MPRA 2007a) with *Halophila* spp. the most common seagrass species on shallow soft substrates and sand veneers. Distributions of these species extend from the intertidal zone to approximately 15m water depth (DEC & MPRA 2007a). Surveys to the northwest and southeast of Barrow Island from 2002 to 2004 did not identify any significant seagrass meadows but confirmed the presence of sparse coverage of *Halophila* and *Halodule* spp. in shallow areas east of Barrow Island (RPS BBG 2005).

A significant meadow of large seagrasses at Mary Anne Reef east of Onslow was identified almost 30 years ago and its presence today is unconfirmed. The meadow was several hundred hectares of *Cymodocea angustata* at 30–50% cover, occurring primarily at a depth of 2–3 m (Walker & Prince 1987).

3.2.7 Timor Province

Seagrass has been reported on the reef flats of offshore reefs of this bioregion (Whiting 1999, Hale & Butcher 2013). Five species of seagrass were reported at Ashmore Reef with *Thalassia hemprichii* being the dominant species (Pike & Leach 1997, Skewes *et al*. 1999b, Brown & Skewes 2005). The total area of seagrass at Ashmore Reef in 1999 was estimated to be 470 ha (Skewes *et al*. 1999b). However, much of this was very sparse cover and there were only 220 ha of seagrass with a greater than 10% cover (Brown & Skewes 2005). Seagrass grew in a sparse, patchy distribution across the sand flats, but had a higher coverage on the reef flat area, where it extended to within 100 m of the reef crest. The area of greatest cover and diversity was in the west and south-west areas of the reef on the inner reef flat (Brown & Skewes 2005). These seagrass meadows support a small but significant population of dugongs estimated at around 100 individuals comprising all age classes from calves to adults (Hale & Butcher 2005).

Similarly, Scott Reef supports five species of seagrass (URS 2006), with *Thalassia hemprichii* most abundant (Skewes *et al*. 1999a, URS 2006). The area of seagrass at Scott Reef is significantly less than that recorded for Ashmore Reef (approximately 100 ha) (Woodside 2011). The highly energetic environment and significant tidal exposure of Scott Reef restricts the area of habitats potentially suitable for seagrass establishment to a small proportion of the total area, resulting in low abundance (Skewes *et al*. 1999a, URS 2006).

Seringapatam Reef was found to have a seagrass cover of 2 ha out of 5,519 ha (0.04%) composed of *Thalassia hemprichii* and *Halophila ovalis* in approximately equal quantities (Skewes *et al*. 1999a). This finding contrasts with a more recent survey where only one species of seagrass (*Halophila decipiens*) was recorded at Seringapatam (Huisman *et al*. 2009).

Skewes *et al*. (1999a) did not observe any seagrass communities at Hibernia Reef.

3.2.8 Northwest Shelf Transition

Extensive and diverse intertidal seagrass meadows are known from islands in the southern Kimberley, particularly in the Sunday Island One Arm Point area (Walker 1995, Walker & Prince 1987). Ten species of seagrasses have been recorded at One Arm Point, with the majority of meadows low to moderate in abundance and dominated by *Thalassia hemprichii* with *Halophila ovalis*, *Halodule uninervis* and *Enhalus acoroides* (Seagrass-Watch 2019).

While some seagrasses have been collected from intertidal sites in the central and north Kimberley (Walker *et al*. 1996, Walker 1997), these areas were not found to be species rich and did not support extensive seagrass meadows like those found in the southern Kimberley.

Subtidal seagrass meadows in the Northwest Shelf Transition are not well mapped, although dugongs are known to feed on seagrass communities in coastal waters of the Joseph Bonaparte Gulf (DEWHA 2008a).

3.2.9 International Waters

Important areas outside of the IMCRA bioregions include:

Indonesia (west)

Within Indonesian waters, the lower intertidal and upper subtidal zones are considered important areas for the growth of seagrass (Hutumo and Moosa 2005). Pioneering vegetation in the intertidal zone is dominated by

Halophila ovalis and *Halodule pinifolia* while *Thalassodendron ciliatum* dominate the lower subtidal zones. Wide areas of the Indonesian coastal waters are covered by dense beds of seagrass.

Seagrass habitats are widely distributed across the Lesser Sunda Ecoregion. Preliminary data from the United Nations Environment Program's (UNEP) World Conservation Monitoring Centre (WCMC) has identified the following areas as potential areas of importance for seagrass, many of which are outside the EMBA (DeVantier *et al.* 2008):

+ North-west Bali;
+ South-west and west Lombok;
+ North-east Sumbawa;
+ Komodo Islands;
+ Savu; and
+ South coast of Timor-Leste.

The Kepulauan Seribu National Park is also known for its rich diversity of seagrasses (refer to **Section 9.8**).

3.3 Macroalgae

Macroalgae are important contributors to primary production and nutrient cycling in the region, providing food and habitat for vertebrate and invertebrate fauna. Macroalgae are also recognised for their role in spatial subsidies; the movement of nutrients or energy between neighbouring habitats. Spatial subsidies involving macroalgae include the movement of wrack from macroalgal beds to bare substrates and shorelines (Orr 2004).

Macroalgae are primarily associated with hard substrates. They occur in moderate to high cover on exposed hard substrates, but typically have lower cover on hard substrates that are covered with a veneer of sediment (SKM 2009, BHPBIO 2011). Macroalgae exhibit very high seasonal and interannual variation in biomass (Heyward *et al*. 2006) and distribution, abundance and biodiversity (Rio Tinto 2009, BHPBIO 2011). The distribution of hard substrates therefore indicates areas that may support macroalgal communities, although abundance and diversity may fluctuate annually.

Macroalgae are susceptible to disturbance from factors such as sedimentation, scouring and turbidity but the marked seasonality in biomass, abundance, diversity and distribution suggests macroalgae are likely to be resilient to acute, short-term disturbance acting at local scales. Macroalgae may be more susceptible to impacts acting over longer time scales (years) and at certain times of the year, where recruitment at a regional scale could be affected. Indirect impacts affecting the numbers, distribution and community structure of herbivorous fish can also be expected to have impacts (either positive or negative) on macroalgal habitats (Vergès *et al*. 2011).

Two bioregions (Northwest Province and Central Western Transition) lie entirely in deep waters below the photic zone. Benthic macroalgae are not present hence these bioregions are not discussed further.

3.3.1 Southwest Shelf Province

Species diversity of macroalgae is very high. The south coast of the bioregion is characterised by a relatively higher diversity of temperate macro-algal species compared with the Southwest Shelf Transition. These colonise the exposed rocky shorelines and rocky reefs (DEWHA 2008a).

3.3.2 Southwest Shelf Transition

The Houtman Abrolhos have known species of benthic algae with macroalgae communities considered important in supporting a diversity of marine life.

More than 340 species of macroalgae (including 54 species of green algae, 71 species of brown algae, and 222 species of red algae) have been recorded from rock platforms around Rottnest Island (Amalfi 2006).

3.3.3 Central Western Shelf Province

Although seagrasses are the most visually dominant organisms found in Shark Bay (Walker *et al*. 1989) macroalgae are also a significant component within the system, with 161 taxa of benthic macroalgae reported from the location (Kendrick *et al*. 1990). The seagrass meadows host a large number of epiphytic algal species (Harlin *et al*. 1985, Kendrick *et al*. 1990), which numerically dominate the algal flora of the area. Eighty algal species were epiphytic on the seagrass *Amphibolis antarctica*, and of these, over half have been reported both as epiphytes and benthic algae. Benthic macroalgae can be found growing on occasional subtidal rock (limestone–sandstone) platforms and extensive sand flats that occur throughout Shark Bay, and as drift within seagrass meadows (Kendrick *et al*. 1990).

The benthic algae of Shark Bay are not predominantly temperate as is the case with the seagrasses (Walker *et al*. 1989) and seagrass epiphytes (Kendrick *et al*. 1990). The majority of taxa are either of tropical or cosmopolitan distribution. Their local distribution within Shark Bay is correlated with salinity, with benthic algal species richness lower in areas of high salinity (Kendrick *et al*. 1990).

Limestone platforms occur along the bioregion's coastline and high energy environments are likely to be dominated by large brown algae including *Ecklonia radiata* and *Sargassum* spp. with articulated coralline algae making up the understorey. More diverse algae assemblages may be observed in sheltered locations such as potholes and ledges (DoF 2007).

3.3.4 Central Western Shelf Transition

Macroalgal beds along the Ningaloo coastline are generally found on the shallow limestone lagoonal platforms and occupy about 2,200 ha of the Ningaloo Marine Park and Muiron Islands Marine Management Area (CALM & MPRA 2005a). Macroalgal communities within the area have been broadly described (Bancroft & Davidson 2000). The dominant genera are the brown algae *Sargassum*, *Padina*, *Dictyota* and *Hydroclathrus* spp. (McCook et al. 1995).

3.3.5 Northwest Transition

Although macroalgae is present at the Rowley Shoals, it is not recognised as a key habitat component in the Mermaid Reef Marine National Nature Reserve Plan of Management (EA 2000) or the Rowley Shoals Marine Park Management Plan (DEC & MPRA 2007b).

There is nothing to suggest that the algal flora of the Rowley Shoals is unique within the Indo-Pacific (Huisman *et al*. 2009). A study of macroalgae at 16 locations at Mermaid Reef recorded over 100 species (Huisman *et al*. 2009). The algal flora recorded at the Rowley Shoals represents a small portion of the highly diverse Indo-Pacific flora. The majority of species that were recorded at Mermaid Reef had been previously recorded from mainland north-western Australia or from Indonesia (Huisman *et al*. 2009).

3.3.6 Northwest Shelf Province

Macroalgae are diverse and widespread throughout the Northwest Shelf Province. They are restricted to depths where sufficient light penetrates to the substrate and therefore tend to be most common in shallow subtidal waters down to approximately 20 m depth.

In the nearshore regions of the Pilbara, macroalgae are often a dominant component of the mosaic of benthic organisms found on hard substrates in shallow water. In these shallow waters, regular disturbance to reef habitats from seasonal changes in sedimentation/ erosion patterns and the less frequent impacts of cyclones and storms through sedimentation and scouring may substantially alter the distribution and composition of the benthic communities associated with reefs, including macroalgal habitats (BHPBIO 2011).

Macroalgae dominate shallow (<10 m) submerged limestone reefs and also grow on stable rubble and boulder surfaces in the Dampier Archipelago (CALM & MPRA 2005). Huisman and Borowitzka (2003) reported approximately 200 species of macroalgae from the Dampier Archipelago. Low relief limestone reefs that are dominated by macroalgae, account for 17% (approximately 35,460 ha) of the marine habitats within the proposed Marine Management Area (CALM 2005a).

Epibenthic dredge surveys along the coastline north of Broome identified 43 species of algae from 22 families (Keesing *et al*. 2011). The lower species diversity collected by this study is attributed to the method of collection and limited depth range (11–23 m) (Keesing *et al*. 2011).

Macroalgae occur around the numerous small offshore islands within this bioregion (including Thevenard Island, Airlie Island and Serrurier Island) associated with limestone pavement and protected areas of soft sediments. Dominant species are consistent with those described for the Dampier Archipelago (Woodside 2011).

In the shallow offshore waters of the Pilbara region, macroalgae are the dominant benthic habitat on hard substrates in both the Montebello and Barrow Islands Marine Parks and are the main primary producers (DEC & MPRA 2007a, Chevron 2010). Shallow water habitats outside these marine parks are also likely to support substantial areas of macroalgal habitat wherever conditions are suitable.

Macroalgae occupy approximately 40% of the benthic habitat area in the Montebello/ Lowendal/ Barrow Island region (CALM 2005b). At least 132 macroalgal taxa occur around Barrow Island, with most thought to be widely distributed in the tropical Indo-Pacific region (Chevron 2005).

Macroalgae monitoring around the Lowendal and Montebello Islands since 1996 (The Ecology Lab 1997, IRCE 2002 2003 2004 2006 2007, URS 2009) has found macroalgal cover and biomass to be naturally spatially and temporally variable. *Sargassum* spp. represented 70% of the macroalgal assemblage in 2009, compared to 96% in 2002 (URS 2009). Sargassum spp. cover as a percentage of total macroalgae cover was significantly lower in 2009 than in previous years, primarily due to an increase in filamentous algae at a number of sites (URS 2009).

3.3.7 Timor Province

Macroalgae at Ashmore Reef are estimated to cover over 2,000 ha, mostly on the reef slope and crest areas (Hale & Butcher 2013). The algal community is dominated by turf and coralline algae, with fleshy macroalgae comprising typically less than 10% of total algal cover (Skewes *et al*. 1999b).

Surveys at Scott and Seringapatam Reefs recorded over 100 species of marine algae (Huisman *et al*. 2009). The marine algal community was similar between reefs and also similar to the Rowley Shoals. Algae found at these offshore atolls forms a small subset of the Indo-Pacific algal flora, with virtually all of the species identified thus far having been previously collected from north-western Australia or from localities further north. Although further research is necessary, at present there is nothing to suggest that the macroalgae communities of these offshore atolls are unique within the Indo-Pacific (Huisman *et al*. 2009).

3.3.8 Northwest Shelf Transition

There is a lack of information regarding the marine benthic flora of north-west Western Australia and no comprehensive marine flora list exists for the region (Huisman 2004). However, about 70 algae species were collected during a survey of intertidal reefs on the central Kimberley coast in 1997 (Walker 1997).

Tropical macroalgae species are typically associated with areas of hard substrate and various types of macroalgae occur on rock platforms intermingled with coral and sponge. Abundance and biomass typically exhibit strong seasonal trends (Heyward *et al*. 2006).

The diversity and abundance of algae in the Kimberley is probably linked to the region’s extreme tidal exposure and highly turbid waters, reducing light penetration and resulting in deposition of fine sediments (Walker 1997). However, the role of algae appears crucial to the growth of reefs in the highly turbid waters of the Kimberley coast and islands (Brooke 1997). *Sargassum* spp. and coralline algae may be dominant (DPAW 2013).

3.3.9 International Waters

No information on macroalgae in international waters has been identified other than for Timor-Leste waters.

Timor-Leste

See **Section 3.1.6** for a description of habitat typical of shoals and banks in the Timor Sea.

3.4 Non-Coral Benthic Invertebrates

The offshore marine environment from Busselton to the Northern Territory border is overwhelmingly dominated by soft sediment seabeds; sandy and muddy substrates, occasionally interspersed with hard substrates covered with sand veneers, and rarely, exposed hard substrate. In shallow waters, non-coral benthic invertebrates may form part of the mosaic of benthic organisms found on hard substrates, alongside macrophytes and coral colonies. As light reduces with water depth, non-coral benthic invertebrates are the dominant community, albeit at low densities.

Non coral benthic invertebrates feed by filtering small particles from seawater, typically by passing the water over a specialised filtering structure. Examples of filter feeders are sponges, soft and whip corals and sea squirts.

3.4.1 Southwest Transition

There is little available information on benthic biological communities of this bioregion however deep sea crabs, such as the champagne crab and crystal crab are known to inhabit the seafloor of the slope (DEWHA 2008b).

3.4.2 Southern Province

There is little information available on the benthic biological communities within the bioregion, however it is described as a unique region of deep-sea habitats that includes the Diamantina Fracture Zone Key Ecological Feature. The Diamantina Fracture Zone is described as structurally complex deep water environment of seamounts and numerous closely spaced troughs and ridges, which represents a unique region of deep-sea habitats including 26 endemic species of demersal fish (DSEWPaC) 2012b).

3.4.3 Central Western Province

The understanding of marine life in this bioregion is mostly confined to the demersal fish on the continental slope. The exception to this is the Perth Canyon which, although poorly understood, is known to have unique seafloor features with ecological properties of regional significance.

3.4.4 Western Shelf Province

The Central Western Shelf Province occurs on the continental shelf in water depths from 0 to 100 m. Biological communities of the shelf are likely to include a sparse invertebrate assemblage of sea cucumbers, urchins, crabs and polychaetes on sand substrates. Hard substrates are likely to contain sessile invertebrates such as sponges and gorgonians. The biological communities of this bioregion share many similarities with the adjoining temperate region (DEWHA 2008a).

Stromatolites occur in Shark Bay. Although they are a microbial colony (prokaryote), and not an invertebrate (eukaryote), they are described here as a unique benthic biological community. Stromatolites are rock-like structures built by cyanobacteria. Shark Bay's stromatolites are 2,000 to 3,000 years old and are similar to life forms found on Earth up to 3.5 billion years ago. Until about 500 million years ago, stromatolites were the only macroscopic evidence of life on the planet; hence they provide a unique insight into early life forms and evolution. The stromatolites are located in the hypersaline environment of Hamelin Pool and are one of the reasons for the area's World Heritage Listing (DPAW 2009).

3.4.5 Central Western Transition

The Central Western Transition extends from the shelf break to the continental slope with some parts of the bioregion occurring on the abyssal plain. Water depths range from 80 m to almost 6,000 m. Sediments are dominated by muds and sands that decrease in grain size with increasing depth. The present level of understanding of the marine environment in this bioregion is generally poor. The harder substrate of the slope in waters of 200–2,000 m deep is likely to support populations of epibenthic fauna including bryozoans and sponges. These support larger infauna and benthic animals such as crabs, cephalopods, echinoderms and other filter feeding epibenthic organisms. In the deeper waters of the abyss, the benthic communities are likely to be sparse (DEWHA 2008a).

Santos

3.4.6 Central Western Shelf Transition

The Central Western Shelf Transition is located entirely on the continental shelf and is comprised mainly of sandy sediments in depths between 0 and 80 m (DEWHA 2008a).

Some sponge species and filter-feeding communities found in deeper waters offshore from the Ningaloo Reef appear to be significantly different to those of the Dampier Archipelago and Abrolhos Islands, indicating that the Commonwealth waters have some areas of potentially high and unique sponge biodiversity (Rees *et al*. 2004).

3.4.7 Northwest Province

The Northwest Province is located entirely on the continental slope in water depths of predominantly between 1,000–3,000 m and is comprised of muddy sediments. Despite the present poor knowledge of the benthic communities on the Exmouth Plateau, information on sediments in the bioregion indicates that benthic communities are likely to include filter feeders and epifauna. Soft-bottom environments are likely to support patchy distributions of mobile epibenthos, such as sea cucumbers, ophiuroids, echinoderms, polychaetes and sea pens.

3.4.8 Northwest Transition

The Northwest Transition is located from the shelf break (200 m water depth) over the continental slope to depths of more than 1,000 m at the Argo Abyssal Plain. Benthic habitat mapping surveys and epibenthic sampling conducted by CSIRO at the continental slope (approximately 400 m water depth) showed that all survey sites predominantly comprised soft muddy sediment, which was often riffled. Gravel, boulders and small outcrops were occasionally recorded. Epifaunal abundance was similar all sites, with epifauna limited to sparsely distributed isolated individuals. Epifauna included isolated scattered sessile crinoids, anemones, glass sponges and seapens. Occasional non-sessile fauna included urchins, prawns and other decapods, holothurians and sea stars. Modelling indicated a 1 km long beam trawl across the continental shelf (approximately 400 m water depth) would be expected to yield sparse (<20 individuals) and low diversity (<10 species) of epibenthic fauna (≥1 cm body size) (Williams *et al*. 2010). Deeper on the continental slope at approximately 700 m and approximately 1,000 m, habitats were similar to those observed at 400 m (Williams *et al*. 2010).

Although soft sediment habitat may appear monotonous and featureless, there is likely to be some marked differences in terms of ecological functioning and faunal composition between shelf and deep-sea areas, with the 200 m isobath widely believed to represent a key boundary (Wilson 2013, Brewer *et al*. 2007, Gage & Tyler 1992). Beyond the 200 m isobath, deep-sea benthic communities rely exclusively on the settling of organic detritus from the overlying water column as a food source. The spatial and temporal distribution of benthic fauna depends on factors such as sediment characteristics, depth and season (Wilson 2013).

Due to contrasting depths, the Rowley Shoals supports a diverse marine invertebrate community including a number of endemic species. Invertebrate species (excluding corals) at the Rowley Shoals include sponges, cnidarians (jellyfish, anemones), worms, bryozoans (sea mosses), crustaceans (crabs, lobsters, etc.), molluscs (cuttlefish, baler shells, giant clams, etc.), echinoderms (starfish, sea urchins) and sea squirts (DEC & MPRA 2007b).

3.4.9 Northwest Shelf Province

This bioregion is located primarily on the continental shelf in water depths from 0 to 200 m (DEWHA 2008a). The sandy substrates on the shelf within this bioregion are thought to support low density benthic communities of bryozoans, molluscs and echinoids (DEWHA 2008a). Sponge communities are also sparsely distributed on the shelf, but are found only in areas of hard substrate. The region between Dampier and Port Hedland has been described as a hotspot for sponge biodiversity (Hooper & Ekins 2004).

Epibenthic dredge surveys in nearshore areas around Broome covered 1,350 m^2 of seabed in depths between 11 and 23 m. The survey recorded 357 taxa comprising 52 sponges, 30 ascidians, 10 hydroids, 52 cnidarians (not including scleractinian corals), 69 crustaceans, 73 molluscs and 71 echinoderms. The most important species on soft bottom habitats in terms of biomass was the heart urchin *(Breynia desorii)*, whilst sponges were the dominant fauna by biomass on hard bottom habitats. The biomass of other filter feeders, especially ascidians, soft corals, gorgonians was also high, indicating the importance of these groups in characterising hard bottom habitats.

In 2007, CSIRO conducted extensive benthic habitat mapping surveys and epibenthic fauna (living on the surface and ≥1 cm body size) sampling in deep waters (100–1,000 m) spanning thirteen sites between Barrow Island and Ashmore Reef running along the continental shelf and across the continental slope of the North West Shelf (Williams *et al*. 2010). At the continental shelf margin (approximately 100 m water depth) Williams *et al*. (2010) reported that similar benthic habitats occurred at each survey site across the breadth of the North West Shelf. Benthic habitats at this depth comprised a mix of riffled muddy sand (sometimes as a veneer over rocky subcrops) together with gravel to pebble-sized rubble, cobbles, boulders and some rock outcrops. Typical epifauna found at these depths included scattered isolated hydroids, sea fans and soft corals and often small sponges. Other fauna observed at some of the sites included scattered isolated sea whips, crinoids, sea pens, urchins and anemones. Epibenthic fauna along the continental shelf margin were quantified as sparse and low diversity (Williams *et al*. 2010). Modelling indicated that a trawl sample of 1 km length would generally be expected to yield approximately 80 individuals represented by 15 species (Williams *et al*. 2010) in 100 m depth waters.

At the shelf edge (approximately 200 m water depth), two sites were surveyed. Both sites were similar to the continental shelf margin, except the northern site mainly comprised coarse material. Epifauna observed at the northern site was similar at 200 m as at 100 m. At the southern site, epifauna included sparse and scattered individual soft corals, anemones, glass sponges and stalked crinoids (Williams *et al.* 2010). Modelling indicated epibenthic fauna were sparse and had low diversity, numbering approximately 20–40 individuals in a 1 km long trawl sample represented by approximately 5–10 species (Williams *et al*. 2010).

Baseline studies undertaken in nearshore areas of the Pilbara (SKM 2009, Rio Tinto 2009, BHPBIO 2011) and offshore areas around Barrow Island (Chevron 2010) have shown that filter feeder communities are a dominant component of benthic habitats in depths >10 m where reduced light appears to inhibit extensive development of hard corals and macroalgae. The pavement habitats between Barrow Island and the mainland are covered by a sediment veneer that appears to periodically move, exposing areas of pavement reef. Sessile benthic organisms that require hard substrates for attachment, such as gorgonians, are frequently seen emerging through a shallow veneer of sand. This type of substrate (sediment veneer) with sparse filter feeder communities is common throughout this area (SKM 2009, Rio Tinto 2009, BHPBIO 2011).

3.4.10 Timor Province

The Timor Province is located on the continental slope and abyssal plain and water depths range from 200 m to almost 6,000 m. Benthic studies in this bioregion are scarce, however data from the North West Slope Trawl Fishery suggests that muddy sediments in the Timor Province support significant populations of crustaceans (Brewer *et al*. 2007). Additionally, research into the demersal fish communities of the continental slope has identified the Timor Province as an important bioregion. This is due to the presence of a number of endemic fish species, and two distinct demersal community types associated with the upper slope (water depths of 225–500 m) and mid-slope (water depths of 750–1,000 m) (Last *et al*. 2005). The current understanding of the relationship between demersal fish communities and benthic environments on the continental slope is rudimentary (DEWHA 2008a).

Over 130 species of sponges have been recorded at the Ashmore Reef National Nature Reserve (Russell & Hanley 1993).

Studies of Seringapatam Reef have observed the dominant benthic habitats to include filter feeders, such as sponges, gorgonians, hydroids and seapens (Heyward et al. 2013 cited in ConocoPhillips 2018).

3.4.11 Northwest Shelf Transition

The Northwest Shelf Transition is located on the continental shelf with a small area extending onto the continental slope, with water depths ranging from 0–330 m. Nearshore areas may support significant filter feeding communities but these have not yet been described (Masini *et al*. 2009).

Pipeline route surveys north of the Kimberley in water depths from 10–250 m recorded a seabed largely devoid of hard substrate, with only sparse epibenthic fauna noted on the predominantly sandy substrate. Occasional epibenthic fauna (featherstars, gorgonians, bryozoans, sea urchins, hydroids and sponges) were recorded in areas where rocky substrate or outcrops were present (URS 2010a).

In contrast, benthic surveys at Echuca Shoals identified broad areas of hard substrate with substantial epibenthic fauna. The shallow shoal areas were dominated by a flat 'reef' platform with crinoids, sea whips, soft corals and low densities of hard corals. With increasing depth (25–80 m) soft corals and sponges became increasingly dominant. At greater depths (80–100 m) the density of epibenthic fauna decreased substantially with sea whips and sea fans became dominant (URS 2010a).

3.4.12 International Waters

No information on non-coral benthic invertebrates in international waters has been identified other than for Timor-Leste waters.

Timor-Leste

See **Section 3.1.6** for a description of habitat typical of shoals and banks in the Timor Sea.

3.5 Plankton

Plankton abundance and distribution is patchy, dynamic and strongly linked to localised and seasonal productivity (Evans *et al.* 2016). Fluctuations in abundance and distribution occur both vertically and horizontally in response to tidal cycles, seasonal variation (light, water temperature and chemistry, currents and nutrients) and cyclonic events. As a key indicator for ecosystem health and change, Plankton distribution and abundance has been measured for over a century in Australia (Richardson *et al.* 2015). The compilation of this data has been made publicly available through the Australian Ocean Data Network (Australian Ocean Data Network 2017) and has been used in the Australia State of the Environment 2016 report (Jackson *et al.* 2017) to nationally assess marine ecosystem health. According to their findings, warming ocean temperatures has extended the distribution of tropical phytoplankton species (which have a lower productivity), further south resulting in a decline in primary productivity in oceanic waters north of 35°C, especially the North West Shelf (Evans *et al.* 2016). Trends of primary productivity across Australia are however variable with the South West of Australia experiencing an increase in productivity and northern Australia experiencing no change between 2002-2016 (Evans *et al.* 2016).

Within the EMBA, peak primary productivity varies on a local and regional scale. For example, peak phytoplankton biomass in waters surrounding Broome has been observed in May with a high variability recorded in August, whereas recorded phytoplankton biomass in waters surrounding Geographe Bay has been found to peak during winter and is localised close to the coast (Bloundeau-Patissier *et al.* 2011). In general, these peaks are linked to mass coral spawning events, peaks in zooplankton and fish larvae abundance and periodic upwelling. Regional upwelling is most common close to the coast and where surface waters diverge. Despite the suppression of major upwelling along the WA coast by the Leeuwin Current, known key upwelling regions include the Ningaloo region (Hanson & McKinnon 2009) and Cape Mentelle (Pattiaratchi 2007). It is also expected that a high abundance of plankton will occur within areas of localised upwelling in the EMBA where the seabed disrupts the current flow.

In waters surrounding Indonesia, seasonal peaks in phytoplankton biomass is linked to monsoon related changes in wind. When the winds reverse direction (offshore vs. onshore), nutrient concentrations decrease/increase because of the suppression/enhancement of upwelling (National Aeronautics and Space Administration (NASA) 2017). Annual variability of phytoplankton productivity in waters surrounding Indonesia is heavily influenced by the El Niño-Southern Oscillation climate pattern (NASA 2017). For example, phytoplankton productivity around Indonesia increases during El Niño events.

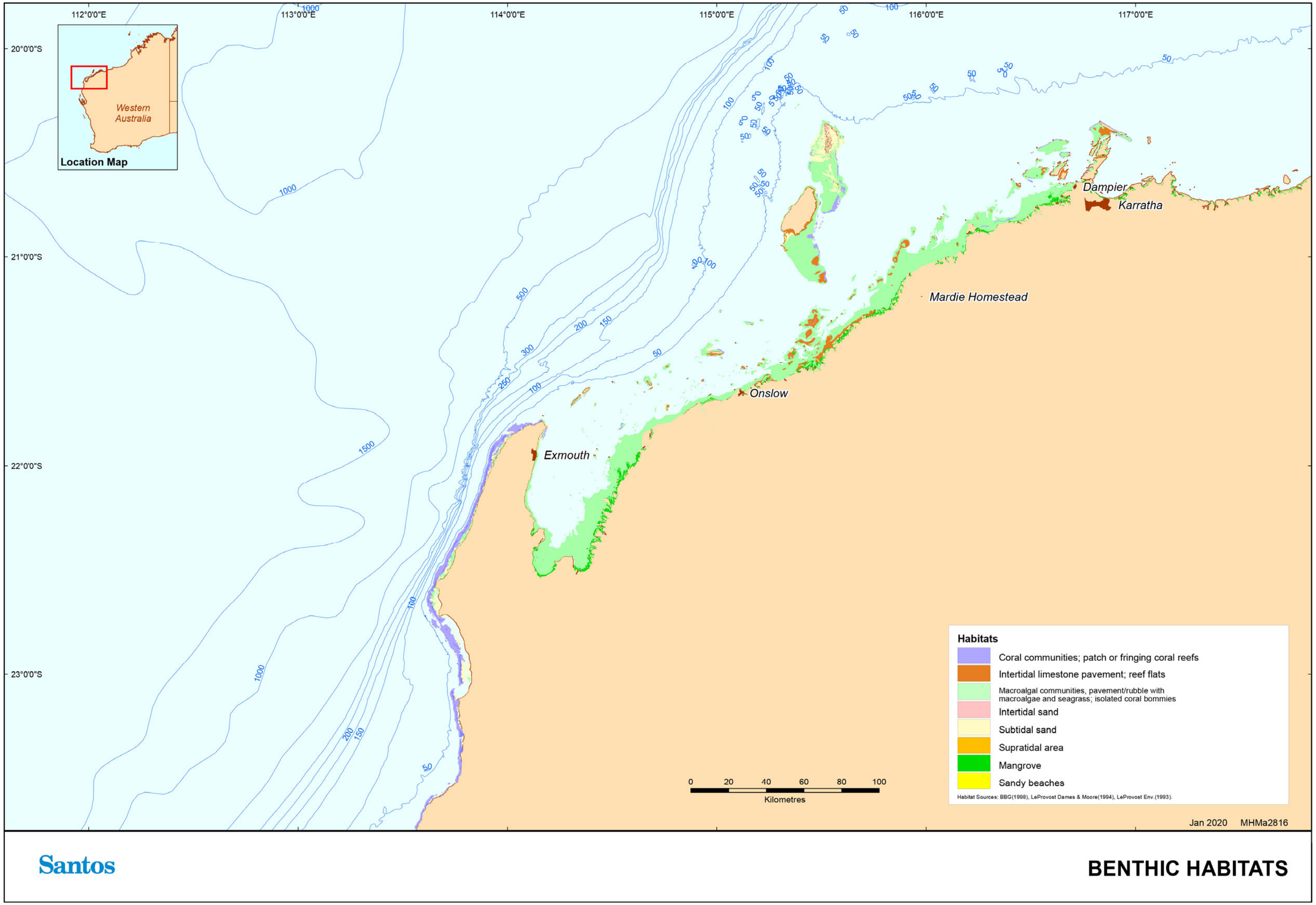


Figure 3-1: Benthic habitats from Coral Bay to Dampier

4. Shoreline Habitats

Shoreline habitats are defined as those habitats that are adjacent to the water along the mainland and of islands that occur above the LAT and most often in the intertidal zone.

The following section broadly categorises shoreline habitats as the following biological communities; mangroves, intertidal mud/sand banks, beaches, and rocky shores. These communities are discussed in **Sections 4.1- 4.5**, in terms of the 14 IMCRA v. 4.0 bioregions where relevant and where information is available.

Figure 3-1 broadly illustrate these habitats within the Northwest Shelf Province and Central Western Shelf Transition.

4.1 Mangroves

Mangroves commonly occur in sheltered coastal areas in tropical and sub-tropical latitudes (Kathiresan and Bingham 2001). Up to eight species of mangroves are found further north in the Central Western Shelf Transition region, but at most locations the dominant mangrove (in terms of area of intertidal zone occupied) is *Avicennia marina*, with the stilt rooted mangrove *Rhizophora stylosa* often occurring as thin zones of dense thickets within the broad zone of *A. marina*. Mangroves are found wherever suitable conditions are present including wave dominated settings of deltas, beach/dune coasts, limestone barrier islands and ria/archipelago shores (Semeniuk 1993). Mangrove plants have evolved to adapt to fluctuating salinity, tidal inundation and fine, anaerobic, hydrogen sulfide rich sediment (Duke *et al.* 1998).

Mangroves are important primary producers and have a number of ecological and economic values. For example, they play a key role in reducing coastal erosion by stabilising sediment with their complex root systems (Kathiresan and Bingham 2001). They are also recognised for their capacity to help protect coastal areas from the damaging effects of erosion during storms and storm surge. Mangroves are also important in the filtration of run-off from the land which helps maintain water clarity for coral reefs which are often found offshore in tropical locations (National Oceanic and Atmospheric Administration (NOAA) 2010). The intricate matrix of fine roots within the soil also binds sediments together.

Mangroves play an important role in connecting the terrestrial and marine environments (Alongi 2009). Numerous studies (e.g. Nagelkerken *et al.* 2000, Alongi 2002, Alongi 2009, Kathiresan and Bingham 2001) have shown mangroves to be highly productive and an important breeding and nursery areas for juvenile fish and crustaceans, including commercially important species (Kenyon *et al*. 2004). They also provide habitat for many juvenile reef fish species.

Mangroves also play an important ecosystem role in nutrient cycling and carbon fixing (NOAA 2010). The trees absorb carbon dioxide from the atmosphere and the organic matter such as fallen leaves forms nutrient rich sediments creating a peat layer that stores organic carbon (Alongi 2009, Ayukai 1998).

The muddy sediments that occur in mangrove forests are home to a variety of epibenthic, infaunal and meiofaunal invertebrates (Kathiresan and Bingham 2001). Crustaceans known to inhabit the mud in mangrove systems include fiddler crabs, mud crabs, shrimps and barnacles. Within the water channels of the estuary, various finfish are found from the smaller fish such as gobies and mudskippers (which are restricted to life in the mangroves) through to larger fish such as barramundi (*Lates calcarifer*) and the mangrove jack (*Lutjanus argentimaculatus).* Mangroves and their associated invertebrate-rich mudflats are also an important habitat for migratory shorebirds from the northern hemisphere, as well as some avifauna that are restricted to mangroves as their sole habitat (Garnet and Crowley 2000).

The two key State regulatory documents relevant to the protection and management of mangroves in WA are:

- EPA (2001) Guidance Statement for Protection of Tropical Arid Zone Mangroves along the Pilbara Coastline. Guidance Statement No. 1; and
- EPA (2016) Technical Guidance – Protection of Benthic Communities and Habitats.

4.1.1 Central Western Shelf Province

Shark Bay (in the Central Western Shelf Province) supports the southern-most area of substantial mangrove habitat in Western Australia (Rule *et al.* 2012). The mangroves of Shark Bay comprise only one species, the white mangrove *Avicennia marina*, and these trees occur around the coastline in widely dispersed and often isolated stands of varying size.

4.1.2 Central Western Shelf Transition

The regional mangroves from Exmouth to Broome (within the Central Western Shelf Transition and southern part of the Northwest Shelf Province) represent Australia's only 'tropical-arid' mangroves. The most significant stand of mangroves in the Central Western Shelf Transition is Mangrove Bay on the western side of the Cape Range Peninsula in the Ningaloo Marine Park. This small area of mangrove (37 ha) represents the largest area of mangrove habitat within the Ningaloo Marine Park and is considered extremely important from a biodiversity conservation perspective (CALM 2005).

4.1.3 Northwest Shelf Province

In the Pilbara region, the coast is a complex of deltas, limestone barrier islands and lagoons, with a variable suite of substrates. As a result, mangroves in this region form relatively diverse fringing stands, albeit often stunted in stature but at times quite extensive in area. The mangroves along the Pilbara coastline are the largest single unit of relatively undisturbed tropical arid zone habitats in the world. The area has nine mangrove taxa and a total of 632 km^2 mangroves (MangroveWatch 2014). As with most arid zone mangroves, Pilbara mangroves are characterised by open woodlands and shrublands that are of relatively lower productivity than the mangrove communities of the wet tropics because of the extreme water and salinity stresses that affect the intertidal zone in the Pilbara (EPA 2001). Significant stands of mangroves in the Pilbara include:

+ Exmouth Gulf: mangrove assemblages within the Bay of Rest on the western shore of the Gulf and the extensive mangrove system on the eastern shore of the Gulf that extends as a series of tidal flats and creek channels from Giralia Bay to Yanrey Flats (Astron 2014). These areas of mangrove are also designated as 'regionally significant' by the EPA (2001). The importance of these mangroves to the Exmouth Prawn Fishery is discussed in Kangas et al. (2006);
+ Mainland coast and nearshore islands: mangrove assemblages at Ashburton River Delta, Coolgra Point, Robe River Delta, Yardie Landing, Yammadery Island and the Mangrove Islands are all designated as 'regionally significant' by the WA EPA (2001) and the EPA will give these mangrove formations the highest degree of protection with respect to geographical distribution, biodiversity, productivity and ecological function; and
+ Montebello, Barrow and Lowendal Islands: mangrove assemblages all lay within designated reserves. The mangrove communities of the Montebello Islands are considered globally unique as they occur in lagoons of offshore islands (DEC 2007). Mangrove stands identified on Varanus Island occur on the west coast in discrete patches within the tidal and supratidal zones, at South Mangrove Beach and a small embayment (Astron 2016). Mangrove stands on Varanus Island have been identified as healthy, with similar stands also identified as present on Bridled Island to the north of Varanus Island (Astron 2016).

The mangroves of the Kimberley are particularly diverse and relatively untouched. They occupy a variety of coastal settings including rocky shores, beaches and tidal flats (Cresswell and Semeniuk 2011). They belong to the Indo-Malaysian group of Old World Mangroves centred in the Indian-Pacific area (Cresswell and Semeniuk 2011). Of the eighteen species of mangrove plants known to Australia all are represented in the Kimberley including *Avicennia marina, Aegialitis annulata, Aegiceras corniculatum, Rhizophora stylosa, Ceriops tagal, Osbornia octodonta, Bruguiera exaristata, Camptostemon schultzii, Excoecaria agallocha, Sonneratia alba,* and *Xylocarpus australasicus* (Pendretti and Paling, 2001; Waples, 2007). Of these, ten occur only in the Kimberley (Waples 2007). *Rhizophora stylosa* and *Avicennia marina* are the most common mangrove species along the WA Coast.

Mangroves line much of the coastal area within the western Kimberley (and within the proposed Horizontal Falls Marine Park area). They are known to line the shore in the upper reaches of Talbot Bay and to fringe many of the islands of the Buccaneer Archipelago. There are large stands in the southern section of Dugong Bay. Kingfisher Islands has been noted to exhibit extensive mangroves where 10 species of mangrove have been recorded (Wilson 2013). Mangroves line the shores of the southern coast of Collier Bay and large tracts are found in Walcott Inlet and Secure Bay (Duke *et al.* 2010). The mangroves on the eastern side of the inlet extend about 30 km inland (Gueho 2007, Pendretti and Paling 2001, Zell 2007). Further along the coast mangroves have been identified lining much of the shores of Doubtful Bay. Mangroves are also known to line the shores of the Sale River and have been identified in George Water. For detailed maps of mangrove distribution refer to Pendretti and Paling (2001).

4.1.4 Northwest Shelf Transition

Mangroves are also a prominent feature of the North Kimberley. Fringing mangroves have developed around the edge of Prince Frederick Harbour and to the east of Cape Voltaire extending along the shores of Walmesly Bay and Port Warrender (Zell 2007). This region is humid and *Xylocarpus granatum* is localised here (Cresswell and Semeniuk 2011). The rocky coastline between Cape Pond and Cape Voltaire does not lend itself to mangrove development; instead coastal woodland grows on the shores above high water mark. Mangroves are interspersed with rocky outcrops and beaches around much of the Admiralty Gulf, Vansittart Bay and Napier Broome Bay (with extensive stands around the Drysdale estuary). Cape Londonderry marks the westerly limit of *Scyphiphora hydrophylacea* (Duke *et al.* 2010).

Between Cape Londonderry and Cape Dussejour mangrove communities are sparse, and limited to a few small stands in the bays as this part of the coastline is dominated by high relief rocky shores which are exposed to the prevailing easterly winds (Wilson 1994). Extensive mangroves do however line the shores of the islands and rivers in the Cambridge Gulf, where 12 mangrove species have been recorded (Wilson 2013). The mangroves of the Ord River are notable in terms of their structural complexity and diversity. Fourteen species of mangrove have been recorded in the boundaries (Pedretti and Paling 2001). The mangroves of the Cambridge Gulf are important for saltwater crocodiles and mangrove bird communities. A unique type of flycatcher which is an intermediate between *Microcea flavigater* and *Microeca tormenti* has been identified in the mangroves of the Cambridge Gulf (Johnstone 1984). Additionally, the area is important for maintaining stocks of the commercially exploited species of the Red-Legged Banana Prawns (*Penaeus indicus)* (Kenyon *et al.* 2004).

4.1.5 Timor Province

Details on habitats in the Timor Province is provided in **Section 12.3.12**.

4.1.6 International Waters

Subawa's south coast in Indonesia is thought to contain the most significant stand of mangroves in the Lesser Sunda Ecoregion (DeVantier 2008). Other significant stands have been mapped at the following locations (DeVantier 2008):

+ North-west and south east Bali;
+ North coast of Nusa Lembongan;
+ North-east and east Sumba;
+ South-west, north-west, north and east Flores and Maumere;
+ Komodo Island, and nearby islands; and
+ South west, south, central and north Timor-Leste.

Several Indonesian National Parks, including Karimunjawa National Park, Kepulauan Seribu National Park, Meru Betiri National Park, Bali Barat National Park and Komodo National Park contain mangrove forest (refer to **Section 9.8**).

4.2 Intertidal Mud/Sand Flats

Intertidal mudflats form when fine sediment carried by rivers and the ocean is deposited in a low energy environment. Tidal mudflats are highly productive components of shelf ecosystems responsible for recycling organic matter and nutrients through microbial activity. This microbial activity helps stabilise organic fluxes by reducing seasonal variation in primary productivity which ensures a more constant food supply (Robertson 1988). Intertidal sand and mudflats support a wide range of benthic infauna and epifauna which graze on microscopic algae and microbenthos, such as bivalves, molluscs, polycheate worms and crustaceans (Zell 2007).

The high abundance of invertebrates found in intertidal sand and mudflats provides an important food source for finfish and shellfish which swim over the area at high tide. Mudflats have also been shown to be significant nursery areas for flatfish. During low tide, these intertidal areas are also important foraging areas for indigenous and migratory shorebirds. Mudflats also play a vital role in protecting shorelines from erosion (Wade and Hickey 2008).

4.2.1 Central Western Shelf Province

Shark Bay in the Central Western Shelf Province has a protected intertidal ecological community ‘Subtropical and Temperate Coastal Saltmarsh’, as listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). It is the northerly limit for this community and there is a transition zone for many saltmarsh species (CALM 1996). The EPBC ‘Listed Advice’ (DSEWPaC 2013a) reports that sediments associated with these communities generally consist of poorly-sorted anoxic sandy silts and clays, and may have salinity levels that are much higher than seawater due to evaporation. The drainage characteristics of coastal soils, along with tidal patterns and elevation, can strongly influence the distribution of flora and fauna within the Coastal Saltmarsh ecological community (DSEWPaC 2013a).

4.2.2 Northwest Shelf Province

Within Northwest Shelf Province both Roebuck Bay and Eighty Mile beach are areas with significant intertidal mudflats that are used by birds in spring and summer including species listed as threatened under the *Biodiversity Conservation Act 2016* (BC Act) or EPBC Act, or listed on the IUCN Red List of Threatened Species (IUCN 2019). Intertidal mudflats are also an important feature of the Kimberley coast forming in many bays and inlets of the region (Waples 2007). The sediments that dominate these flats are generally of terrigenous origin (Wilson 2013).

The mudflats of the Kimberley coast have been shown to be important for migratory birds of the East Asian-Australasian Flyway, which is estimated to support more than five million migratory shorebirds (Barter 2002, Bennelongia Pty Ltd 2010, Wade and Hickey 2008). The migratory birds visit the mudflats of the Kimberley coast to feed on benthic organisms prior to embarking on a 10,000–15,000 km migration to their breeding grounds in the Artic (Wade and Hickey 2008).

4.2.3 Northwest Shelf Transition

Extensive mud flats are located in Collier Bay, where the highest tidal range in Australia is found. (Wilson 2013, Zell 2007). A study by (Duke *et al*. 2010, Masini *et al*. 2009) also identified fringing mudflats around Walcott Inlet, and Doubtful Bay. The tidal mudflats of Walcott Inlet are up to 5 km wide and support a rich intertidal invertebrate community (Gibson and Wellbelove 2010). These invertebrate communities in turn also support large numbers of waterbirds (Wilson 1994).

Extensive intertidal mudflats occur in Prince Frederick Harbour and are generally backed by mangroves. The mudskipper is known to feed on these mudflats at low tide. Intertidal flats are also a feature of the estuary of the Mitchell River. The mudflats of Port Warrender are known to support 20 shorebird species and tern species and it is likely the other mudflats in the region also support high numbers of birds. The ecological significance of the wetlands of the Mitchell River has been recognised in *A Directory of Important Wetlands in Australia*. Mud and sand flats are also known to surround much of Deep Bay and Napier Broome Bay.

Intertidal sand and mudflats are a common feature of the East Kimberley. Large sand bars are present on the river mouths of the King George River, Berkeley River and Lyne River and intertidal mudflats are extensive along the edges of the Cambridge Gulf. The estuary is wide and very shallow in some sections, and the silt and clay is continually picked up and redeposited by strong tidal currents (Robson *et al.* 2008). The tidal flats of the Ord River in the Cambridge Gulf have been listed as a wetland of international importance for the conservation of waterbirds under the Ramsar convention. The area supports a variety of fauna including shorebirds and mudskippers. Tidal mudflats are also extensive along the coast between the Cambridge Gulf and the WA-NT Border.

4.2.4 Timor Province

Details on habitats in the Timor Province is provided in **Section 12.3.12**.

4.2.5 International Waters

Although no specific areas of intertidal mud or sand flats have been identified for international waters, the southern coasts of the islands that make up the Lesser Sunda Ecoregion of Indonesia and Timor-Leste do contain numerous estuarine habitats. These estuaries are likely to contain intertidal and tidal sand and mud flats that support a range of benthic invertebrate species that in turn attract other species such as birds and fish. Such estuaries in the Lesser Sunda Ecoregion are typically mangrove lined. Within the Lesser Sunda Ecoregion, the following areas are recognised as containing estuarine habitat (Wilson et al. 2011):

+ Lombok;
+ Sumba;
+ Central south and central north coasts of Sumbawa;
+ North-east coast of Flores; and
+ South-west coast of Timor-Leste.

The Irebere Estuary, located on the south-eastern coast, Tilomar located on the southern coast and Nino Konis Santana located on the eastern coast of Timor-Leste has been recognised as an Important Bird Area (Birdlife International 2018).

Several National Parks in the Ecoregion also contain estuarine habitats (likely to include intertidal sand and mud flats), including Karimunjawa National Park (refer to **Section 9.8**).

4.3 Intertidal Platforms

Intertidal platforms are areas of hard bedrock and/or limestone with or without a sediment veneer of varying thickness. These platforms can vary from low to high relief and provide a habitat for a diverse range of intertidal organisms (Morton and Britton in Jones 2004, SKM 2009, 2011, Hanley and Morrison 2012) and some species of shore birds (Garnet and Crowley 2000). They are common within each of the coastal bioregions within the EMBA.

4.3.1 Southwest Shelf Province and Southwest Shelf Transition

Intertidal platforms within the Northwest and Southwest bioregions support a mosaic of fauna and flora that typically exhibits strong variability in percent cover, community composition, abundance and diversity both between and within reefs at varying spatial and temporal scales (SKM 2009, 2011). Reef platforms typically exhibit zonation of fauna and flora from upper to lower levels on the intertidal zone, with increasing diversity, abundance and biomass lower in the intertidal (Morton and Britton in Jones 2004, SKM 2009, 2010, 2011, Hanley and Morrison 2012).

On the south coast of the Southwest Shelf Province, the coastal geomorphology changes from the predominant limestone reefs to eroded Precambrian rocks. Intertidal platforms are also common along the Southwest Shelf Transition. Shark Bay in the Central Western Shelf Province has a high diversity of intertidal marine habitats as a result of the diversity of benthic substrate, salinity and the broad geographical features which influence depth, water movement and turbidity (CALM 1996, DSEWPaC 2013b). This includes extensive, limestone platforms (as well as sand flats, mud flats, salt marsh and mangroves and beaches (CALM 1996).

4.3.2 Central Western Shelf Province and Transition

Limestone pavements extend out from the beach into subtidal zones, e.g. along the Ningaloo Coast and North West Cape; and higher relief platforms (>0.5 m off high water mark) are also present at a number of headlands along the North West Cape.

4.3.3 Northwest Shelf Province and Northwest Shelf Transition

Large tidal regimes are likely to be the defining environmental factor influencing the distribution of intertidal flora and fauna in the Northwest Shelf Province and Northwest Shelf Transition. The intertidal area of the Kimberley has an extreme tidal range (hypertidal) which creates unique environmental conditions and habitats not seen else anywhere else in the world. As a remote area many of the habitats are untouched and they are recognised as having significant conservation value (DPaW 2013). DPaW (2013) reports that as a result of the monsoonal influxes of freshwater and land-derived nutrients distinctive tropical marine ecosystems have occurred.

4.3.4 International Waters

While no significant areas of intertidal platforms have been identified in international waters, the high energy southern coastlines of the islands of the Lesser Sunda Ecoregion of Indonesia (and also including Timor-Leste) are likely to have areas of exposed pavements consisting of limestone and remnant lava flows (Wilson *et al*. 2011).

4.4 Sandy Beaches

Sandy beaches are those areas within the intertidal zone where unconsolidated sediment has been deposited (and eroded) by wave and tidal action. Sandy beaches can vary from low to high energy zones; the energy experienced influences the beach profile due to varying rates of erosion and accretion. Sandy beaches are found across the EMBA and vary in length, width and gradient. They are interspersed among areas of hard substrate (e.g. sandstone) that form intertidal platforms and rocky outcrops. There is a wide range of variation in sediment type, composition, and grain size along the EMBA.

Sandy beaches provide habitat to a variety of burrowing invertebrates and subsequently provide foraging grounds for shorebirds (Garnet and Crowley 2000). The number of species and densities of benthic macroinvertebrates that occur in the sand are typically inversely correlated with sediment grain-size and exposure to wave action, and positively correlated with sedimentary organic content and the amount of detached and attached macrophytes (Wildsmith *et al.* 2005). However, the distributions of these faunas among habitats will also reflect differences in the suite of environmental variables that characterize those habitats (Wildsmith *et al.* 2005).

Sandy habitats are important for both resident and migratory seabirds and shorebirds (refer **Section 8**). While sand flats and beaches generally support fewer species and numbers of birds than mudflats of similar size; some species such as the beach thick knee (*Esacus giganteus*) a crab eater, are commonly associated with sandy beaches (Garnet and Crowley 2000). Sandy beaches can also provide an important habitat for turtle nesting and breeding (see marine turtles **Section 6.1**).

Sandy beaches also provide important nesting habitat for the six species of marine turtles that nest within WA (refer **Section 6.1**).

4.4.1 Southwest Shelf Province

The hooded plover (*Thinornis rubricollis*) is a shorebird found on several beaches within the South West capes. Hooded plovers live on sandy surf beaches and prefer beaches backed by dunes rather than cliffs (DEC 2013). In addition to this, beaches in the South West province provide a variety of socio-economic values including tourism, commercial and recreational fishing, and support other recreational activities.

4.4.2 Southwest Shelf Transition

Sandy beaches throughout the Abrolhos host breeding populations of the Australian sea lion. The Abrolhos represent the northernmost breeding population of Australian sea lions. The current population at the Abrolhos is estimated to be approximately 90 individuals (DoF 2012).

In addition to this, beaches in the South West province provide a variety of socio-economic values including tourism, commercial and recreational fishing, and support of other recreational activities.

4.4.3 Northwest Shelf Province

Eighty Mile Beach Marine Park is one of the Australia's largest uninterrupted sandy beaches (stretching 220 km) and is an important feeding grounds for small wading birds that migrate to the area each summer, travelling from countries thousands of kilometres away (DEC 2012a). It is also a listed Ramsar wetland (see **Section 9** on Protected Areas).

4.4.4 Northwest Shelf Transition

Sand habitat within the Camden Marine Park is mainly associated with shorelines and inlets on both mainland and island shores. Some beach deposits on islands in the Kimberley are composed of skeletal carbonate sand, while they may also consist of sediments from inland areas carried to the sea by rivers and gullies (DPaW 2013). The sediment coarseness of the sand may vary, and may also be littered with dead shell, rock and/or coral material. Sea cucumbers that ingest sand and filter out microscopic food are often common in this habitat DPaW 2013).

Generally, in this region, sand habitat is adjacent to either dense mangrove stands or rocky cliffs (DPaW 2013). Beaches can be highly influenced by tide and weather conditions. Those that overlie rock are likely to shift and be ephemeral in nature.

4.4.5 International Waters

No significant areas of sandy beaches in international waters have been identified. However, the southern coastlines of the islands of the Lesser Sunda Ecoregion of Indonesia and Timor-Leste are known to contain sandy beaches consisting of soft black sand, formed by volcanic activity. Within this region, a number of National Parks are considered important sites for turtle nesting beaches, including the Meru Betiri National Park (refer to **Section 9.8**).

4.5 Rocky Shorelines

Rocky shorelines are found across the EMBA and are often indicative of high energy areas (wave action) where sand deposition is limited or restricted (perhaps seasonally or during a cyclone). They are formed from limestone pavement extending out from the beach into subtidal zones, for example along the Ningaloo Coast and North West Cape; higher relief platforms (>0.5 m off high water mark) are also present at a number of headlands along the North West Cape. This habitat is also widespread heading south towards Perth.

Rocky shores can include pebble/ cobble, boulders, and rocky limestone cliffs (often at the landward edge of reef platforms). Rocky outcrops typically consist of hard bedrock, but some of the coastline has characteristic limestone karsted cliffs with an undercut notch. Rocky shorelines can vary from habitats where there is bedrock protruding from soft sediments to cliff like structures that form headlands. Rocky shorelines are an important foraging area for seabirds and habitat for invertebrates found in the intertidal splash zone (Morton and Britton cited in Jones 2004). For example, oyster catchers and ruddy turnstones feed along beaches and rocky shorelines (see seabirds in **Section 8.2.2**).

4.5.1 International Waters

The Lesser Sunda Ecoregion contains numerous rocky shores, particularly on the exposed southern coastlines of the islands that make up the ecoregion. Areas of rocky shores include the following (DeVantier 2008):

- The Bukit Peninsula and Nusa Penida areas of Bali;
- South Lombok;

- South-east Sumbawa;
- Nusa Tengara;
- Sumba; and
- Timor-Leste, including Roti Island, Fatu and Atapupu.

5. Fish and Sharks

Fish distributions in the EMBA are discussed with respect to the IMCRA Provincial Bioregions which were defined using CSIRO's 1996 regionalisation of demersal fish on the continental shelf to the shelf break, and their 2005 regionalisation of demersal fish on the continental slope to approximately 1,200 m depth (DEH 2006). The EPBC species listed as threatened and migratory found in the EMBA, according to the Protected Matters search (**Appendix A**), are shown in **Table 5-5-1** along with their WA conservation listing (as applicable) and discussed in **Section 5.2** below.

The following WA conservation codes apply to WA conservation significant fauna:

- Threatened species (listed under BC Act):
    - Critically endangered
    - Endangered
    - Vulnerable
- Specially protected species (listed under BC Act):
    - Migratory
    - Species of special conservation interest (conservation dependant fauna)
    - Other specially protected species
- Priority species (non-statutory state based administrative process):
    - Priority 1, 2 and 3: poorly-known species – possible threatened species that do not meet survey criteria or are otherwise data deficient. Ranked in order of priority. In urgent need of further survey.
    - Priority 4: species that are adequately known, are either: rare but not threatened; meet criteria for near threatened; or delisted as threatened species within last five years for reasons other than taxonomy. Requiring regular monitoring.

A detailed account of commercial and recreational fisheries that operate in the region is provided in in the Commercial Fisheries **Section 14.7** and detailed in *The State of the Fisheries Report* 2017/2018 (Gaughan *et al.*, 2019).

Table 5-5-1: EPBC listed fish and shark species in the EMBA

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016[1]	Other WA Conservation Code		
Blind gudgeon (*Milyeringa veritas)*	Vulnerable	Vulnerable	-	Species or species habitat known to occur within area.	None - No BIA defined
Balstons pygmy perch (*Nannatherina balstoni*)	Vulnerable	Vulnerable	-	Species or species habitat likely to occur within area.	None - No BIA defined

[1] The Wildlife Conservation (Specially Protected Fauna) Notice 2018 has been transitioned under regulations 170, 171 and 172 of the Biodiversity Conservation Regulations 2018 to be the lists of threatened, extinct and specially protected species under Part 2 of the BC Act.

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016[1]	Other WA Conservation Code		
Blind cave eel (*Ophisternon candidum)*	Vulnerable	Vulnerable	-	Species or species habitat known to occur within area.	None - No BIA defined
Black-stripe minnow (*Galaxiella nigrostriatal*)	Endangered	Endangered	-	Species or species habitat known to occur within area.	None - No BIA defined
Grey nurse shark (*Carcharias taurus*)	Vulnerable	Vulnerable	-	Species or species habitat known to occur within area.	None - BIA not found in EMBA
Great white shark (*Carcharodon carcharias*)	Vulnerable & Migratory	Vulnerable	-	Foraging, feeding or related behaviour known to occur within area.	Yes – Refer to **Table 5-3**
Whale shark (*Rhincodon typus*)	Vulnerable & Migratory	Specially protected (species otherwise in need of special protection)	-	Foraging, feeding or related behaviour known to occur within area.	Yes – Refer to **Table 5-3**
Northern river shark (*Glyphis garricki)*	Endangered	-	Priority 1	Breeding likely to occur within the area.	None - BIA not found in EMBA
Dwarf sawfish (*Pristis clavata)*	Vulnerable & Migratory	-	Priority 1	Breeding known to occur within area.	Yes – Refer to **Table 5-3**
Freshwater sawfish (*Pristis pristis)*	Vulnerable & Migratory	-	Priority 3	Species or species habitat known to occur within area.	Yes – Refer to **Table 5-3**
Narrow sawfish (*Anoxypristis cuspidate)*	Migratory	-	-	Species or species habitat known to occur within area.	None - No BIA defined
Green sawfish (*Pristis zijsron)*	Vulnerable & Migratory	Vulnerable	-	Breeding known to occur within area.	Yes – Refer to **Table 5-3**
Oceanic whitetip shark (*Carcharhinus longimanus*)	Migratory	-	-	Species or species habitat likely to occur within area.	None - BIA not found in EMBA
Shortfin mako *(Isurus oxyrinchus)*	Migratory	-	-	Species or species habitat likely to occur within area .	None - No BIA defined

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016[1]	Other WA Conservation Code		
Longfin mako *(Isurus paucus)*	Migratory	-	-	Species or species habitat likely to occur within area.	None - No BIA defined
Reef manta ray *(Manta alfredi)*	Migratory	-	-	Species or species habitat known to occur within area.	None - No BIA defined
Giant manta ray *(Manta birostris)*	Migratory	-	-	Species or species habitat known to occur within area.	None - No BIA defined
Porbeagle *(Lamna nasus)*	Migratory	-	-	Species or species habitat may occur within area.	None - No BIA defined

In addition a review of conservation dependent species[2] identified five species of fish / sharks that may occur in the EMBA:

+ Orange roughy (*Hoplostethus atlanticus*);
+ Southern blue fin tuna (*Thunnus maccoyii*);
+ Southern dogfish (*Centrophorus zeehaani*);
+ School shark (*Galeorhinus galeus*); and
+ Scalloped hammerhead (*Sphyrna lewini*).

5.1 Regional Surveys

Within the EMBA a number of important geographical areas for fish exist, including Ningaloo Marine Park, Montebello/Barrow Island Marine Park, Abrolhos Marine Park and the Rowley Shoals.

5.1.1 Southwest Shelf Province

At least 150 species have been identified within the capes region as being reef-associated (Hutchins 1994 cited in DEC 2013). Of these, 77% are warm temperate species, 18% are subtropical species and 5% are tropical (DEC 2013).

The most abundant finfish species across the region identified during surveys were the Maori wrasse (*Opthalmolepis lineolatus*), red banded wrasse (*Pseudolabrus biserialis*), McCulloch scalyfin (*Parma mccullochi*), and western king wrasse (*Coris auricularis*). The yellow headed hulafish (*Trachinops noarlungae*), black headed puller (*Chromis klunzingeri*), rough bullseye and common bullseye (*Pempheris multiradiata* and *P. klunzingeri*) were also common at Eagle Bay and Geographe Bay (Westera *et al.* 2007 cited in DEC 2013).

5.1.2 Southwest Shelf Transition

A total of 389 finfish species have been recorded at the Abrolhos (DoF 2012). The Abrolhos and their surrounding coral and limestone reef systems consist of a combination of abundant temperate macroalgae with coral reefs, supporting substantial populations of large species such as baldchin groper and coral trout. Some of the species occurring in the Abrolhos are dependent on larvae carried southward by the Leeuwin

[2] Conservation dependent species are listed species under the EPBC Act and are considered as part of the Commonwealth marine area.

Current from areas further north, such as Shark Bay or Ningaloo Reef. Similarly, populations of some of the species occurring at Rottnest Island are dependent on larvae generated from breeding populations at the Abrolhos (DoF 2012).

More than 20 species of sharks have been identified at the Abrolhos (DoF 2012). These sharks include:

+ Port Jackson sharks (*Heterodontus portusjacksoni*);
+ Tiger shark (*Galeocerdo cuvier*);
+ Whaler sharks (*Carcharhinus brachyurus*); and
+ Wobbegongs (*Orectolobus maculatus*).

Abrolhos waters are considered to be an important food source for sharks, due to the resident fish populations. Various species of rays have been recorded at the Abrolhos. These include the manta ray and the white spotted eagle ray (DoF 2012).

5.1.3 Central Western Province

The Perth Canyon appears to be an important ecological feature attracting krill and fish aggregations that in turn attract larger species such as predatory fish and pygmy blue whales (DSEWPaC 2012). Demersal slope fish assemblages in this bioregion are characterised by high species diversity. Scientists have described 480 species of demersal fish that inhabit the slope of this bioregion and 31 of these are considered endemic to the bioregion. Demersal fish on the slope in this bioregion in particular have high species diversity compared with other more intensively sampled oceanic regions of the world. Below 400 m water depth demersal fish communities are characterised by a diverse assemblage where relatively small, benthic species (grenadiers, dogfish and cucumber fish) dominate.

5.1.4 Central Western Shelf Province

The Central Western Shelf Province is located near Shark Bay and is the northern limit of a transition region between temperate and tropical marine fauna. Of the 323 fish species recorded from Shark Bay, 83% are tropical species with 11% warm temperate and 6% cool temperate species (CALM 1996).

5.1.5 Central Western Shelf Transition

Ningaloo is the largest fringing coral reef in Australia, forming a discontinuous barrier that encloses a lagoon that provides habitat for many fish species. Gaps that regularly intercept the main reef line provide channels for water exchange with deeper, cooler waters (CALM 2005). Ningaloo Reef is a well known biodiversity hotspot, supported by the direct link between the reef and the ancient reef systems found closer to the equator by the Leeuwin Current (Kemps 2010). Approximately 500 species of fish have been reported to inhabit the reef (Kemps 2010). The Piercam project from inception in 2005 to 2013, identified 165 fish species from 50 families at the Point Murat Navy Pier alone, located within the Ningaloo Marine Park (Whisson & Hoschke 2013).

Seasonal aggregations of whale sharks occur at Ningaloo each year (CALM 2005). There is limited data available on species diversity and distribution of sharks in the Ningaloo area as chondrichthyan biodiversity for the area has not been specifically recorded. Despite this, it is possible that the Ningaloo Reef Marine Park contains the largest and most diverse collection of sharks on the Australian coastline (Stevens *et al.* 2009). It was estimated in 2009 by Last and Stevens (cited in Stevens *et al.* 2009), that there are likely to be 118 species of chondrichthyan fishes occurring in the park. Of these species, 59 are shark species predicted to be found at depths of less than 200 m (Stevens *et al.* 2009).

The lagoon at Ningaloo Reef appears to provide a juvenile habitat and nursery area for shark species such as the grey nurse shark (*C. taurus*), black-tipped reef shark (*Carcharhinus melanopterus*) and other reef sharks (Carcharhinidiae) (Stevens *et al.* 2009). A study conducted on the distribution and abundance of elasmobranches in the Ningaloo Marine Park, in 2009, tracked the movements of six key shark species. Species such as *Galeocerdo cuvier* (tiger shark) and *Sphyrna mokarran* (great hammerhead) were found to remain for brief time periods in the park, in contrast to other species found to re-visit the Ningaloo area (Stevens *et al.* 2009). Several species of sharks within Ningaloo have been identified as key indicator species for the health of the system (Stevens *et al.* 2009).

Barrow Island includes Biggada Reef, an ecologically significant fringing reef, and the Montebello Islands comprise over 100 islands, the majority of which are rocky outcrops; providing fish habitat (DEC 2007a). Within the Barrow/Montebello region, at least 380 fish species have been recorded (de Lestang & Jankowski 2017). Most species exhibit wide distributions, with local species composition closely resembling that of the Dampier Archipelgao. Coral habitats support the most diverse fish community in this region, comprising, among others, many species of damselfish (Pomacentridae), parrotfish (Scaridae), snappers (Lutijanidae) and groupers (Serranidae) (de Lestang & Jankowski 2017). The region's macroalgal habitats are considered important nursery areas for a diverse range of fish species, such as emperor (Lethrinidae), threadfin bream (Nemipteridae), tuskfish (Labridae) and trevally (Carangidae) (de Lestang & Jankowski 2017).

Ramsar wetlands within the area (e.g. Eighty Mile Beach and Ashmore Reef National Nature Reserve) can also provide important habitat for fish (see **Section 9.2**).

5.1.6 Central Western Transition

The biological communities of the Central Western Transition are thought to be distinctive owing to the proximity of deep oceans areas to the continental slope and shelf, resulting in close interaction between pelagic species of the Cuvier Abyssal Plain and those of the slope and shelf (DEWHA 2008a).

The present level of understanding of the marine environment in this bioregion is generally poor. The diversity of fish and cephalopod species changes with depth, generally decreasing species numbers with increasing depth. The demersal slope fish bioregionalisation identified some endemism in communities in this bioregion (Last *et al*. 2005), however, it is lower than other areas of the North-west Marine Region (DEWHA 2008a).

Bentho-pelagic fish, such as deep-water snappers (e.g. *Paracaesio* spp, and *Eletis* spp.), hatchetfish (*Argyropelecus* spp.), dragonfish (*Melacosteus* spp.), viperfish (*Chauliodus* spp.) and a number of eels species migrate between the benthic and pelagic systems, forming an important link between these systems (DEWHA 2008a).

Transient fish species through the Central Western Transition bioregion include southern bluefin tuna (migrating to and from spawning grounds), broadbill swordfish (*Xiphius gladius*), bigeye tuna (*Thunnus obesus*), yellowfin tuna (*Thunnus albacares*) and striped marlin (*Tetrapturus audax*). Pelagic sharks also range across the bioregion following schools of pelagic fish (DEWHA 2008a).

5.1.7 Northwest Shelf Province and Northwest Province

The demersal zone of the North West Shelf (which includes the Northwest Province and Northwest Shelf Province) hosts a diverse assemblage of fish of tropical Indo-west Pacific affinity, with up to 1,400 species known to occur, with a great proportion of these occurring in shallow coastal waters (Allen *et al*. 1988). Last *et al*. (2005) and Fox and Beckley (2005) described the North-west Province as being characterised by a high level of endemism and species diversity. Certain areas of increased biological activity (e.g. Glomar Shoals) attract demersal fish species such as Rankin cod, red emperor, crimson snapper and spangled emperor that are exploited by commercial trawl and trap fisheries (Sainsbury *et al*. 1992, Fletcher and Santoro 2013).

The shallow waters (<30 m) of the Dampier Archipelago, in the Northwest Shelf Province, support a characteristic and rich fish fauna of 650 species from a variety of habitats including coral and rocky reefs, mangroves, sand and silty bottoms and sponge gardens (Hutchins 2003 & 2004). The majority of these species are found over hard substrate, but significant numbers are also found from soft bottom and mangrove areas. The outer islands of the Archipelago are inhabited predominantly by coral reef fishes whereas inner areas close to the mainland are occupied by mangrove and silty-bottom dwellers. The inter-island passages have a relatively rich soft bottom fauna. EPBC Act protected fish species within the Dampier Archipelago include the dwarf sawfish (*Pristis clavata*), freshwater sawfish (*Pristis pristis*) and narrow sawfish (*Anoxypristis cuspidate*).

The fish fauna of the archipelago is less diverse than the islands of the West Pilbara to the south, but are closely related to the fauna at the offshore Montebello Islands (Hutchins 2004). The fish fauna of Barrow/ Lowendal/ Montebello Islands are widespread throughout the Indo-west Pacific region.

Within the southern portion of the Northwest and Northwest Shelf Province, small pelagic fish (e.g. lantern fishes) comprise a third of the total fish biomass (Bulman 2006) and inhabit a range of marine environments, including inshore and continental shelf waters. These small pelagic fish play an important ecological role, not only for this particular area but for the entire NWMR. They feed on pelagic phytoplankton and zooplankton and provide a food source for a wide variety of predators such as marine mammals, sharks, large pelagic fish and seabirds, thus providing a vital link between many of the region's trophic systems (Mackie *et al*. 2007).

Pelagic fish in the Northwest and Northwest Shelf Province include tuna, mackerel, herring, pilchard and sardine, and game fish such as marlin and sailfish (BBG 1994, Brewer *et al*. 2007), some of which are targeted by both commercial and recreational fishers. In particular, adult and juvenile southern bluefin tuna are thought to migrate through the North West Shelf on their way to and from spawning grounds in the north-eastern Indian Ocean. However, the timing of these migrations and the use of regional currents to assist their migration is still unclear. The oceanic waters of the North West Shelf are also believed to provide important spawning and nursery grounds for a number of large pelagic fish species. **Table 5-2** provides a summary of the key fish species and likely timing of their spawning in the region (DoF correspondence).

5.1.8 Northwest Shelf Transition

Creek systems, mangroves and rivers, and ocean beaches within this region provide habitat for a variety of species including barramundi, tropical emperors, mangrove jack, trevallies, sooty grunter, threadfin and cods (Fletcher and Santoro 2013). The offshore atolls and the continental shelf waters in the Northwest Shelf Transition are also geographically important for fish species. They support species of recreational and commercial interest, including saddle-tail snapper and red emperor, cods, coral and coronation trout, sharks, trevally, tuskfish, tunas, mackerels and billfish (Gaughan et al. 2019).

The Rowley Shoals within the Northwest Shelf Transition comprise three oceanic reef systems approximately 30–40 km apart, namely Mermaid Reef, Clerke Reef and Imperieuse Reef. The Shoals are thought to provide a source of invertebrate and fish recruits for reefs further south and as such are regionally significant (DEC 2007b). See **Section 11** on State Marine Parks and Nature Reserves for further details on important geographical areas for fish.

5.1.9 Northwest Transition

The Northwest Transition bioregion may support sparse populations of bentho-pelagic fish and cephalopods in low densities. Pelagic fish species likely to be present include grenadiers and hatchetfish (*Argyropelecus* spp.) as well as transient populations of highly mobile pelagic fish. Adult and juvenile southern bluefin tuna are through to migrate through this bioregion on their way to and from spawning grounds in the north-eastern Indian Ocean (DEWHA 2008a).

The slope habitat of this bioregion is associated with important populations of demersal fish species and supports the second richest demersal fish assemblage nationally (Last *et al*. 2005). Over 508 fish species have been identified on the slope in this area and 64 of these species are endemic. The high diversity and endemism of the demersal fish fauna indicates important interactions between physical processes and trophic structures in this bioregion. For more information on the slope habitat for fish and sharks, refer to **Section 10.1.18**.

The Rowley Shoals within the Northwest Transition comprise three oceanic reef systems approximately 30–40 km apart, namely Mermaid Reef, Clerke Reef and Imperieuse Reef. The Shoals are thought to provide a source of invertebrate and fish recruits for reefs further south and as such are regionally significant (DEC 2007b).

5.1.10 Timor Province

The diversity of demersal fish assemblages on the continental slope in the Timor Province (as well as the Northwest Transition and the Northwest Province) is high compared to elsewhere along the Australian continental slope (DSEWPaC 2012). Elements of the Timor Province are not well known, due to limited survey data in the northern limits of the region. The province is geographically extensive and includes 418 fish species, 64 of which are endemic to the region (Last *et al.* 2009). Key indicator species include *Bembrops nelsoni*, *Bythaelurus* sp., *Halicmetus* sp., *Malthopsis* spp, *Neobythites australiensis*, *Nobythites bimaculatus*, *Neobythites macrops*, *Neobythites soelae*, *Parapterygotrigla* sp., *Physiculus roseus* (Last *et al.* 2005).

Santos

Scott and Seringapatam Reefs are regionally important for the diversity of their fauna, including 558 fish species (Department of the Environment (DoE) 2014). Scott Reef has enormous habitat diversity and is considered a hot spot for fish, with five endemic species (DoE 2014). Scott Reef has biogeographic significance due to the presence of species which are at or close to the limits of their geographic ranges, including fish known previously only from Indonesian waters such as cardinalfish, azure damselfish (*Chrysoptera hemicyanea*), comb-tooth blenny (*Escnius schroederi*) and several Gobiids (DoE 2014).

The diversity of fish at Ashmore Reef is also higher than other comparable reefs in the bioregion with over 760 species recorded (Russell *et al.* 2005, Kospartov *et al.* 2006. The majority of fish species are shallow water, benthic taxa that typically inhabit depths down to 100 m and are widely distributed throughout the Indo-West Pacific (Russell *et al.* 2005). The most species rich groups are gobies (Gobiidae), damselfishes (Pomacentridae), wrasses (Labridae), cardinal fishes (Apogonidae), moray eels (Muraenidae), butterflyfishes (Chaetodontidae), and rockcods and groupers (Serranidae) (Allen 1989, Russell *et al*. 2005).

5.1.11 Christmas Island Province

The Christmas Island Province is in deep, offshore waters (2,200 m – 6,000 m depth range). These waters provide habitat for pelagic finfish species including tuna (*Thunnus* sp.) and wahoo (*Acanthocybium solandri*), and some demersal species such as ruby snapper (*Etelis carbunculus*).

Table 5-2: Spawning and aggregation times of key commercially caught fish species within the North West Shelf

Species		Month											
Species Common Name	**Species Latin Name**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Blacktip shark	*Carcharhinus tilstoni* and *C. limbatus*												
Goldband snapper	*Pristipomoides multidens*												
Rankin cod	*Epinephelus multinotatus*												
Red emperor	*Lutjanus sebae*												
Sandbar shark	*Carcharhinus plumbeus*												
Spanish mackerel	*Scomberomorus commerson*												
Pink snapper	*Pagrus auratus*												
Baldchin groper	*Choerodon rubescens*												
Crystal (snow) crab	*Chaceon spp.*												
King George whiting	*Sillaginodes punctate*												
Spangled emperor	*Lethrinus nebulosus*												
Pearl oyster	*Pinctada maxima*												
Blue-spotted emperor	*Charaxes cithaeron*												
Dusky whaler	*Carcharhinus obscurus*	May occur throughout the year											
Whiskery shark	*Furgaleus macki*												
Gummy shark	*Mustelus antarcticus*	Peak pupping periods unknown											
Fish	other species	Timing of spawning activity varies between species											

5.2 Fish Species

Four species of fish listed as Threatened under the EPBC Act (**Table 5-5-1**) were identified in the Protected Matters search (**Appendix A**):

+ Balston's pygmy perch (*Nannatherina balstoni*);
+ Black-stripe minnow (*Galaxiella nigrostriata*);
+ Blind gudgeon (*Milyeringa veritas*); and
+ Blind cave eel (*Ophisternon candidum*).

In addition the Barrow cave gudgeon (*Milyeringa justitia*) has been identified as relevant threatened species under the BC Act. This species is not listed under the EPBC Act.

5.2.1 Blind Gudgeon, Balston's Pygmy Perch and Blind Cave Eel

Both the blind gudgeon (*Milyeringa veritas*) and blind cave eel (*Ophisternon candidum*) are known to occur on the Cape Range Peninsula (in the Central Western Shelf Transition) (Humphreys and Feinberg 1995), and a related species of the genus Milyeringa, the Barrow cave gudgeon (*Milyeringa justitia*) has also been noted at Barrow Island (Humphreys 1999). The Barrow cave gudgeon is listed as Vulnerable under the WA BC Act. They have been recorded in waters ranging from fresh to seawater at depths of up to 33 m in caves and 50 m in wells and bores. Both species are restricted to either caves or groundwater (Humphreys and Blyth 1994) and are the only two vertebrate animals known from Australia for this (DoE 2014a).

The Balston's pygmy perch distribution ranges from Moore River (75 km north of Perth) at the northern extent to Two Peoples Bay near Albany. This freshwater species is typically associated with shallow waters near riparian vegetation and is considered to have low salinity tolerance, making it unlikely to occur in estuarine conditions (DoEE, 2016).

5.2.2 Black-stripe minnow

The black-stripe minnow inhabits coastal wetlands of south-west WA between Augusta and Albany. During summer when ephemeral pools dry out, individuals burrow into the moist soil below to aestivate until the rains return in autumn (Bray and Gomon 2017). The Conservation Advice for black-striped minnow in Australia (2018) updated the species listing to endangered status. The species is not expected to occur in significant numbers in marine and coastal environments in the EMBA due to their freshwater distribution, but they may be vulnerable to inflows from permanent rivers and streams (DoE 2018).

5.2.3 Syngnathids

The EPBC Protected Matters search also identified 72 'listed marine species of fish which are largely from the family Syngnathidae (**Appendix A**). Syngnathids are a group of bony fishes that include seahorses, pipefishes, pipehorses and sea dragons, although taxonomic uncertainty still surrounds a number of these (DEWHA 2012a). Knowledge about the distribution, abundance and ecology of syngnathids is limited, although no species is currently listed as threatened or migratory.

5.3 Sharks, Rays and Sawfishes

The diversity of marine environments in the waters within the NWMR has led to a rich fauna of cartilaginous fish (sharks and rays). Of the approximately 500 shark species found worldwide, 19% (94) are found in the region (DEWHA 2008a). The EPBC Act Protected Matters search (**Appendix A**) identified four species of shark, and three species of sawfishes listed as threatened within the search area between south west WA and NT border (**Table 5-5-1**), including:

+ Grey nurse shark (*Carcharias taurus*);
+ Great white shark (*Carcharodon carcharias*);
+ Northern river shark (*Glyphis garricki*);

+ Whale shark (*Rhincodon typus*);
+ Dwarf sawfish (*Pristis clavata*);
+ Freshwater sawfish (*Pristis pristis*); and
+ Green sawfish (*Pristis zijsron*).

In addition, the oceanic whitetip shark (*Carcharhinus longimanus*), the narrow sawfish (*Anoxypristis cuspidate*), two species of ray, the reef manta ray (*Manta alfredi*) and giant manta ray (*Manta birostris*), the porbeagle (*Lamna nasus*) and the longfin (*Isurus paucus*) and shortfin (*Isurus oxyrinchus*) mako sharks are listed as migratory within the search area (**Table 5-5-1).**

The Biologically Important Areas (BIAs) for relevant species detailed above are illustrated in **Figure 5-1, Figure 5-2** and **Figure 5-3**.

5.3.1 Grey Nurse Shark

The grey nurse shark (*Carcharias taurus*) is listed as vulnerable under the EPBC Act and the BC Act, and may be found within the EMBA. In Australia, the grey nurse shark is now restricted to two populations, one on the east coast from southern Queensland to southern NSW and the other is predominantly found around the southwest coast of WA, but has been recorded on the North West Shelf (DEWHA 2012b, Pogonoski *et al*. 2002). It is believed that the east and west coast populations do not interact and ongoing research will probably confirm that the populations are genetically different (Last and Stevens 2009).

While it is thought that grey nurse sharks have a high degree of site fidelity, some studies (McCauley 2004) suggest that grey nurse sharks move between different habitats and localities, exhibiting some migratory characteristics. In certain areas grey nurse sharks are vulnerable to localised pressure due to high endemism. The status of the west coast population is poorly understood although they are reported to remain widely distributed along the WA coast and are still regularly encountered, albeit with low and indeterminate frequency (Chidlow *et al*. 2006).

Grey nurse sharks are often observed hovering motionless just above the seabed, in or near deep sandy-bottomed gutters or rocky caves, and in the vicinity of inshore rocky reefs and islands (Pollard *et al*. 1996). The species has been recorded at varying depths, but is generally found between 15–40 m (Otway & Parker 2000). Grey nurse sharks have also been recorded in the surf zone, around coral reefs, and to depths of around 200 m on the continental shelf (Pollard *et al*. 1996). Grey nurse sharks feed primarily on a variety of teleost and elasmobranch fishes and some cephalopods (Gelsleichter *et al*. 1999, Smale 2005).

No grey nurse shark BIAs were identified in the EMBA.

5.3.2 Great White Shark

The great white shark (*Carcharodon carcharias*) is listed as vulnerable and migratory under the EPBC Act and is listed as vulnerable under the BC Act. In Australia, great white sharks have been recorded from central Queensland around the south coast to northwest WA, but may occur further north on both coasts (Last and Stevens 2009). There are no known aggregation sites for white sharks in the North-west marine region, but the species has been recorded in North West Shelf waters during humpback migrations (DEWHA 2012b). They are widely but not evenly distributed in Australian waters and are considered uncommon to rare compared to most other large sharks (CITES 2004).

Study into great white shark populations is difficult (Cailliet 1996) given the uncertainty about their movements, emigration, immigration and difficulty in estimating the rates of natural or fishing mortality.

Great white sharks can be found from close inshore around rocky reefs, surf beaches and shallow coastal bays to outer continental shelf and slope areas (Pogonoski *et al*. 2002). They also make open ocean excursions and can cross ocean basins (for instance from South Africa to the western coast of Australia and from the eastern coast of Australia to New Zealand). Great white sharks are often found in regions with high prey density, such as pinniped colonies (DEWHA 2009). The relevant great white shark BIAs in the EMBA are detailed in **Table 5-3** and is shown on **Figure 5-1** (DoEE 2019b).

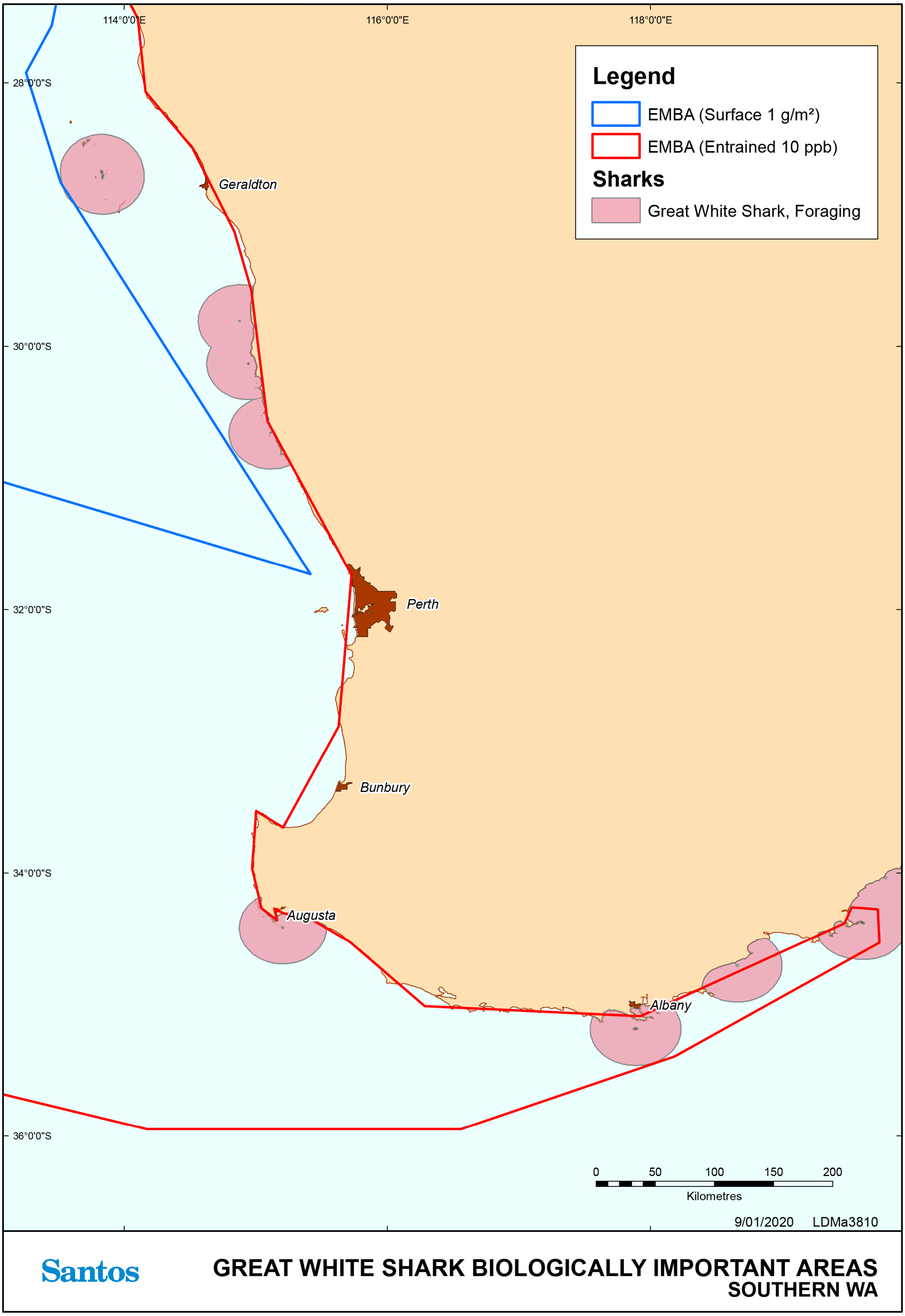


Figure 5-1: Biologically important area – great white shark

5.3.3 Northern River Shark

The northern river shark (*Glyphis garricki*) is listed as endangered under the EPBC Act and is one of the rarest species of shark in the world. Adults only recorded in marine habitats, whereas neonates, juveniles and subadults recorded in freshwater, estuarine and marine environments. It is also listed as a Priority 1 conservation species in WA.

The associated recovery plan (Sawfish and River Sharks Multispecies Recovery Plan, Commonwealth of Australia 2015) identifies adults and juveniles are being known in WA marine waters north of Derby. Pupping and juvenile sharks are identified as known to occur in Cambridge Gulf and pupping is also identified as likely to occur in King Sound. Under the associated recovery plan all areas where aggregations of individuals have been recorded displaying biologically important behaviours such as breeding, foraging, resting or migrating are considered critical to the survival of the species unless population data suggests otherwise.

5.3.4 Whale Shark

The whale shark (*Rhincodon typus*) is listed as vulnerable and migratory under the EPBC Act and is also listed as a specially protected species under the BC Act as a species of special conservation interest (conservation dependent fauna). The species is also classified as vulnerable on the World Conservation Union's Red List of Threatened Species (Norman 2005) and are protected under the WA *Conservation and Land Management Act 1984* and WA *Fish Resources Management Act 1994*.

The whale shark is the largest of all fish (>18 m; Borrell *et al*. 2011; Chen *et al*. 1997, Compagno 2001) and is a migratory species with worldwide geographical ranges between 30º N and 35º S (Last and Stevens 2009). There is a general lack of knowledge on many aspects of whale shark biology, including definitive migration patterns. The species is oceanic but often forms aggregations in coastal waters at sites throughout the tropics. Typically, these aggregations are seasonal and often coincide with specific productivity events that are a focus of feeding for the animals. For example, whale sharks aggregate to feed on dense swarms of copepods in Baja California (Clark and Nelson 1997), fish spawn off Belize (Heyman *et al*. 2001) and red crab larvae at Christmas Island (Meekan *et al*. 2009).

One of the best known aggregation sites for whale sharks occurs along the central and NW coast of Western Australia from March to July and is focused at Ningaloo Reef, within the Exmouth region. The small size and general absence of female whale sharks from Ningaloo Reef suggests that the region may be important for feeding rather than breeding (Norman and Stevens 2007). The timing of this aggregation coincides with a pulse in seasonal productivity that results in large abundances of tropical krill on which these filter feeding sharks feed (Meekan *et al*. 2006, Jarman and Wilson 2004). At Ningaloo Reef, whale sharks are often found swimming close to the reef front, within a few kilometres of the shore and in water of less than 50 m deep. A tourist industry based on snorkelling with the sharks in this area has developed over the last 15 years and is now estimated to be worth over $4 million annually to the local economy of the Ningaloo region.

Estimates of the size of the population participating in the Ningaloo aggregation are between 300 and 500 individuals (Meekan *et al*. 2006), but research indicates that the Ningaloo population of whale sharks is declining (Bradshaw *et al*. 2007).

Whale sharks are known to be highly migratory with migrations of 13,000 km being recorded (Eckert and Stewart 2001). Research on the migration patterns of whale sharks in the western Indian Ocean, and isolated and infrequent observations of individuals, indicate that a small number of the Western Australian population migrate through the North West Shelf. Wilson *et al*. (2006) tagged 19 whale sharks in 2003 and 2004, with long term movements patterns successfully recorded from six individuals. All travelled northeast into the Indian Ocean after departing Ningaloo Reef, with one tracked to Ashmore Reef and another to Scott Reef. Whale sharks are occasionally observed from Santos'' offshore oil and gas facilities on the North West Shelf (Harriet Alpha and Stag platforms). In general, migration along the northern WA coastline broadly follows the 200 m isobath and typically occurs between July and November (DoE 2015).

A biologically important area for whale sharks is located in northern WA, offshore of the Pilbara and Kimberley coastline, and broadly follows the 200 m isobath The relevant whale shark BIAs in the EMBA are detailed in **Table 5-3** and is shown on **Figure 5-2**.

DBCA has a wildlife management program to manage whale shark interactions in reserves - *Whale shark management with particular reference to Ningaloo Marine Park, Wildlife Management Program no. 57 (2013).*

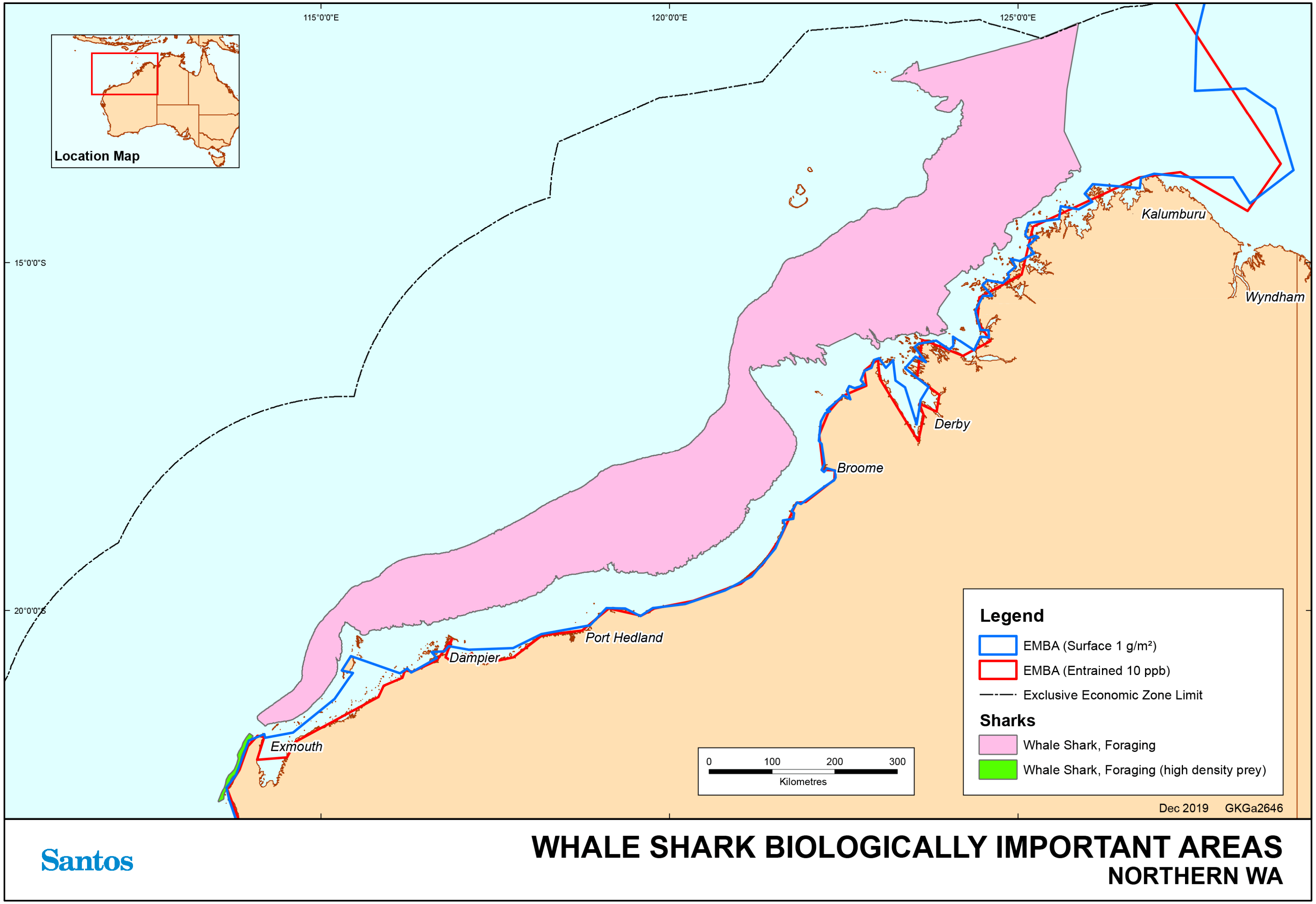


Figure 5-2: Biologically important area – whale shark

5.3.5 Dwarf Sawfish

The dwarf sawfish (*Pristis clavata*) is listed as vulnerable under the EPBC Act and thought to be restricted to Australia (DoE 2014b). It is also listed as a Priority 1 conservation species in WA. The Australian distribution of the dwarf sawfish is considered to extend across northern Australia and along the Kimberley and Pilbara coasts (Last and Stevens 2009, Stevens *et al*. 2005). However, the majority of records of dwarf sawfish in WA have come from shallow estuarine waters of the Kimberley region which are believed to be nursery (pupping) areas, with immature juveniles remaining in these areas up until three years of age (Thorburn *et al*. 2004). Adults are known to seasonally migrate back into inshore waters (Peverell 2007); although it is unclear how far offshore the adults travel as captures in offshore surveys are very uncommon. The species' range is restricted to brackish and salt water (Thorburn *et al*. 2007).

The recovery plan identifies pupping as known to occur in the King Sound, the Cambridge Gulf and 80 Mile Beach, with pupping likely to occur identified at a number of locations along the Pilbara and Kimberly Plan (Commonwealth of Australia, 2015). Under the associated recovery plan all areas where aggregations of individuals have been recorded displaying biologically important behaviours such as breeding, foraging, resting or migrating are considered critical to the survival of the species unless population data suggests otherwise.

The relevant sawfish BIAs in the EMBA are detailed in **Table 5-3** and are shown on **Figure 5-3**.

5.3.6 Freshwater and Green Sawfish

The freshwater sawfish (*Pristis pristis)* and green sawfish (*Pristis zijsron)* are both listed as vulnerable under the EPBC Act. The freshwater sawfish is listed as a Priority 3 conservation species in WA, while the green sawfish is listed as Vulnerable under the BC Act.

Both species are wider-ranging than the dwarf sawfish and are also found in the Indo-west Pacific (DoE 2014c, DoE 2014d). Important areas for sawfishes include King Sound, and the Fitzroy, Durack, Robinson and Ord rivers for the freshwater sawfish; and Cape Keraudren for the green sawfish (Stevens *et al*. 2008, Thorburn *et al*. 2007, 2008).

Sawfishes generally inhabit inshore coastal, estuarine and riverine environments. The freshwater sawfish has been recorded in north-west Australia from rivers (including isolated water holes), estuaries and marine environments (Stevens *et al*. 2005). Newborns and juveniles primarily occur in the freshwater reaches of rivers and in estuaries, while most adult freshwater sawfish have been recorded in marine and estuarine environments (Peverell 2005, Thorburn *et al*. 2007). It is believed that mature freshwater sawfish enter less saline waters during the wet season to give birth (Peverell 2005) and freshwater river reaches play an important role as nursery areas (DoE 2014c).

The green sawfish has predominantly been recorded in inshore coastal areas, including estuaries and river mouths with a soft substrate, although there have been records of sawfish offshore in depths up to 70 m (Stevens *et al*. 2005). This species does not occupy freshwater habitats (DoE 2014d).

Short-term tracking has shown that green sawfish appear to have limited movements that are tidally influenced, and they are likely to occupy a restricted range of only a few square kilometres within the coastal fringe, with a strong association with mangroves and adjacent mudflats (Stevens et al. 2008). Sawfishes feed close to the benthos on a variety of teleost fishes and benthic invertebrates, including cephalopods, crustaceans and molluscs (Compagno & Last 1999, Last & Stevens 2009, Pogonoski *et al*. 2002, Thorburn *et al*. 2007, 2008).

Baseline surveys undertaken for Chevron's Wheatstone project identified green sawfish habitat and nursery area for juveniles within the north-eastern lagoon of the Ashburton Delta and in Hooley Creek near Onslow. Distribution of sawfish in these creeks is spatially and seasonally variable due to changing tidal and environmental conditions. However, they typically return to inshore waters to breed and pup during the wet season (i.e. January) (Chevron 2011).

The relevant sawfish BIAs in the EMBA are detailed in **Table 5-3** and are shown on **Figure 5-3**.

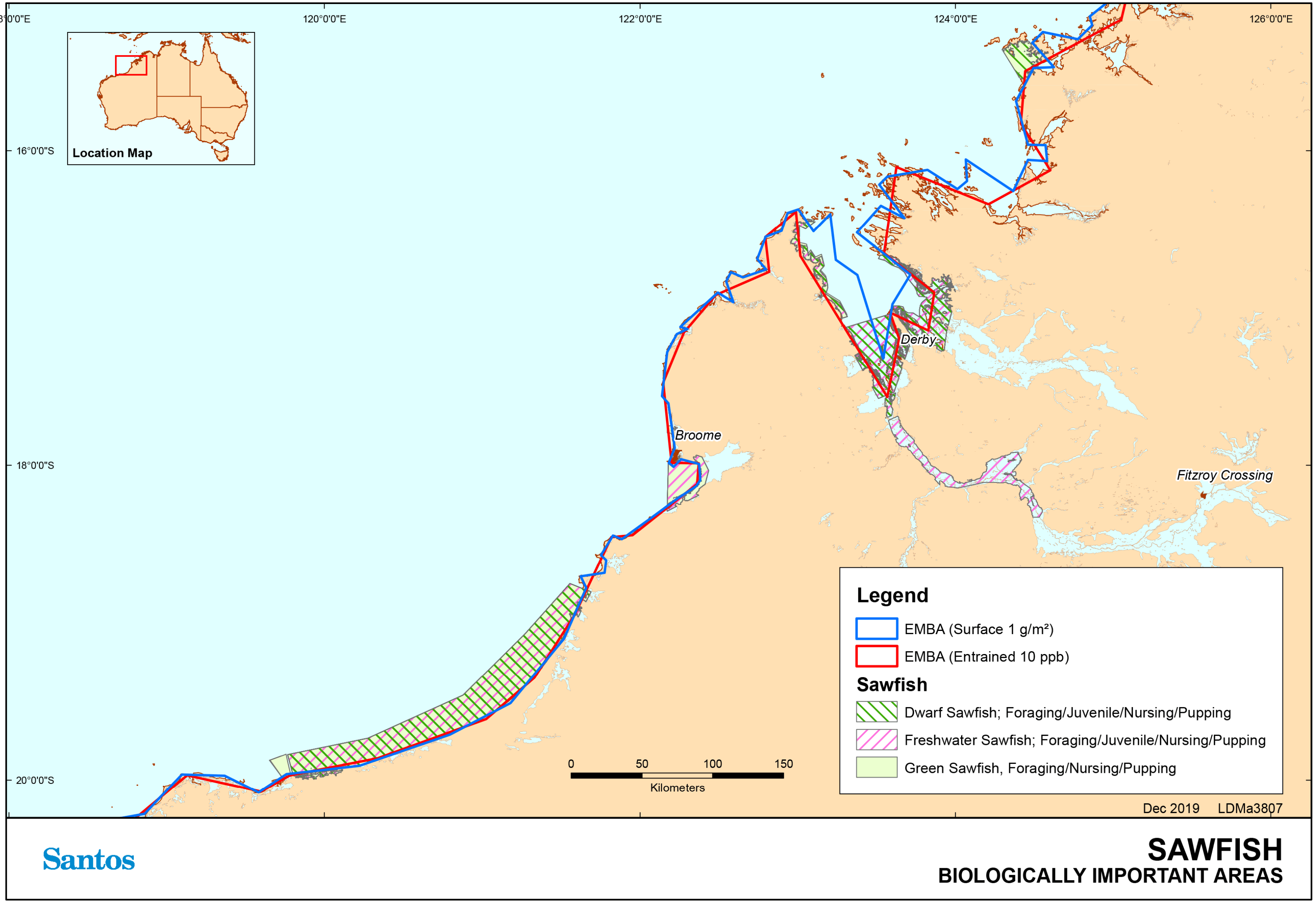


Figure 5-3: Biologically important areas – sawfish

5.3.7 Narrow Sawfish

The narrow sawfish (*Anoxypristis cuspidata*) is listed as migratory under the EPBC Act. It is a marine or marginal (brackish water) species found from inshore waters to a depth of 40 m (Compagno *et al.* 2006). Though details of its ecology are not precisely known, it probably spends most of its time on or near the bottom in shallow coastal waters and estuaries. A study showed the narrow sawfish to be the most abundant amongst the sawfish sampled in the Gulf of Carpentaria (Peverell, 2005) which holds some consistency with the offshore distribution of the species as shown by a study of Northern Prawn Fishery by-catch. Peverell (2005) also used catch data of offshore surface net fisheries to conclude that narrow sawfish also inhabit the mid-water column and can thus be described as a benthopelagic animal. The narrow sawfish is known to form aggregations of mature females during the months of October to November. Its Australian distribution is unclear though it is most common in the Gulf of Carpentaria with southward ranges extending to Broad Sound in Queensland and the Pilbara Coast (circa 116°E), Western Australia (Last & Stevens 2009).

5.3.8 Giant Manta Ray / Reef Manta Ray

The giant manta ray appears to be a seasonal visitor to coastal or offshore sites. Giant manta rays are often seen aggregating in large numbers to feed, mate, or clean. Sightings of these giant rays are often seasonal or sporadic but in a few locations their presence is a more common occurrence. This species is not regularly encountered in large numbers and, unlike some other rays do not often appear in large schools (>30 individuals) when feeding. Overall, they are encountered with far less frequency than the smaller manta species, despite having a larger distribution across the globe (IUCN 2019).

The giant manta ray (*Mobula birostris*) occurs in tropical, sub-tropical and temperate waters of the Atlantic, Pacific and Indian Oceans. They are commonly sighted along productive coastlines with regular upwelling, oceanic island groups and particularly offshore pinnacles and seamounts. The giant manta ray is commonly encountered on shallow reefs while being cleaned or is sighted feeding at the surface inshore and offshore. It is also occasionally observed in sandy bottom areas and seagrass beds (IUCN 2019).

The reef manta ray (*Mobula birostris*) has a circumtropical and sub-tropical distribution, existing in the Pacific, Atlantic and Indian Oceans. Within this broad range, however, actual populations appear to be sparsely distributed and highly fragmented. This is likely due to the specific resource and habitat needs of this species.

Overall population size is unknown, but subpopulations appear, in most cases, to be small (about 100–2,000 individuals). A proportion of the individuals in some populations undertake significant coastal migrations (IUCN 2019). Since the species is migratory it is possible that individuals may be encountered in the operational area, however, given that they generally do not aggregate in large groups, high numbers are not expected to be encountered during the activities.

5.3.9 Oceanic Whitetip Shark

The oceanic whitetip shark (*Carcharhinus longimanus*) is listed as migratory under the EPBC Act. The oceanic whitetip shark is widespread throughout tropical and subtropical waters of the world (30° N to 35° S) (IUCN 2020). They are an oceanic and pelagic species that regularly occurs in waters of 18 to 28°C, usually >20°C (IUCN 2020). Within Australian waters, they are found from Cape Leeuwin (Western Australia) through parts of the Northern Territory, down the east coast of Queensland and New South Wales to Sydney (Last and Stevens 2009). They are usually found in surface waters, though can reach depths of >180 m (Castro et al. 1999). They have occasionally been recorded inshore but are more typically found offshore or around oceanic islands and areas with narrow continental shelves (Fourmanoir 1961, Last and Stevens 1994).

5.3.10 Shortfin Mako and Longfin Mako Sharks

The shortfin mako and longfin mako sharks are listed as migratory under the EPBC Act. The longfin mako is widely distributed but rarely encountered oceanic shark that ranges from Geraldton around the north coast to at least Port Stephens in New South Wales (DSEWPaC 2012). The shortfin mako is an oceanic and pelagic species, although they are occasionally seen inshore. They are found throughout temperate seas but are rarely found in waters colder than 16°C.

5.3.11 Porbeagle (Mackerel Shark)

The porbeagle (mackerel shark) (*Lamna nasus*) is listed as migratory under the EPBC Act. The porbeagle is wide-ranging, typically occurring in oceanic waters off the continental shelf, although they occasionally enter coastal waters (Francis *et al*. 2002 cited in DoE 2014e). The porbeagle is known to undertake seasonal migrations, although the timing and details of these migratory movements are not well understood (Saunders *et al.* 2011 cited in DoE 2014e).

5.4 Biologically Important Areas / Critical Habitat – Fish

BIAs 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**.** BIAs are identified by DAWE, however, they have no legal status, but are designed to assist decision making under the EPBC Act. They are not designed to identify protected areas, but may inform such processes. **Table 5-3** below provides an overview of BIAs in the EMBA for fish.

The DAWE may make recovery plans for threatened fauna listed under the EPBC Act. The EPBC Act requires that 'habitat critical to the survival of the listed threatened species' is identified in recovery plans, and summary of relevant recovery plans is listed in **Section 13.2**. BIAs may overlap these sites, but may be identified for other purposes. DAWE state that the criteria used to identify 'habitat critical to the survival of the species' are more complex than those used to identify BIA. Specifically, the Sawfish and River Sharks Multispecies Recovery Plan (DoEE 2015) cites that *"all areas where aggregations of individuals have been recorded displaying biologically important behaviour such as breeding, foraging, resting or migrating, are considered critical to the survival of the species unless population survey data suggests otherwise"*.

In addition, both the EPBC Act and WA BC Act and associated regulations (2018) provide for the listing of critical habitat - habitat 'critical to the survival of the threatened species'. To date no critical habitat in WA has been listed under either Act.

Table 5-3: Biologically important areas - fish

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
Great white shark	*Carcharodon carcharias*	Foraging – associated with pinniped colonies in the mid-west and south west and waters off Bremer Bay	Waters off pinniped colonies throughout the South-west Marine Region Waters off Bremer Bay
Whale shark	*Rhincodon typus*	Foraging (high density prey) – Ningaloo Reef Foraging – Wider Ningaloo Region	Ningaloo Marine Park and adjacent Commonwealth waters Northward from Ningaloo along 200 m isobath
Dwarf sawfish	*Pristis clavata*	Foraging – Eighty Mile Beach, King Sound, Camden Sound Nursing - Eighty Mile Beach, King Sound, Fitzroy River and May Robinson River Pupping – Eighty Mile Beach, King Sound, Fitzroy River and May Robinson River	Eighty Mile Beach Camden Sound - eastern shore Fitzroy River Mouth, May and Robinson River - tidal tributaries King Sound (inshore waters)

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
		Juvenile – King Sound, Fitzroy River and May Robinson River	
Freshwater sawfish	*Pristis pristis*	Nursing – King Sound Foraging – King Sound, Roebuck Bay, Eighty Mile Beach Pupping – Roebuck Bay, Eighty Mile Beach Juvenile – Roebuck Bay	Eighty Mile Beach King Sound - tidal tributaries Roebuck Bay
Green sawfish	*Pristis zijsron*	Pupping – Cape Keraudren, Eighty Mile Beach, Roebuck Bay, Willie Creek, Cape Leveque Foraging - Cape Keraudren, Roebuck Bay, Cape Leveque, Camden Sound Nursing - Cape Keraudren, Eighty Mile Beach, Ashburton River and Hooley Creek near Onslow	Eighty Mile Beach Camden Sound Cape Keraudren Cape Leveque Roebuck Bay Willie Creek Ashburton River Hooley Creek

6. Marine Reptiles

Thirty-three species of listed marine reptiles under the Commonwealth EPBC Act are known to occur in Australian waters in the EMBA, according to the Protected Matters search (**Appendix A**). An examination of the species profile and threats database (DoEE 2019) showed that some listed reptile species are not expected to occur in significant numbers in the marine and coastal environments in the EMBA due to their terrestrial distributions. Hence, these species are not discussed further.

Of the remaining reptile species identified in the Protected Matters search (**Appendix A**), eight are listed as threatened and seven are listed as migratory. These species are show in **Table 6-1** along with their WA conservation listing (as applicable)[3]. BIAs within the EMBA area discussed in **Table 6-3**.

Table 6-1: EPBC listed marine reptile species in the EMBA

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code		
Green turtle (*Chelonia mydas*)	Vulnerable Migratory	Vulnerable	-	Breeding known to occur within area	Yes – refer to **Table 6-3**
Flatback turtle (*Natator depressus*)	Vulnerable Migratory	Vulnerable	-	Breeding known to occur within area	Yes – refer to **Table 6-3**
Hawksbill turtle (*Eretmochelys imbricata*)	Vulnerable Migratory	Vulnerable	-	Breeding known to occur within area	Yes – refer to **Table 6-3**
Loggerhead turtle (*Caretta caretta*)	Endangered Migratory	Endangered	-	Breeding known to occur within area	Yes – refer to **Table 6-3**
Olive ridley turtle (*Lepidochelys olivacea*)	Endangered Migratory	Endangered	-	Foraging feeding or related behaviour known to occur within area	Yes – refer to **Table 6-3**
Leatherback turtle (*Dermochelys coriacea*)	Endangered Migratory	Vulnerable	-	Foraging feeding or related behaviour known to occur within area	Yes – refer to **Table 6-3**
Short-nosed seasnake (*Aipysurus apraefrontalis*)	Critically Endangered	Critically Endangered	-	Species or species habitat known to	None - No BIA defined

[3] An overview of WA fauna conservation codes is provided in **Section 5** (fish and sharks).

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code		
				occur within area	
Leaf-scaled seasnake (*Aipysurus foliosquama*)	Critically Endangered	Critically Endangered	-	Species or species habitat known to occur within area	None - No BIA defined

6.1 Marine Turtles

Six species of marine turtle occur in, use the waters, and nest on sandy beaches, in WA. These are the green turtle (*Chelonia mydas*), flatback turtle (*Natator depressus*), hawksbill turtle (*Eretmochelys imbricata*), loggerhead turtle (*Caretta caretta*), olive ridley turtle (*Lepidochelys olivacea)* and leatherback turtle (*Dermochelys coriacea*) (**Table 6-1**).

These six species are listed on the EPBC Act List of Threatened Species as either 'endangered' or 'vulnerable' and all six species are also listed as 'migratory'. They are also listed as threatened species under the BC Act.

A summary of the different habitat types used during the various life stages of marine turtle species identified in the EMBA is given in **Table 6-2.**

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Table 6-2: Summary of habitat types for the life stages of the six marine turtle species in the EMBA (DSEWPaC, 2012b)

Life Stage		Green turtle	Flatback turtle	Hawksbill turtle	Loggerhead turtle	Olive ridley turtle	Leatherback turtle
Post-hatchling		Open ocean pelagic habitats (poorly studied for Australian populations)	Coastal waters (poorly studied for Australian populations)	Open ocean pelagic habitats (poorly studied for Australian populations)	Pelagic (poorly studied for Australian populations)	Pelagic (poorly studied for Australian populations)	Pelagic (no data for Australian populations)
Adult	Mating	Offshore from nesting beaches.	Currently unknown for North West Shelf region.	Offshore from nesting beaches.	Little is known for North West Shelf region but expected to occur either en-route or adjacent to nesting beaches.	Not recorded within North West Shelf region.	Not recorded within North West Shelf region.
	Nesting	Typically, high energy, steeply sloped beaches with deep sand and deep water approach.	Typically, low-energy beaches that are narrow with a low to moderate slope. Beach approach obstructed by broad intertidal mud or limestone platforms.	Typically beaches close to nearshore coral reefs and sediment comprised of coarse sand and coral rubble.	Poorly studied for North West Shelf region by generally prefer high energy, relatively narrow, steeply sloped, coarse-grained beaches.	Not recorded within North West Shelf region.	Not recorded within North West Shelf region.
	Internesting	Shallow coastal waters within several kms of nesting beach. Inter-nesting buffers of 20 km identified around all nesting habitats.	Shallow nearshore waters within 5-60 km of nesting beach. Inter-nesting buffers of 40-60 km identified around all nesting habitats.	Shallow coastal waters within several kilometres of nesting beach. Inter-nesting buffers of 20 km identified around all nesting habitats.	Shallow coastal waters within several kilometres of nesting beach. Inter-nesting buffers of 20 km identified around all nesting habitats.	Not recorded within North West Shelf region. Inter-nesting buffers of 20 km identified around all nesting habitats.	Not recorded within North West Shelf region.
	Foraging	Neritic habitats associated with seagrass and algae, and mangrove habitats.	Turbid, shallow inshore waters, subtidal, soft-bottomed habitats of the continental shelf.	Subtidal and intertidal coral and rocky reef habitats of the continental shelf.	Subtidal and intertidal coral and rocky reefs, seagrass and deeper soft-bottomed habitats of the continental shelf.	Many feed within continental shelf waters, however it is not known if others are pelagic, as with the east Pacific population.	Mostly pelagic but will forage close to shore and over continental shelf in temperate waters.

6.1.1 Loggerhead Turtle

The loggerhead turtle (*Caretta caretta*) has a worldwide distribution, living and breeding in subtropical to tropical locations (Limpus 2008b). Breeding aggregations in Australia occur on both the east coast (Queensland and NSW) and the west. The annual nesting population in Western Australia is thought to be 3,000 females annually (Baldwin *et al*. 2003), and this is considered to support the third largest population in the world (Limpus 2008b). Loggerhead turtles have one genetic breeding stock within Western Australia (Commonwealth of Australia 2017a).

The WA distribution of sandy beach nesting areas extends from Shark Bay to the southern area of the North West Shelf, with occasional late summer nesting crawls recorded as far north as Barrow and Varanus Islands and the Lowendal and Rosemary Islands (DSEWPaC 2012d). Major nesting locations include the Muiron Islands, the Ningaloo Coast south to Carnarvon and the islands around Shark Bay, which includes Dirk Hartog Island, one of the principal nesting and internesting sites in WA (Limpus 2008). The Recovery Plan for Marine Turtles in Australia (2017) identifies the Muiron Islands (as a principal rookery), and all waters within a 20 km radius as habitat critical to the survival of loggerhead turtles (Commonwealth of Australia 2017a).

Estimates of up to 5,000 female loggerhead turtles have been predicted within the Ningaloo Marine Park and Muiron Islands Marine Management Area (Waayers 2010). Earlier surveys found higher proportions of nesting loggerheads in the southern areas of the reserves (CALM 2005a). Aerial surveys conducted in 2000 and 2001 in the Exmouth region recorded only 12 sightings in Commonwealth waters and these turtles were most likely loggerheads (BHP 2005). In a survey commissioned by Santos around the islands in the Exmouth Region, loggerhead turtles were recorded nesting on Flat Island north of the Exmouth Gulf which was the first time they had been recorded in that location (Astron 2014). Loggerhead nesting and breeding occurs from November to March, with a peak in late December/early January (Limpus 2008b).

Foraging areas are widespread for loggerhead turtle populations and migrations from nesting to feeding grounds can stretch thousands of kilometres, including feeding grounds as far north as the Java Sea of Indonesia for the WA population (Limpus 2008b). Shark Bay has been identified as an important foraging habitat for loggerhead turtles (Commonwealth of Australia 2017a). Loggerhead turtles are carnivorous and feed primarily on benthic invertebrates from depths of up to approximately 50 m to near shore tidal areas including areas of rocky and coral reef, muddy bays, sand flats, estuaries and seagrass meadows (Limpus 2008b).

Figure 6-1 illustrates the BIAs and habitat critical (draft) for loggerhead turtles (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017a).

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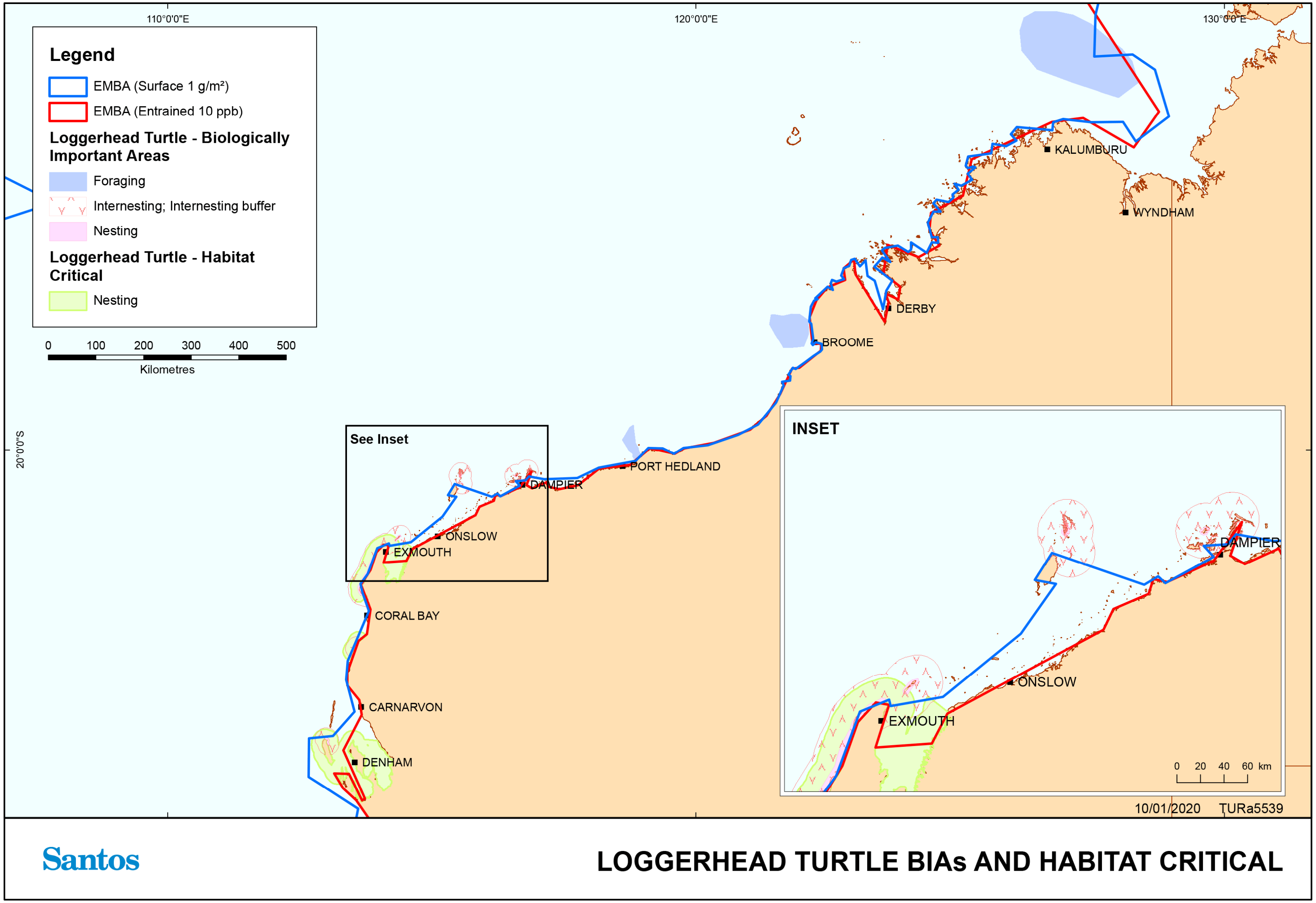

Figure 6-1: Biologically Important Areas and Habitat Critical – Loggerhead Turtle

6.1.2 Green Turtle

Australian population of green turtles is estimated to be approximately 70,000 and is divided into seven genetically distinct breeding aggregations. The species is widespread and abundant in WA waters with an estimated 20,000 individuals occurring, arguably the largest population in the Indian Ocean (Limpus 2008a). There are three distinct breeding stocks in WA waters which include: the North west Shelf stock, the Scott-Browse stock and the Ashmore Stock (Commonwealth of Australia 2017a).

The North west Shelf population is one of the largest in the world and the most significant rookery is the western side of Barrow Island (Prince 1994, Limpus 2008a). Other principal rookeries include the Lacepede Islands, Montebello Islands, Dampier Archipelago, Browse Island and North West Cape (Prince 1994, Limpus 2008a, DSEWPaC 2012b). See **Table 6-3** for a complete list.

Surveys by Waayers (2010) within the Ningaloo Marine Park and Muiron Islands Marine Management Area estimated up to 7,500 female green turtles used these areas. In 2014, Santos commissioned a survey of the islands in the Exmouth Region which found that North and South Muiron Islands were significant nesting sites for green turtles with over 100 green turtles nesting overnight on one beach at North Muiron Island (Astron 2014). The green turtle is also known to breed in large numbers in the dunes above the extensive beaches found on Serrurier Island, with counts indicating the island supports the second largest rookery in the Pilbara (Oliver 1990).

Lower density green turtle nesting has also been recorded on Jurabi coast, Thevenard Island, Lowendal Islands and in Exmouth Gulf (Limpus 2008a). Only low numbers of green turtles have been observed nesting on Varanus Island, as well as Airlie Island (Pendoley Environmental 2011). From monitoring undertaken in 2016/17 by Santos on Varanus Island; three green turtles were observed to nest over a four week tagging effort (Astron 2017).

Green turtle nesting abundance and timing fluctuates significantly from year to year depending on environmental variables, locality and food availability (Pendoley Environmental 2011). Nesting of green turtles has been recorded from August to March on Serrurier Island (Woodside 2002), from December to March along coast adjacent to Ningaloo (CALM 2005a) and from October to February on Varanus Island (Pendoley Environmental 2011). On Barrow Island, mating aggregations may commence from October with peak nesting from December to January, with hatchlings emerging through summer and early autumn. However, nesting on Barrow Island has been recorded all year round (Chevron 2005 and 2008, Pendoley 2005). Nesting on the Scott Reef-Sandy Islet and Browse Island has been observed all year round with peaks between December and January (Commonwealth of Australia 2017a). The re-nesting period for female green turtles is approximately five years (Hamann *et al*. 2002).

Green turtles spend the first five to ten years of their life drifting on ocean currents, before moving to reside in shallower benthic habitats, including tropical coral and rocky reefs and seagrass beds. Green turtles have been known to migrate more than 2,600 km between feeding and breeding grounds (Limpus 2008a).

Green turtles are omnivores, mainly feeding in shallow benthic habitats on seagrass and/ or algae, but are also known to feed on sponges, jellyfish and mangroves (Limpus 2008a). Green turtles are unlikely to forage or dwell within deeper offshore waters due to the water depths; however, they may occasionally migrate through it.

Figure 6-2 illustrates the BIAs and habitat critical (draft) for green turtles (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017a).

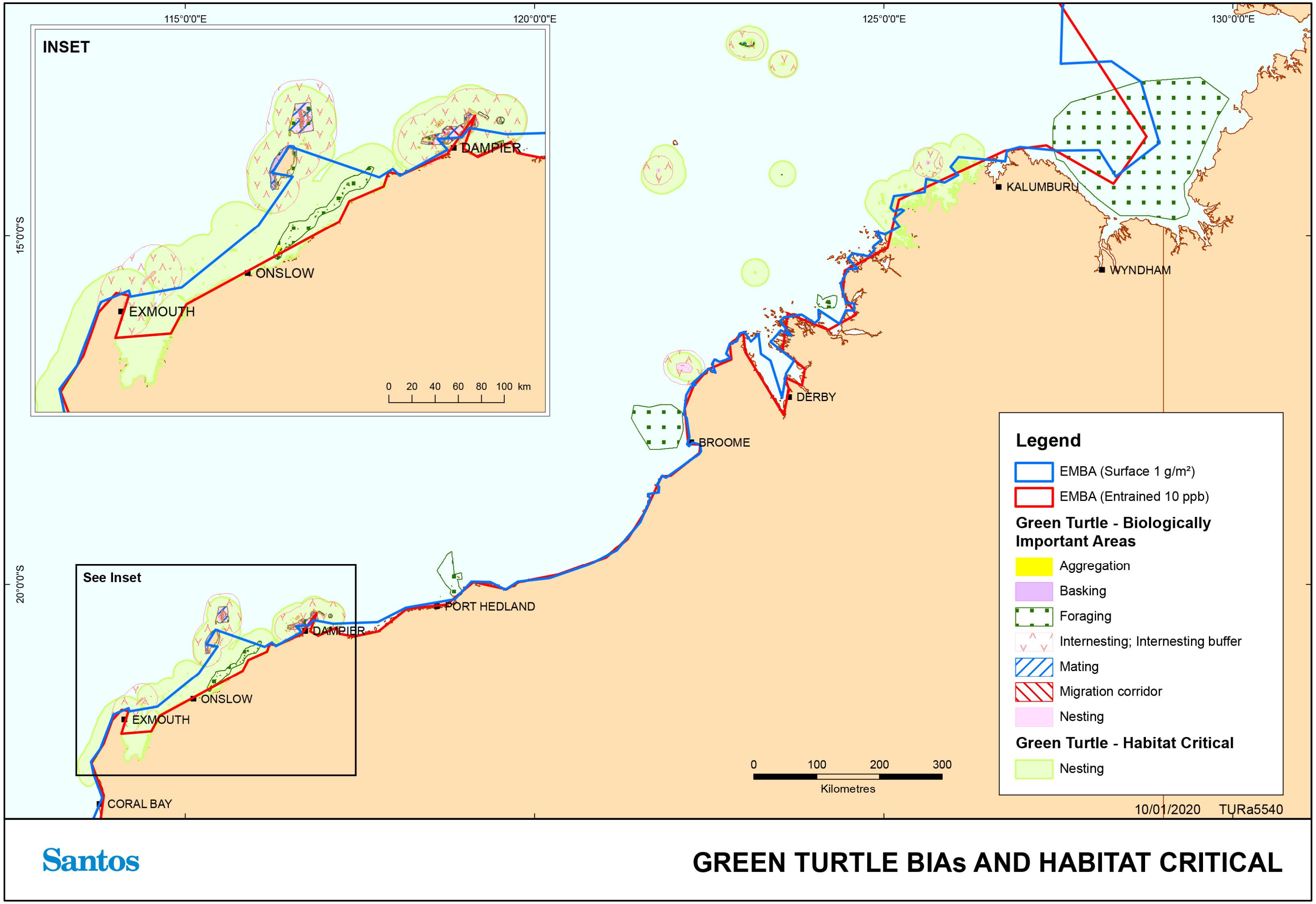

Figure 6-2: Biologically Important Areas and Habitat Critical – Green Turtle

6.1.3 Hawksbill Turtle

Hawksbill turtles (*Eretmochelys imbricata*) have a global distribution throughout tropical and sub-tropical marine waters. The Western Australian stock is concentrated on the North West Shelf (Dampier Archipelago) (Limpus 2009a), and is considered to be one of the largest hawksbill populations remaining in the world. The estimated number of nesting hawksbill turtles in WA waters is between 2,000 and 4,500 individuals (Morris 2004).

In WA, their nesting range is relatively small and extends from the Muiron Islands to the Dampier Archipelago, a distance of approximately 400 km. The most significant breeding areas, that support hundreds of nesting females annually, are around sandy beaches within the Dampier Archipelago, Montebello Islands, Lowendal Islands and Barrow Island (Pendoley 2005, Limpus, 2009a).

The largest known nesting area for the North West Shelf population is the sandy shoreline of Rosemary Island, within the Dampier Archipelago, particularly on the north-western side of the Island. It is believed that the Rosemary Island rookery may support up to 1,000 nesting females annually (Limpus 2009). Low density nesting is also known from Barrow Island, Airlie Island, Muiron Islands and North West Cape/ Ningaloo coast (Cape Range) (Limpus 2009a). Nesting hawksbills have also been found on NE Regnard Island and SW Regnard Island, confirming the Regnard Islands as hawksbill rookeries (Pendoley Environmental 2009).

The hawksbill turtle nesting population within the Exmouth region is also considered important as the populations in Western Australia represent the largest remaining population in the Indian Ocean (CALM 2005). The best estimate of numbers within the Ningaloo Marine Park and Muiron Islands Marine Management Area is between 20–700 individuals (Waayers 2010).

A snapshot survey of Varanus Island and the Lowendal Islands conducted for Santos during October 2012 found the five most frequented beaches by hawksbills, based on the track counts, were Beacon Island (*n*=43), Parakeelya (*n*=41), Kaia (*n*=40), Rose (*n*=30) and Pipeline (*n*=28). Results of the October 2012 three-day track census program showed that Beacon Island also hosted the highest daily number of overnight emergences by hawksbills and is therefore an important nesting beach for hawksbill turtles (Pendoley Environmental 2013).

On Varanus Island, hawksbill turtle nesting activity is predominantly distributed on the island's east coast, including Pipeline, Harriet, and Andersons beaches (Pendoley Environmental 2019). Individual hawksbill turtles appear to show a strong fidelity to these beaches, often returning to the same beach to nest within the season (Pendoley Environmental 2019). Between 1986 and 2019, a total of 571 individual hawksbill turtles were tagged on Varanus Island.

Nesting is reported to occur between October and February in WA (Commonwealth of Australia 2017a). Hawksbill turtles have been observed breeding on the North West Shelf between July and March with peak nesting activity around the Lowendal Islands between October and December (Limpus 2009a).

Female hawksbills skip annual breeding opportunities (Kendall & Bjorkland 2001), presumably due to high energy demands of breeding (Chaloupka & Prince 2012).

Individuals may migrate up to 2,400 km between their nesting and foraging grounds (DSWEPaC 2012a). Satellite tracking of nesting turtles on Varanus Island (32 km) and Rosemary Island has shown adult turtles to feed between 50 and 450 km from their nesting beaches (DSWEPaC 2012a).

Adults tend to forage in tropical tidal and sub-tidal coral and rocky reef habitat where they feed on an omnivorous diet of sponges, algae, jelly fish and cephalopods (DSWEPaC 2012a). Hawksbill turtles are unlikely to spend significant time within offshore waters as it is too deep to act as a feeding ground. However, it is likely they may migrate through those areas.

Figure 6-3 illustrates the BIAs and habitat critical (draft) for hawksbill and olive ridley turtles (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017a).

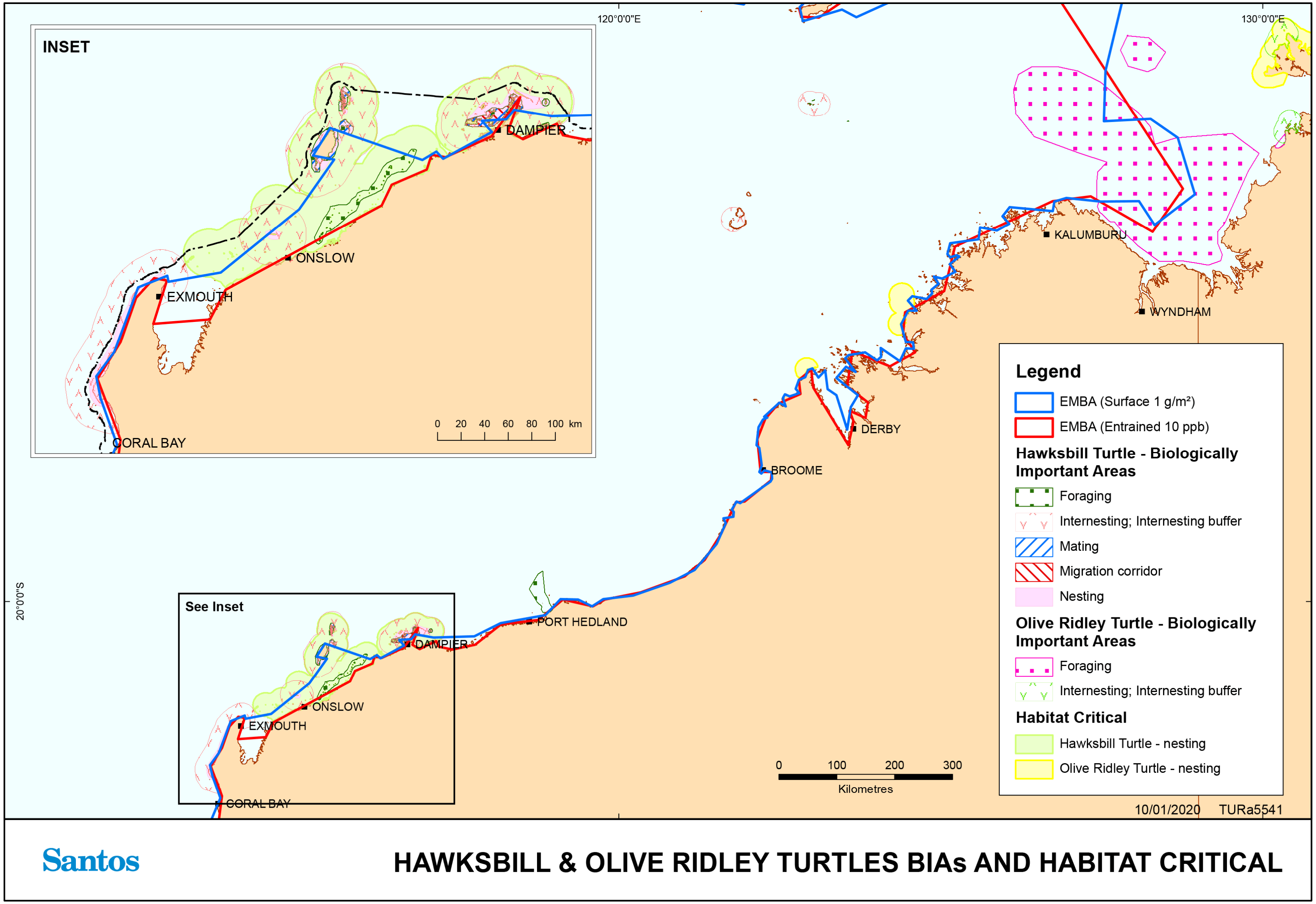

Figure 6-3: Biologically Important Areas and Habitat Critical – Hawksbill and Olive Ridley Turtle

6.1.4 Flatback Turtle

The flatback turtle (*Natator depressus*) has an Australasian distribution, with all recorded nesting beaches occurring within tropical to sub-tropical Australian waters. One third of the total breeding for the species occurs in Western Australia (WA) (Limpus, 2007). The management of the flatback turtle in Australia is broken up into five stocks currently described around Australia; eastern Queensland, Arafura Sea, Cape Domett, South-west Kimberley and Pilbara stocks (Commonwealth of Australia 2017). The Pilbara stock nests throughout the North West Shelf and is characterised by summer nesting (October to March), and the northern stock at Cape Domett breeds mainly in winter (July to September) (Commonwealth of Australia 2017a). The South-west Kimberley stock is also characterised by summer nesting.

The southern WA nesting population of flatback turtles occurs from Exmouth to the Lacepede Islands off the Kimberley coast (DSEWPaC 2012c). On the North West Shelf, significant rookeries are centred on Barrow Island especially the east coast beaches (DSEWPaC 2012b).

Montebello Islands, Thevenard Island, Varanus Island, the Lowendal Islands, King Sound and Dampier Archipelago are also significant rookeries (Pendoley 2005, Limpus 2007, Pendoley Environmental 2011). Nesting is also widespread along the mainland beaches from Mundabullangana on the Pilbara coast north, including Cemetery Beach near Port Hedland, Eighty Mile Beach and to Broome (Limpus 2007, DSEWPaC 2012b).

Long term monitoring of flatback turtles nesting in the Port Hedland area, specifically at Cemetery Beach and Pretty Pool Beach, was undertaken between 2004 and 2014. Monitoring results indicated the main nesting season of flatback turtles in the area was between mid-October and January, which is consistent with other rookeries in the Pilbara region including Barrow Island, Mundabullangana, Karratha and Onslow (Waayers and Stubbs 2016). The onset of the nesting season appears to be relatively consistent each year and is thought to be associated with the southern movement of warmer sea surface temperatures along the northern WA coast.

There have been occasional records of nesting by flatback turtles on the Jurabi Coast and Muiron Islands (CALM 2005). During turtle surveys for Santos, WA flatback turtle nesting was recorded on Bessieres Islands (Astron 2014), Serrurier, Flat, Table and Round Island in previous surveys (Pendoley Environmental 2009). Flatback turtle tracks have been seen on Forty Mile beach and evidence of flatback nesting was recorded on the same beach the next day (Pendoley Environmental 2009). Previously the status of the flatback population(s) was undetermined and although not well quantified, it was estimated to be many thousands of females (Limpus 2007). However, Pendoley *et al*. (2014) reported both Barrow Island and Mundabullangana flatback turtles as substantial reproductive populations with 4,000 and 3,500 turtles tagged at each location between 2006/2006 and 2010/2011. Cemetery beach at Port Hedland had approximately 350 turtles were tagged over two seasons of monitoring (2009/2010 and 2011/12).

Satellite tracking of adult (female) flatback turtles shows they use a variety of inshore and offshore marine areas off the east and west coasts of Barrow Island. Females inter-nest close to their nesting beaches, typically in 0–10 m of water (Chevron 2008). However, flatback turtles also travel approximately 70 km and inter-nest in shallow nearshore water off the adjacent mainland coast, before returning to Barrow Island to lay another clutch of eggs. The average inter-nesting period is 13–16 days.

From long-term tagging studies on Varanus Island and Pendoley's observations, it appears that the nesting season for flatback turtles peaks in December and January with subsequent peak hatchling emergence in February and March. Flatbacks have been observed to nest on Varanus Island between November and February (Chevron 2008, Pendoley Environmental 2011 & 2013). Population monitoring of flatback turtles on Varanus Island, calculated from 16 seasons, indicates a mean population estimate of 226 (+/- 97). Modelled flatback turtle populations have shown a slight decline from 2008/09 to 2016/17, which is considered to be part of fluctuations in the natural cycle (Astron 2017). Flatback turtles tend to nest on all beaches on Varanus Island (Astron 2017). Flatback hatching and emergence success is noted as higher compared to that reported for other Western Australian rookeries (Pendoley et al. 2014; cited Astron 2017).

Unlike other sea turtles, the flatback turtle lacks a wide oceanic dispersal phase and adults tend to be found in soft sediment habitats within the continental shelf of northern Australia (DSEWPaC 2012b). Little information is known on the diets of flatback turtles (DSEWPaC 2012b), however, they are believed to forage on primarily soft-bodied invertebrates (Commonwealth of Australia 2017a).

Figure 6-4 illustrates the BIAs and habitat critical (draft) for flatback turtles (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017a).

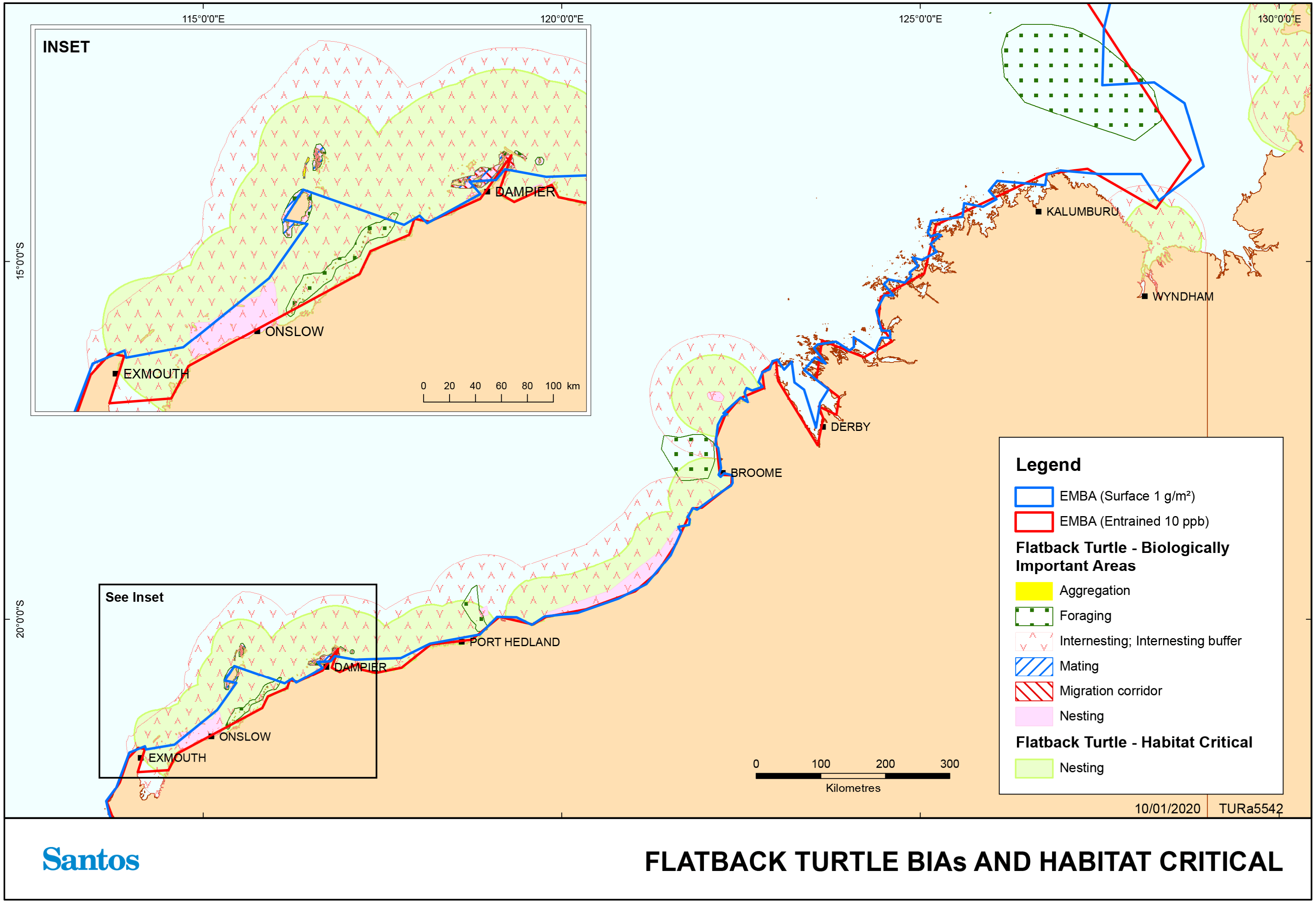

Figure 6-4: Biologically Important Areas and Habitat Critical – Flatback Turtle

6.1.5 Leatherback Turtle

The leatherback turtle *(Dermochelys coriacea)* has the widest distribution of any marine turtle, and can be found from tropical to temperate waters throughout the world (Márquez 1990). There are no major leatherback turtle centres of nesting activity that have been recorded in Australia, although scattered isolated nesting (one to three nests per annum) occurs in southern Queensland and the Northern Territory (Limpus and McLachlin 1994).

There have been several records of leatherback turtles off the coast of WA, but no confirmed nesting sites (Limpus 2009c). Turtle observations have mainly occurred south of the North West Shelf area and in open waters (>200 m deep) (Limpus 2009c). Due to the lack of nesting sites around Australian coastal waters, it is presumed that leatherback turtles observed in Australian waters are migrating from neighbouring countries to utilise feeding grounds in Australia (Limpus 2009c).

The leatherback turtle will feed at all levels of the water column and is carnivorous feeding mainly on pelagic, soft-bodied marine organisms such as jellyfish, which occur in greatest concentrations in areas of upwelling or convergence (DSEWPaC 2012d). The leatherback turtle is a highly pelagic species with adults only going ashore to breed.

No leatherback turtle BIAs or habitat critical (draft) are found within the EMBA.

6.1.6 Olive Ridley Turtles

Olive ridley turtles (*Lepidochelys olivacea*) are the least common turtle species encountered with critical nesting habitat occurring near Vulcan Island, Darcy Island, Prior Point and Llanggi and Cape Leveque (Commonwealth of Australia 2017). This species forages within the shallow benthic habitats of northern Western Australia and is thought to feed primarily on gastropods and small crabs within the benthic, soft-bottomed communities of the continental shelf (Limpus 2009). Olive Ridley turtles forage as far south as the Dampier Archipelago-Montebello Islands.

BIAs for this endangered species are known to occur in the vicinity of Joseph Bonaparte Depression (DSEWPaC 2012b, Commonwealth of Australia 2017a). See **Figure 6-3** for identified olive ridley turtle BIAs and critical habitats (draft) within the EMBA (as defined in the Recovery Plan for Marine Turtles in Australia (Commonwealth of Australia 2017a).

6.2 Seasnakes

Storr *et al*. (1986) estimate nine genera and 22 species of sea snakes occur in WA waters, with 25 listed marine seasnake species being recorded in the search area (**Appendix A**). Little is known of the distribution of individual species, population sizes or aspects of their ecology. Seasnakes are essentially tropical in distribution, and habitats reflect influences of factors such as water depth, nature of seabed, turbidity and season (Heatwole and Cogger 1993). Seasnakes are widespread throughout waters of the North West Shelf in offshore and nearshore habitats. They can be highly mobile and cover large distances or they may be restricted to relatively shallow waters and some species must return to land to eat and rest. In the north-west region of Western Australia, no BIAs have been designated for seasnakes. However, both Ashmore Reef and Cartier Island are characterised for both a high density and high diversity of seasnakes (DSEWPaC 2012b).

Two species of seasnakes listed as threatened under the EPBC Act were identified in the Protected Matters search within the EMBA (**Appendix A**):

+ Short-nosed seasnake (*Aipysurus apraefrontalis*); and
+ Leaf-scaled seasnake (*Aipysurus foliosquama*).

6.2.1 Short-nosed Seasnake

The short-nosed seasnake (*Aipysurus apraefrontalis*) is listed as critically endangered under the EPBC Act and the BC Act. It is a fully aquatic, small snake and is endemic to WA. It has been recorded from Exmouth Gulf, WA to the reefs of the Sahul Shelf, in the eastern Indian Ocean. This species is believed to show strong site fidelity to shallow coral reef habitats in less than 10 m of water, with most specimens having been collected from Ashmore and Hibernia reefs (Minton & Heatwole 1975, Guinea and Whiting 2005).

The species prefers the reef flats or shallow waters along the outer reef edge in water depths to 10 m (McCosker 1975, Cogger 2000). The species has been observed during daylight hours, resting beneath small coral overhangs or coral heads in 1–2 m of water (McCosker 1975). Guinea and Whiting (2005) reported that very few short-nosed seasnakes moved even as far as 50 m away from the reef flat and are therefore unlikely to be expected in high numbers in offshore, deeper waters.

6.2.2 Leaf-scaled Seasnake

The leaf-scaled seasnake *(Aipysurus foliosquama)* is listed as critically endangered under the EPBC Act and the BC Act. It occurs in shallow water (less than 10 m in depth), in the protected parts of the reef flat, adjacent to living coral and on coral substrates (DoE 2014). The species is found only on the reefs of the Sahul Shelf in WA, especially on Ashmore and Hibernia Reefs (Minton and Heatwole 1975). The leaf-scaled seasnake forages by searching in fish burrows on the reef flat (DoE 2014).

6.3 Crocodiles

The salt-water crocodile (*Crocodylus porosus*) is a migratory species under the EPBC Act and is also listed as a specially protected species (other specially protected fauna) under the BC Act. In WA, the species is found in most major river systems of the Kimberley, including the Ord, Patrick, Forrest, Durack, King, Pentecost, Prince Regent, Lawley, Mitchell, Hunter, Roe and Glenelg Rivers. The largest populations occur in the rivers draining into the Cambridge Gulf and the Prince Regent River and Roe River systems. There have also been isolated records in rivers of the Pilbara region, around Derby near Broome and as far south as Carnarvon on the mid-west coast (DEC 2009a).

6.4 Biologically Important Areas/Habitat Critical – Marine Reptiles

Table 6-3 provides an overview of BIAs in the EMBA for marine reptiles, as identified by the DAWE (Commonwealth) and critical habitats identified in associated recovery plans. The DAWE may make recovery plans for threated fauna listed under the EPBC Act. The EPBC Act requires that 'habitat critical to the survival of the listed threatened species' is identified in recovery plans, relevant recovery plans are listed in **Section 13.2**[4].

In addition, both the EPBC Act and WA BC Act and associated regulations (2018) provide for the listing of habitat critical - habitat 'critical to the survival of the threatened species. To date no habitat critical in WA has been listed under either Act.

[4] Further background information on BIA and identification of critical habitat in recovery plans is provided in **Section 5.4**.

Table 6-3: Biologically important areas/critical habitats and geographic locations - reptiles

Species	Scientific name	Aggregation area and use	BIAs within EMBA	Habitat Critical within EMBA
Loggerhead turtle	*Caretta caretta*	Nesting, migration, foraging and internesting – Islands and coastline of the Kimberley region and islands of the North West Shelf, Ningaloo coast and Jurabi coast	Cohen Island De Grey River to Bedout Island Dirk Hartog Island Gnarloo Bay James Price Point Lowendal Island Montebello Island Muiron Island Ningaloo Coast and Jurabi coast Rosemary Island Western Joseph Bonaparte Depression	Exmouth and Ningaloo coast Gnaraloo Bay and beaches Shark bay, all coastal and island beaches out the to the northern tip of Dirk Hartog Island
Green turtle	*Chelonia mydas*	Nesting, migration foraging, aggregation, mating, basking and internesting – Offshore islands in the Browse Basin, North West Shelf and Kimberley/Pilbara coastlines Mating/nesting – Dampier Archipelago Basking – Middle Island	Ashmore Reef Barrow Island Browse Island Cartier Island Cassini Island Coral reef habitat west of the Montebello group. Extends the entire length of Montebellos Dampier Archipelago (islands to the west of the Burrup Peninsula) De Grey River area to Bedout Island Delambre Island Dixon Island Greens - inshore tidal and shallow subtidal areas around Barrow Island Hawksbills - shallow water coral reef and artificial reef (pipeline) habitat James Price Point Joseph Bonaparte Gulf Lacepede Island Legendre Island, Huay Island Middle Is. West Coast Barrow Island West Coast and North Coast Montebello Island - Hermite Island, NW Island, Trimouille Island Montebello Islands Montgomery Reef	Mainland east of Mary island to mainland adjacent to Murrara Island including all offshore islands Ashmore Reef and Cartier Reef Browse Island Scott Reef Adele Island Lacepede Island Dampier Archipelago Barrrow Island Montebello Islands Serrier Island and Thevenard Island Exmouth Gulf and Ningaloo Coast

Species	Scientific name	Aggregation area and use	BIAs within EMBA	Habitat Critical within EMBA
			North and South Muiron Island North Turtle Island North West Cape Scott Reef Scott Reef - Sandy Islet Seringapatam Reef String of islands between Cape Preston and Onslow, inshore of Barrow Is	
Hawksbill turtle	*Eretmochelys imbricata*	Nesting, migration, mating, foraging and internesting – Offshore islands in the Browse Basin, North West Shelf and Kimberley/Pilbara coastlines Mating/ nesting/ internesting – Lowendal group, Montebello Islands	Ah Chong and South East Island Ashmore Reef Barrow Island Cartier Island Dampier Archipelago (islands to the west of the Burrup Peninsula) De Grey River area to Bedout Is Delambre Island Delambre Island (and other Dampier Archipelago Islands) Dixon Island Greens - inshore tidal and shallow subtidal areas around Barrow Island Hawksbills - shallow water coral reef and artificial reef (pipeline) habitat Lowendal Island Group Montebello Island - Hermite Island, NW Island, Trimouille Island Montebello Island, Trimoulle and NW islands Ningaloo coast and Jurabi coast Rosemary Island Scott Reef String of islands between Cape Preston and Onslow, inshore of Barrow Island Thevenard Island Varanus Island	Cape Preston to mouth of Exmouth Gulf (including Montebello Islands and Lowendal Islands) Dampier Archipelago (including Delambre Island and Rosemary Island)
Flatback turtle	*Natator depressus*	Nesting, migration, mating, aggregation, foraging, internesting – Islands of the North West	Eighty Mile beach Barrow Island Cape Domett	Cape Domett and Lacrosse Island Lacepede Islands

Species	Scientific name	Aggregation area and use	BIAs within EMBA	Habitat Critical within EMBA
		Shelf and the Pilbara/Kimberley coastlines Mating, nesting – Barrow Island	Cape Thouin/ Mundabullangana/ Cowrie Beach Coral reef habitat west of the Montebello group. Extends the entire length of Montebellos Dampier Archipelago (islands to the west of the Burrup Peninsula) De Grey River area to Bedout Island Delambre Island Dixon Island Holothuria Zone (Northern Kimberley, Holothuria Banks) Intercourse Island James Price Point Lacepede Island Legendre Island, Huay Is Montebello Island - Hermite Island, NW Island, Trimouille Island North Turtle Island Port Hedland, Cemetery Beach Port Hedland, Paradise Beach Port Hedland, Pretty Pool String of islands between Cape Preston and Onslow, inshore of Barrow Is The main nesting beach at Cape Domett is a 1.9-km-long north-west-facing sandy beach on the east of the Cambridge Gulf, East Kimberley, Western Australia (14 48.10S, 128 24.50E), located approximately 80 km north-north-east of the nearest town, Wyndham. Thevenard Island - South coast West of Cape Lambert Western Joseph Bonaparte Depression	Eighty Mile beach Cemetary beach Eco Beach Mundabullangana Beach Dampier Archipelago Barrow Island, Montebello Island, coastal islands from Cape Preston to Locker Island
Leatherback turtle	*Dermochelys coriacea*	None within EMBA	None within EMBA	None within EMBA

Species	Scientific name	Aggregation area and use	BIAs within EMBA	Habitat Critical within EMBA
Olive ridley turtle	*Lepidochelys olivacea*	Foraging, migration – Joseph Bonaparte Gulf – Kimberley region	Western Joseph Bonaparte Depression	Cape Leveque Prior Point and Llanggi Darcy Island Vulcan Island

7. Marine Mammals

Forty-four species of listed marine mammals are known to occur in Australian waters in the EMBA, according to the Protected Matters search (**Appendix A**). An examination of the species profile and threats database (DAWE 2020a) showed that some listed mammal species are not expected to occur in significant numbers in the marine and coastal environments in the EMBA due to their terrestrial distributions. Hence, these species are not discussed further.

Of the remaining listed species, five are listed as threatened and migratory, one is listed as threatened and ten are listed as migratory under the Commonwealth EPBC Act (BIAs for marine mammals are discussed in **Table 7-3**). These species are shown in **Table 7-1** along with their conservation listing under the WA BC Act (as applicable).

The section below gives further details on marine mammal species listed as threatened and migratory and a summary is presented in **Table 7-2**. Identified BIAs are presented in **Table 7-3**.

Santos

Table 7-1: Marine mammals listed as threatened or migratory under the EPBC Act

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999 (Cwth)	BC Act 2016 (WA)	Other WA Conservation Code		
Sei whale (*Balaenoptera borealis)*	Vulnerable Migratory	Endangered	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Blue whale (*Balaenoptera musculus)*	Endangered Migratory	Endangered	-	Foraging, feeding or related behaviour known to occur within area	Yes – Refer to **Table 7-3**
Fin whale (*Balaenoptera physalus)*	Vulnerable Migratory	Endangered	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Southern right whale (*Eubalaena australis)*	Endangered Migratory	Vulnerable	-	Breeding known to occur within area	Yes – Refer to **Table 7-3**
Humpback whale (*Megaptera novaeangliae)*	Vulnerable Migratory	Specially protected (special conservation interest)	-	Breeding known to occur within area	Yes – Refer to **Table 7-3**
Sperm whale (*Physeter macrocephalus)*	Migratory	Vulnerable	-	Foraging, feeding or related behaviour known to occur within area	Yes – Refer to **Table 7-3**
Antarctic minke whale (*Balaenoptera bonaerensis)*	Migratory	-	-	Species or species habitat likely to occur within area	None - No BIA defined
Bryde's whale (*Balaenoptera edeni)*	Migratory	-	-	Species or species habitat likely to occur within area	None - No BIA defined
Pygmy right whale (*Caperea marginate)*	Migratory	-	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Killer whale (*Orcinus orca)*	Migratory	-	-	Species or species habitat may occur within area	None - No BIA defined

Species	Conservation Status			Likelihood of occurrence in EMBA	BIA in EMBA
	EPBC Act 1999 (Cwth)	BC Act 2016 (WA)	Other WA Conservation Code		
Indo-Pacific humpback dolphin (*Sousa chinensis*)	Migratory	-	-	Breeding known to occur within area	Yes – Refer to **Table 7-3**
Spotted bottlenose dolphin (Arafura/ Timor Sea Populations) *(Tursiops aduncus)*	Migratory	-	-	Species or species habitat likely to occur within area	Yes – Refer to **Table 7-3**
Irrawaddy dolphin (Australian snubfin dolphin) *(Orcaella heinsohni)*	Migratory	-	P4	Species or species habitat known to occur within area	Yes – Refer to **Table 7-3**
Dusky dolphin (*Lagenorhynchus obscurus)*	Migratory	-	-	Species or species habitat likely to occur within area	None - No BIA defined
Australian sea lion (*Neophoca cinerea)*	Vulnerable	Vulnerable	-	Breeding known to occur within area	Yes – Refer to **Table 7-3**
Dugong (*Dugong dugon)*	Migratory	Specially protected (species otherwise in need of special protection)	-	Breeding known to occur within area	Yes – Refer to **Table 7-3**

In addition, the New Zealand fur-seal *(Arctocephalus forsteri)*, has been identified as a species of relevance to the EMBA. The New Zealand fur seal is listed as a protected species under WA BC Act (other specially protected), but not listed as threatened under the EPBC Act.

7.1 Threatened and Migratory Species

7.1.1 Sei Whale

Sei whales have a worldwide, oceanic distribution, ranging from polar to tropical waters. Sei whales tend to be found further offshore than other species of large whales (Bannister *et al*. 1996).

Sei whales move between Australian waters and Antarctic feeding areas; however, they are only infrequently recorded in Australian waters (Bannister *et al*. 1996) and their movements and distribution in Australian waters is not well known (DAWE 2020a). There are no known mating or calving areas in Australian waters (Parker 1978 in DAWE 2020a). The National Conservation Values Atlas currently record no BIAs for this species (DAWE 2020b). Surveys of the Bonney Upwelling (outside of the EMBA) between 2000 and 2003 recorded sightings of sei whales feeding during summer and autumn, indicating that this is potentially an important feeding ground (DAWE 2020b).

7.1.2 Blue Whale

Two sub-species of blue whale are recorded in Australian waters: the southern (or true) blue whale (*Balaenoptera musculus intermedia*) and the pygmy blue whale (*Balaenoptera musculus brevicauda*). Southern blue whales are believed to occur in waters south of 60°S and pygmy blue whales occur in waters north of 55°S (i.e. not in the Antarctic) (DEWHA 2008a). By this definition all blue whales in waters from Busselton to the NT border are assumed to be pygmy blue whales and are discussed below.

Pygmy blue whales have a southern hemisphere distribution, migrating from tropical water breeding grounds in winter to temperate and polar water feeding grounds in summer (Bannister *et al*. 1996, Double *et al*. 2014). The WA migration path takes pygmy blue whales down the WA coast to coastal upwelling areas along southern Australia (Gill 2002) and south at least as far as the Antarctic convergence zone (Gedamke *et al*. 2007).

Tagging surveys have shown pygmy blue whales migrating northward relatively near to the Australian coastline (100 km) until reaching North West Cape after which they travelled offshore (240 km) to Indonesia. Passive acoustic data documented pygmy blue whales migrating along the Western Australian shelf break (Woodside 2012). Tagging data collected by Gales *et al.* (2010) has provided the first definitive link between the blue whales that feed off the Perth Canyon and those that occur around Indonesia. This is movement is concordant with the proposed 'Tasmania to Indonesia' population described by Branch *et al.* (2007).

The northern migration passes the Perth Canyon from January to May and north bound animals have been detected off Exmouth and the Montebello Islands between April and August (Double *et al*. 2012a, McCauley & Jenner 2010). During the southern migration, pygmy blue whales pass south of the Montebello Islands and Exmouth from October to the end of January, peaking in late November to early December (Double *et al*. 2012b). Generally, they appear to travel as individuals or in small groups based on acoustic data. For example, analysis of pygmy blue whale calls from noise loggers deployed around Scott Reef (2006 to 2009) for the Woodside Browse project showed that 78% of the calls were from lone whales, 18% were from two whales and 4% were from three or more whales (McCauley 2011; Woodside 2014).

Pygmy blue whales appear to feed regularly along their migration route (i.e. at least once per week or more frequently) and are likely to have multiple food caches along their migratory route (e.g. Rowley Shoals and Ningaloo Reef) (ConocoPhillips 2018).

Recognised feeding areas of significance to this species, located within the EMBA include Ningaloo Reef and the Perth Canyon (DoE 2015a). The Ningaloo Reef area has the capacity to offer feeding opportunities to pygmy blue whales through unique biophysical conditions able to support large biomasses of marine species (Double *et al*. 2014). Surface lunge feeding of pygmy blue whales has been observed at North West Cape and Ningaloo Reef in June (C. Jenner & M-N Jenner, unpublished data, 2001 in Double *et al*. 2014). Outside of the recognised feeding areas, possible foraging areas for pygmy blue whales include the greater region around the Perth Canyon, off Exmouth and Scott Reef in WA (DoE 2015a). These steep gradient features tend to stimulate upwelling and, therefore increased productivity (seasonally variable) (ConocoPhillips 2018). Hence, they provide a favourable foraging area.

Breeding areas have not yet been identified; however, it is likely that pygmy blue whales calve in tropical areas of high localised production such as deep offshore waters of the Banda and Molucca Seas in Indonesia (Double *et al*. 2014, DAWE 2020a). There are no known breeding areas of significance to blue whales in waters from Busselton to the NT border.

The BIAs for blue whale and pygmy blue whale are detailed in **Table 7-3** and depicted in **Figure 7-1** and **Figure 7-2.**

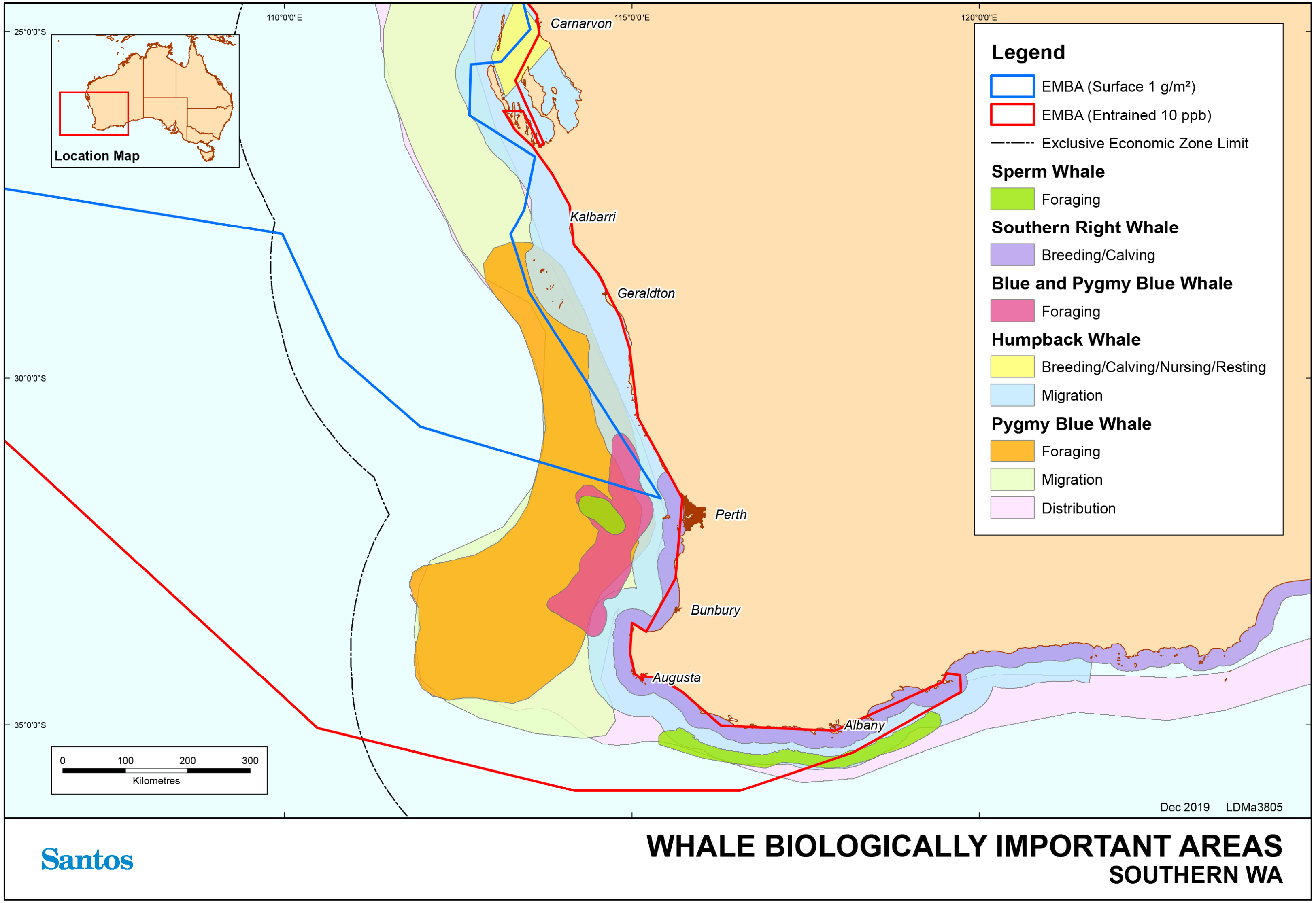

Figure 7-1: Biologically important areas – whales – Southern WA

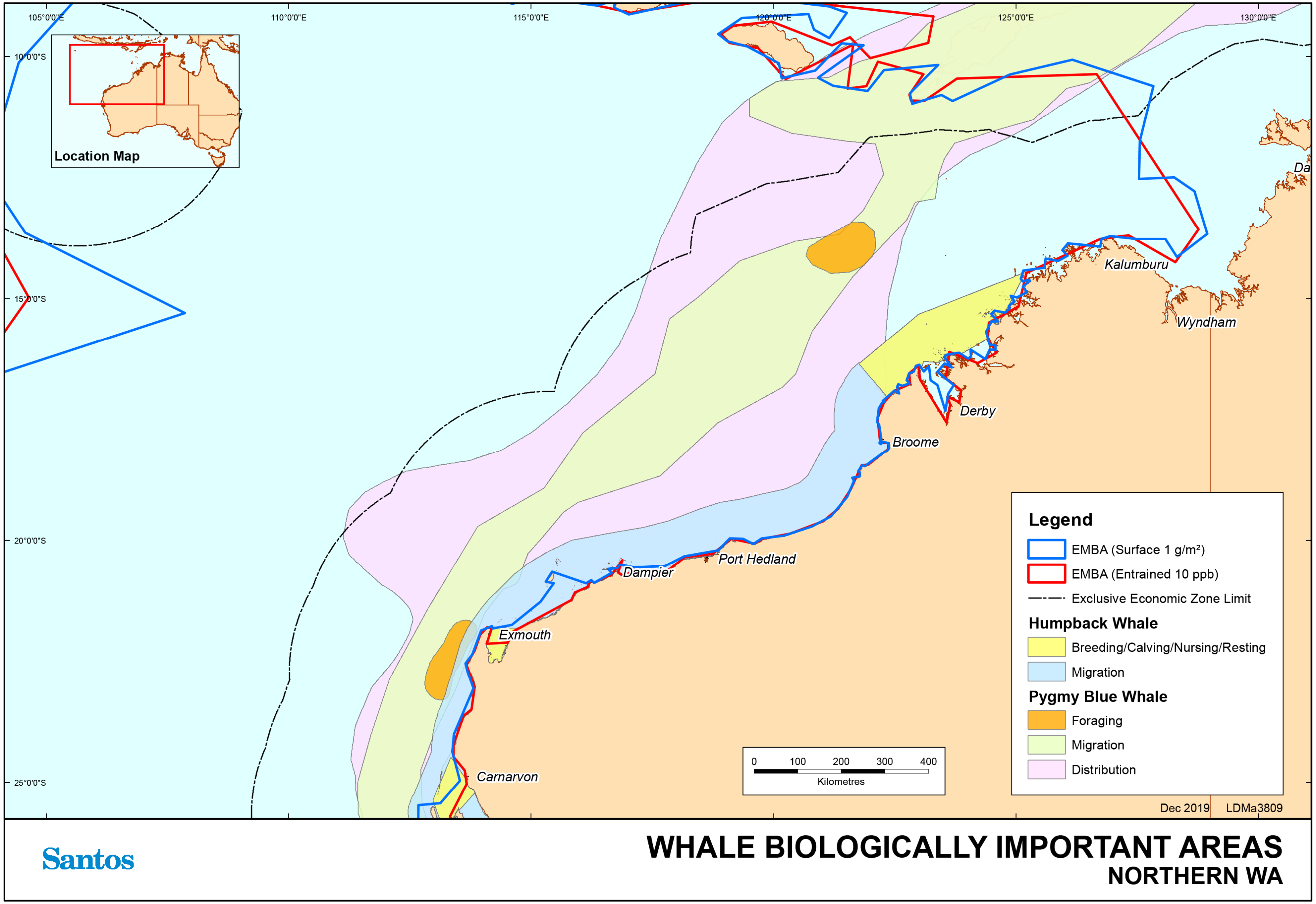

Figure 7-2: Biologically important areas – whales – Northern WA

7.1.3 Fin Whale

Fin whales have a worldwide distribution generally in deeper waters, with oceanic migrations between warm water breeding grounds and cold water feeding grounds.

The fin whale distribution in Australia is not clear due to the sparsity of sightings. Information is known primarily from stranding events and whaling records. According to the Species Profile and Threats database (DAWE 2020a); fin whales are thought to be present from Exmouth, along the southern coastline, to southern Queensland.

Migration paths are uncertain but are not thought to follow Australian coastlines (Bannister *et al*. 1996). There is insufficient data to prescribe migration times for fin whales. During summer and autumn this species has been recorded acoustically at the Rottnest Trench.

There are no known mating or calving areas in Australian waters (DoEE 2019a) and no BIAs for the fin whale are currently identified by the National Conservation Values Atlas (DAWE 2020b).

7.1.4 Southern Right Whale

The southern right whale is present in the southern hemisphere between approximately 30° and 60°S. The species feeds in the Southern Ocean in summer, moving close to shore in winter.

In Australian waters, southern right whales range from Perth, along the southern coastline, to Sydney. Sightings have been recorded as far north as Exmouth although these are rare (Bannister *et al*. 1996).

BIAs including calving and aggregation areas are recorded for this species along the southern coastline of Australia (DAWE 2020b). Details on the BIA for southern right whale are provided in **Table 7-3** and depicted in **Figure 7-1**.

7.1.5 Humpback Whale

Humpback whales have a worldwide distribution, migrating along coastal waters from polar feeding grounds to subtropical breeding grounds. Geographic populations are distinct and at least six southern hemisphere populations are thought to exist based on Antarctic feeding distribution and the location of breeding grounds on either side of each continent (Bannister *et al*. 1996). The population of humpback whales migrating along the WA coastline was recently estimated to be greater than 33,000 whales and likely increasing at exceptionally high growth rates between 10–12% (Hedley *et al*. 2011, Salgado Kent *et al*. 2012).

The west coast Australian humpback whale population migrates from Southern Polar Ocean ‘summer’ feeding grounds to their northern tropical ‘winter’ calving/ breeding grounds in coastal waters of the Kimberley. The northern migration tends to follow deeper waters of the continental shelf, whilst the southward migration concentrates whales closer to the mainland (Jenner *et al*. 2001). Recent satellite tagging of southbound humpback whales indicate that whales generally migrated close to the coastline, within a few tens of kilometres of shore and in a corridor frequently less than 100 km (Double *et al*. 2010). Aerial surveys and noise logger recordings undertaken for Chevron’s Wheatstone Project indicated that the main distribution of humpback whales was sighted at an average distance of 50 km from the mainland during the northern migration and 35 km during the southbound migration (RPS 2010a).

The precise timing of the migration varies between years by up to six weeks, influenced by water temperature, sea ice distribution, predation risk, prey abundance and the location of feeding grounds (DEWR 2007).

Peak northward migration across the North West Shelf is identified as from late July to early August, and peak southward migration from late August to early September (DoEE 2015c). Data collected between 1995 and 1997 by the Centre for Whale Research indicates that the period for peak northern migration into the calving grounds in the Kimberley is mid to late July. The peak for southern migration is in the first half of September (Jenner *et al.* 2001). Actual timing of annual migration may vary by as much as three weeks from year to year due to food availability in the Antarctic (DMP 2003).

Satellite tagging data collected for migrating northbound humpback whales identified a consistent narrow inshore distribution, unlike the southward migration. There was little evidence that the whales tended to venture further from shore and into deeper water at any point on their northward migration. Whales were seen with calves off the North West Cape outside the 'calving grounds; of Lacepede Islands to Camden Sound. This indicates some potential for this area being used as a 'calving site' as well as a migratory corridor. Consequently, the region from the Lacepede Islands to Camden Sound should not be seen as the exclusive 'calving ground' for this population (Double *et al.* 2012b).

Details on the BIA for humpback whales are provided in **Table 7-3** and depicted in **Figure 7-1** and **Figure 7-2**.

7.1.6 Sperm Whale

Sperm whales typically occur in WA along the southern coastline between Cape Leeuwin and Esperance (Bannister *et al.* 1996). Sperm whales are distributed worldwide in deep waters (greater than 200 m) off continental shelves and sometimes near shelf edges, averaging 20 to 30 nautical miles offshore (Bannister *et al.* 1996). The sperm whale is known to migrate northwards in winter and southwards in summer, however, detailed information on the distribution of sperm whales is not available for the timing of migrations. Sperm whales have been recorded in deep water off the North West Cape on the west coast of Western Australia (RPS 2010b) and appear to occasionally venture into shallower waters in other areas (RPS 2010b). Details on the BIA for sperm whales are provided in **Table 7-3** and are shown in **Figure 7-1.**

7.1.7 Antarctic Minke Whale

The Antarctic minke whale is distributed throughout the Southern Hemisphere from 55°S to the Antarctic ice edge during the austral summer and has been recorded in all Australian States (Bannister et al. 1996; Perrin & Brownell 2002). Detailed information on timing and location of migrations and breeding grounds on the west coast of Australia is largely unknown. However, it is believed that the Antarctic minke whale migrates up the WA coast to approximately 20°S during Australian winter to feed and possibly breed (Bannister *et al.* 1996).

7.1.8 Bryde's Whale

The Bryde's whale is found all year round in tropic and temperate waters (Kato 2002). Two forms are recognised: inshore and offshore Bryde's whales. It appears that the inshore form is restricted to the 200 m depth isobar whilst the offshore form is found in deeper waters of 500-1,000 m (DoEE 2019c). Both forms are expected to be found in zones of upwelling where they feed on shrimp like crustaceans (Bannister *et al.* 1996). Little is known about the population abundance of Bryde's whale, the location of exact breeding and calving grounds and large-scale migration patterns (DoEE 2019c). It is however, suggested that the offshore form migrates seasonally, heading towards warmer tropical waters during the winter.

7.1.9 Pygmy Right Whale

The pygmy right whale is considered the most elusive baleen whale and as a result very little is known about the whale's distribution in Australian waters. Records of the pygmy right whale in Australian waters are distributed between 32°S and 47°S and are restricted in the west by the Leeuwin current (Kemper 2002). It is possible that the pygmy right whale will be encountered in the southern extent of the EMBA, particularly in coastal areas of upwelling (Kemper 2002).

7.1.10 Killer Whale

The killer whale has a widespread global distribution and has been recorded in waters of all Australian states/territories (Bannister *et al.* 1996). Whilst more commonly found in cold, deeper waters, killer whales have been observed along the continental slope, shelf and shallow coastal areas of WA. Killer whales are known to make seasonal movements and are most likely to follow the migratory routes of their prey.

7.1.11 Indo-Pacific Humpback Dolphin

The Indo-pacific humpback dolphin is typically found in water less than 20 m deep but has been recorded in waters up to 40 m deep. This species is generally found in association with river mouths, mangroves, tidal channels and inshore reefs (DoEE 2016a). This species of dolphin is known to have resident groups that forage, feed, breed and calve in the state waters of Roebuck Bay, Dampier Peninsula, King Sound north, Talbot Bay, Anjo Peninsula, Vansittart Bay, Napier Broome Bay and Deception Bay (DoEE 2016a).

The Indo-Pacific humpback dolphin BIA in the EMBA is detailed in **Table 7-3** and shown on **Figure 7-3**.

7.1.12 Spotted Bottlenose Dolphin (Indo-Pacific bottlenose dolphin)

The spotted bottlenose dolphin (*Tursiops aduncus*) (Arafura/ Timor Sea populations) is generally considered to be a warm water subspecies of the spotted bottlenose dolphin, occurring in shallow (often <10 m deep) inshore waters (Bannister et al., 1996; Hale et al., 2000). The known distribution of the spotted bottlenose dolphin extends from Shark Bay north to the western edge of the Gulf of Carpentaria in Australia (DoEE 2016b). The spotted bottlenose dolphin BIA in the EMBA is detailed in **Table 7-3** and shown on **Figure 7-3**.

7.1.13 Irrawaddy Dolphin (Australian Snubfin Dolphin)

The Irrawaddy dolphin, also known as the snubfin dolphin (*Orcaella heinsohni*) is known to occur within the waters off northern Australia, extending north from Broome in Western Australia to the Brisbane River in Queensland (DoEE 2016c). Surveys have indicated that the species is typically found in protected shallow nearshore waters, generally less than 20 m deep, adjacent to river and creek mouths close to seagrass beds (DoEE 2016c). The snubfin dolphin was not recorded during any of the aerial surveys undertaken along the Dampier Peninsula coastline in the vicinity of James Price Point but were observed in Roebuck Bay from vessels on several occasions (RPS, 2010b). Based on the extensive survey effort and amenable conditions within the James Price Point coastal area during the survey, it is concluded that this species is seldom found outside of shallow and sheltered bays and inlets (DSD 2010). The Irrawaddy dolphin BIA in the EMBA is detailed in **Table 7-3** and shown on **Figure 7-3.**

7.1.14 Dusky Dolphin

The dusky dolphin's distribution is strongly linked to colder waters. In Australia, the dusky dolphin has been sighted in southern Australia from WA to Tasmania. It is presumed to be primarily an inshore species but has been known to move further offshore, possibly due to its desire for colder waters (Gill *et al.* 2000). Dusky dolphins are expected to be limited in their distribution along the WA coastline due to the presence of the southward-flowing warm water of the Leeuwin Current.

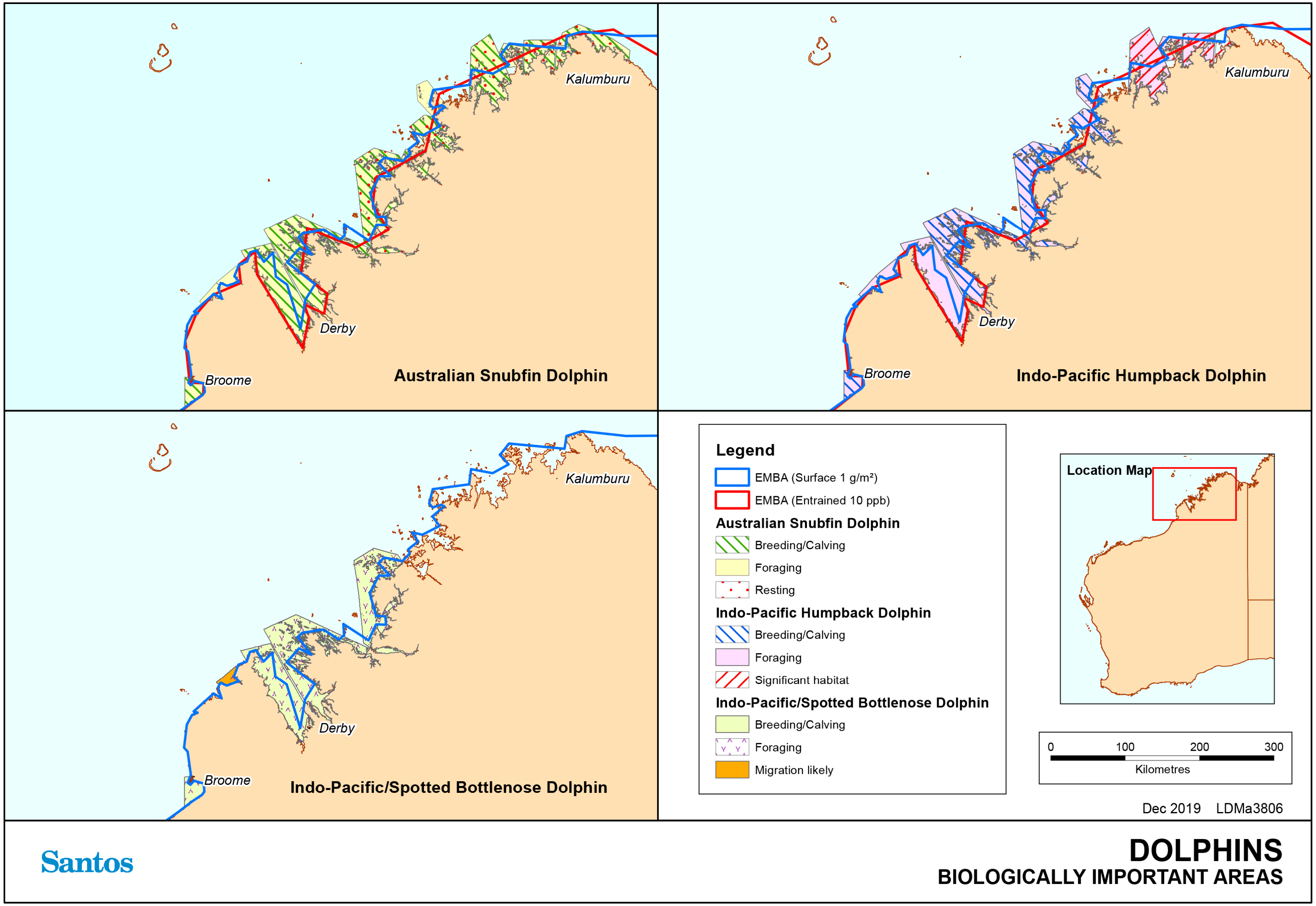

Figure 7-3: Biologically important areas – dolphins

7.1.15 Australian Sea Lion

The Australian sea lion is endemic to Australia. Breeding colonies are found only in South Australian and Western Australian waters. There are currently 76 known Australian sea lion pupping locations along the coast and offshore islands between the Houtman Abrolhos Islands in Western Australia to the Pages Islands in South Australia (DSEWPaC 2013c). The species has also been recorded at Shark Bay (DoE 2014a).

BIAs for foraging, haul-out and breeding sites identified by the National Conservation Values Atlas are located south of the waters from Busselton to the NT border (DAWE 2020b). Male Australian sea lions have been recorded foraging in areas up to 60 km away from their birth colonies, with potentially larger dispersal ranges up to 180 km (Hamer *et al*. 2011). However, female Australian sea lions have restricted home ranges, with high rates of natal site fidelity and limited gene flow with other regions (Campbell 2005). The Australian sea lion BIA in the EMBA is outlined in **Table 7-3** and is depicted in **Figure 7-4.**

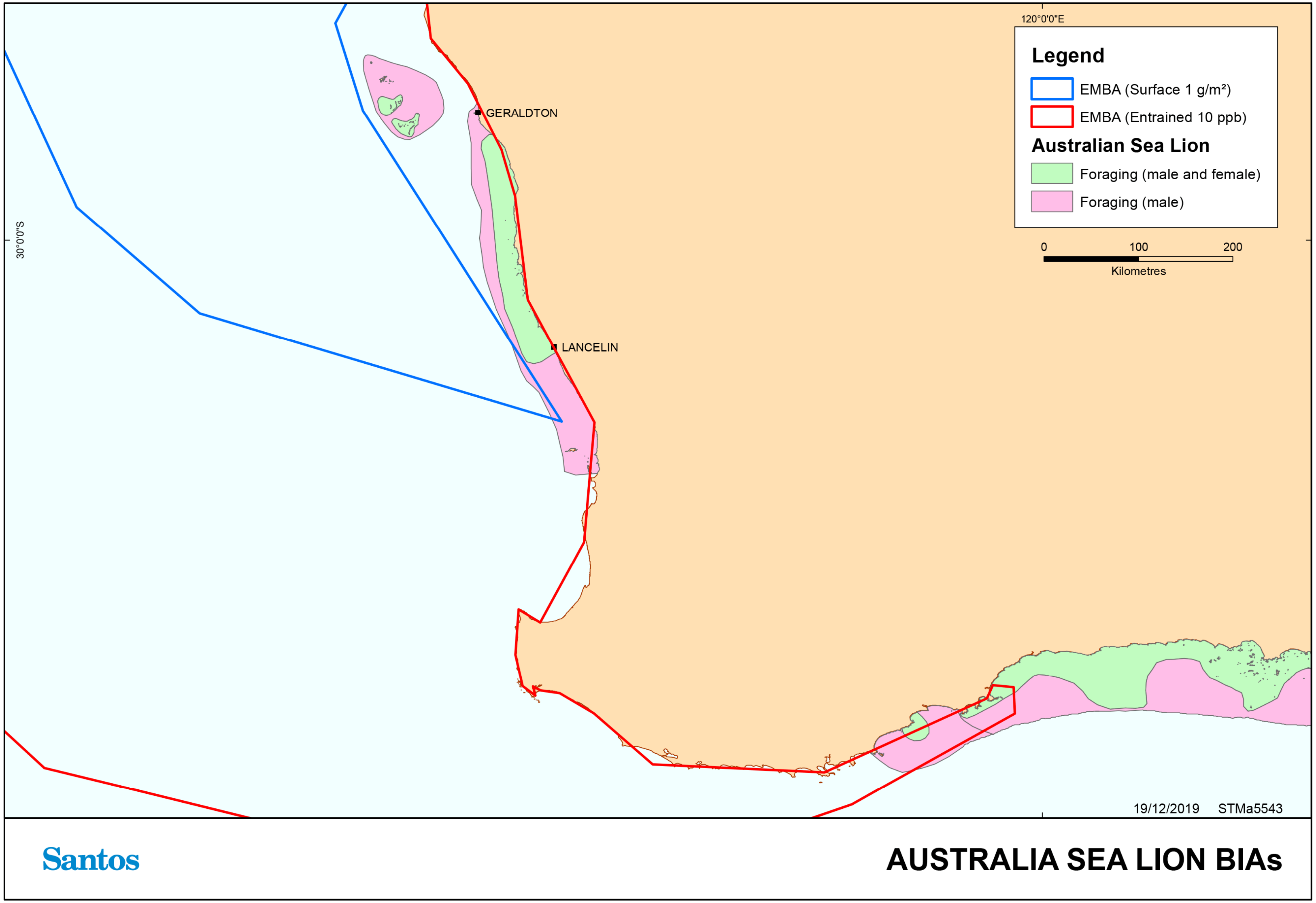

Figure 7-4: Biologically important areas – Australian sea lion

7.1.16 Dugongs

Dugongs (*Dugong dugon*) are large herbivorous marine mammals (up to 3 m) that feed off seagrass and generally inhabit coastal areas. Key populations along the WA coast are principally located at: Shark Bay (the largest resident population in Australia), Ningaloo Marine Park and Exmouth Gulf, the Pilbara coast and offshore areas including Montebello/ Barrow/ Lowendal Islands, and further north at Eighty Mile Beach and off the Kimberley Coast, particularly Roebuck Bay and Dampier Peninsula (Marsh *et al*. 2002; DSEWPaC 2012). Populations are also present at Ashmore Reef. Dugong distribution and movement is based on the abundance, size and species of seagrass meadow. Dugongs can migrate hundreds of kilometres between seagrass habitats. The dugong BIAs in the EMBA are detailed in **Table 7-3** and shown in **Figure 7-5**.

7.1.17 New Zealand fur-seal

The New Zealand fur-seal (also known as the long-nosed fur seal) (*Arctocephalus forsteri*) is a specially protected species (other specially protected) under the BC Act. The New Zealand fur seal is found in Ngari Capes Marine Park (two colonies) and along other parts of Australia's southern coast.[5]

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[5] Identified as a relevant species through review of *Biodiversity Conservation Act 2016* listed species for marine species without an EBPC Act listing.

Figure 7-5: Biologically important areas – dugongs

Table 7-2: Summary of information for marine mammals listed as threatened under the EPBC Act

Aspect	Sei whale	Blue and pygmy blue whales	Fin whale	Southern right whale	Humpback whale	Australian sea lion
Species expected in area	Unknown	Yes	Unknown	Unlikely, southern distribution	Yes	Unlikely, southern distribution
Migration depth (m)	Unknown, prefers offshore waters	500-1,000	Unknown	n/a	Up to 100	n/a
Migration seasonality	Unknown	Apr to Aug (north), Oct to Jan (south)	Unknown	n/a	Jun to Nov	n/a

7.2 Biologically Important Areas / Critical Habitat – Marine Mammals

Table 7-3 below provides an overview of BIAs in the EMBA for marine mammals

The DAWE may also make recovery plans for threated fauna listed under the EPBC Act. The EPBC Act requires that 'habitat critical to the survival of the listed threatened species' is identified in recovery plans, relevant recovery plans are listed in **Section 13.2**[6].

In addition, both the EPBC Act and WA BC Act and associated regulations (2018) provide for the listing of critical habitat - habitat 'critical to the survival of the threatened species'. To date no critical habitat in WA has been listed under either Act.

Table 7-3: Biologically important areas – marine mammals

Species	Scientific name	Aggregation area and use	BIAs within EMBA
Blue and pygmy blue whales	*Balaenoptera musculus*	Migration – along the continental shelf edge off the WA coastline, extending offshore near Scott Reef and into Indonesian waters Foraging – along Ningaloo reef, around Scott Reef, around the Perth canyon	Blue and pygmy blue whale - Head of the Perth Canyon Outer continental shelf from Cape Naturaliste to south of Jurien Bay Outer Perth Canyon Head of the Perth Canyon Pygmy blue whale - Augusta to Derby. Tend to pass along the shelf edge at depths of 500 m to 1000 m; appear close to coast in the Exmouth-Montebello Islands area on southern migration. From Mandurah to south of Cape Naturaliste, seaward to the 50 m depth contour Indonesia- Banda Sea Ningaloo Perth canyon Scott Reef

[6] Further background information on BIA and identification of critical habitat in recovery plans is provided in **Section 5.4**.

Species	Scientific name	Aggregation area and use	BIAs within EMBA
Southern right whale	*Eubalaena australis*	Breeding/calving – along the south west and southern coastline of WA/SA	Bunbury area, WA Camac Island/Fremantle, WA Coast Cape Naturaliste to Cape Leeuwin Coast Perth region to Cape Naturaliste Geographe Bay, WA Perth to Kangaroo Island
Humpback whale	*Megaptera novaeangliae*	Breeding/calving/nursing/resting – Kimberley/Coastal North Lacepede Island, Campden Sound, Exmouth Gulf, Shark Bay Migration - northern migration deeper waters of the continental shelf, southward migration – along the WA mainland	Cape Leeuwin to Houtman Abrolhos Cape Naturaliste Cape Naturaliste to Cape Leeuwin Exmouth Gulf Flinders Bay Geographe Bay Houtman Abrolhos Islands Kimberley/Coastal North Lacepede Island, Camden Sound North of Houtman Abrolhos Shark Bay The migration corridor extends from the coast to out to approximately 100 km offshore in the Kimberley region extending south to North West Cape. From North West Cape to south of shark Bay the migration corridor is reduced to approximately 50 km. West coast - Lancelin to Kalbarri West coast- Bunbury to Lancelin including Rottnest Island
Sperm whale	*Physeter macrocephalus*	Foraging - west end of Perth Canyon and Albany Canyons	Western end of Perth canyon Albany Canyons - Immediately south of the continental shelf edge extending over the continental slope
Indo-Pacific humpback dolphin	*Sousa chinensis*	Breeding, calving, foraging – Kimberley coastal waters and islands Significant habitat – unknown behavior – Admiralty Gulf & Parry Harbour and Bougainville Peninsula Significant habitat - Vansittart Bay, Anjo Peninsula	Admiralty Gulf & Parry Harbour Bougainville Peninsula Camden Sound Area - Walcott Inlet, Doubtful Bay, Deception Bay, Augustus Island (Kuri Bay) Carnot & Beagle bay King Sound North and Yampi Sound and Talbot Bay Fjord area near Horizontal Falls King Sound Southern Sector Maret and Biggee Island Pender bay Port Nelson, York Sound, Prince Frederick Harbour Prince Regent River Roebuck Bay Vansittart Bay, Anjo Peninsula Willie Creek

Species	Scientific name	Aggregation area and use	BIAs within EMBA
Indo-Pacific/spotted bottlenose dolphin	*Tursiops aduncus*	Breeding, calving, foraging – Kimberley coastal waters and islands Migration – Pender Bay	Camden Sound Area - Walcott Inlet, Doubtful Bay, Deception Bay, Augustus Island (Kuri Bay) King Sound North and Yampi Sound and Talbot Bay Fjord area near Horizontal Falls King Sound Southern Sector Pender bay Roebuck Bay
Irrawaddy dolphin (Australian snubfin dolphin)	*Orcella heinsohni*	Breeding, calving, foraging, resting– Kimberley coastal waters and islands	Admiralty Gulf and Parry Harbour Bougainville Peninsula Camden Sound Area - Walcott Inlet, Doubtful Bay, Deception Bay, Augustus Island (Kuri Bay) Cape Londonderry and King George River Carnot and Beagle bay King Sound North and Yampi Sound and Talbot Bay Fjord area near Horizontal Falls King Sound Southern Sector Maret and Biggee Island Ord River Pender bay Port Nelson, York Sound, Prince Frederick Harbour Prince Regent River Roebuck Bay Vansittart Bay, Anjo Peninsula Willie Creek
Australian sea lion	*Neophoca cinerea*	Foraging – male and female – Houtman Abrolhos Island, mid-west coast (more restricted spatial extent than males) Foraging – males Houtman Abrolhos Island, mid-west coast down to Perth Breeding – Buller Island, North Fisherman Island, Beagle Island, Albrolhos Island Haul Out Sites – North Cervantes Island, Sandland Island, Albrolhos Island	Houtman Abrolhos Islands Mid-west coast, includes Beagle Island, Fisherman Island, Jurien Bay, Cervantes and Buller Colonies From Recherche Archipelago to Doubtful Islands – Key colonies, Kimberly island, Glenny and Wickham Island. Haul-Off rock
Dugong	*Dugong dugon*	Foraging –Dampier Peninsula, Roebuck Bay, Shark Bay, Exmouth and Ningaloo coastline Migration – Roebuck Bay and North East Peron Peninsula, Shark Bay Breeding/calving/nursing – Exmouth and the Ningaloo coastline	Ashmore Reef - Far West Ashmore Reef - South (located on sea reef side only, not interior) Between Peron Peninsula and Faure Island, Shark Bay Dirk Hartog Island, Shark Bay East of Faure Island, Shark Bay Exmouth Gulf

Species	Scientific name	Aggregation area and use	BIAs within EMBA
			Kimberley coast, Dampier Peninsula Middle Island, Kimberley coast North East Peron Peninsula, Shark Bay North of Faure Island, Shark Bay Pilbara and Kimberley coast near Dampier Peninsula Pilbara and Kimberley coast near James Price Point Roebuck Bay, Broome South Passage, Shark Bay Useless Loop, Shark Bay

8. Birds

Marine waters and coastal habitats in the EMBA contain key habitats that are important to birds, including offshore islands, sandy beaches, tidal flats, mangroves and coastal and pelagic waters. These habitats support a variety of birds which utilise the area in different ways and at different times of the year (DSEWPaC 2012a). Birds can be broadly grouped according to their preferred foraging habitat as coastal/ terrestrial birds, seabirds and shorebirds.

Coastal or terrestrial species inhabit the offshore islands and coastal areas of the mainland throughout the year. These species are either primarily terrestrial, or they may forage in coastal waters. Resident coastal and terrestrial species include osprey (*Pandion cristatus*), white-bellied sea eagle (*Haliaeetus leucogaster*), silver gull (*Larus novaehollandiae*) and eastern reef egret (*Egreta sacra*) (DEWHA 2008a).

Seabirds include those species whose primary habitat and food source is derived from pelagic waters. These species spend the majority of their lives at sea, ranging over large distances to forage over the open ocean. Seabirds present in the area include terns, noddies, petrels, shearwaters, tropicbirds, frigatebirds boobies and albatrosses (DEWHA 2008a).

Shorebirds, including waders, inhabit the intertidal zone and adjacent areas. Some shorebird species, including oystercatchers are resident (Surman & Nicholson 2013). Other shorebirds are migratory and include species that utilise the East Asian–Australasian Flyway, a migratory pathway for millions of migratory shorebirds that travel from Northern Hemisphere breeding grounds to Southern Hemisphere resting and foraging areas. Shorebirds that regularly migrate through the area include the Scolopacidae (curlews, sandpipers etc.) and Charadriidae (plovers and lapwings) families.

Surveys in the area by Santos and other agencies have built a picture of diverse avifauna. A summary of research is discussed below, followed by information on threatened and migratory birds. Wetlands of international importance are discussed in **Section 9.2**.

8.1 Regional Surveys

8.1.1 Abrolhos Islands

The Abrolhos Islands are one of the most significant seabird nesting areas in the eastern Indian Ocean with over two million birds breed on the islands and small rocky atolls in the Abrolhos (DoF 2012). The mixture of species is unique, as subtropical and tropical species, and littoral and oceanic foragers, share the breeding islands. A total of 95 bird species have been recorded as residents or visitors to the Abrolhos Islands. Of these 35 species are known to breed at the Abrolhos (DoF, 2012):

- Common noddy (rookery – Pelseart Island): The Abrolhos supports 80%of the Australian breeding population of the common noddy (*Anous stolidus*) with up to 250,000 common noddies breed at Pelsaert Island. These birds lay their eggs in spring, but the actual month can vary, depending on their food supply and the weather conditions existing in offshore waters (DoF 2012);
- Caspian tern (rookeries – Leo Island, West Wallabi Island and Pelsaert Island): Unlike other more social terns, Caspian terns (*Hydroprogne caspia*) are usually solitary nesters. There are less than 150 of these breeding at the Abrolhos, across 22 islands (DoF 2012);
- Wedge-tailed shearwaters (rookeries): The Abrolhos are the most important breeding sites in Australia for the wedge tailed shearwater (*Ardenna pacifica*), with between 500,000 and 1,000,000 of these birds breeding there every year, predominantly on West Wallabi Island. The wedge-tailed shearwater breeding colonies at the Abrolhos are the largest in Australia (DoF 2012);
- Bridled tern (rookeries – Gun Island, Leo Island, Pelsaert Island, Little North Island, Fisherman Islands, Beagle Islands and Penguin Island): Bridled terns (*Onychoprion anaethetus*) breed on 90 islands throughout the Abrolhos. These birds fly north for the winter, through Indonesia to waters around the Phillippines. There are approximately 4,000 bridled terns who return to the Abrolhos around October every

year to lay their eggs. Bridled terns nest on more islands in the Abrolhos than any other bird species (DoF, 2012);

- Osprey (nesting area – Pelseart Island): Up to 100 eastern ospreys (*Pandion cristatus*) nest at a number of sites throughout all three island groups at the Abrolhos, including nesting platforms made from converted rock lobster pots and stacked fishing equipment on jetties (DoF 2012);
- White-bellied sea eagle (nesting area – West Wallabi Island): At the Abrolhos, there are up to 50 breeding white-bellied sea eagles (*Haliaeetus leucogaster*), spread across all three island groups (DoF 2012);
- Australian lesser noddy (feeding area and rookeries Morley Island, Wooded Island and Pelseart Island): In Australia the Australian lesser noddy is only known to breed in this area and is known to forage between the islands and the continental shelf edge; and
- Other areas rookeries identified for both the wedge-tailed shearwater and bridled tern within the south west area include Lancelin Island, Rottnest Island and Safety Bay.

8.1.2 North West Cape

Avifauna surveys of the North West Cape have recorded 144 bird species, one third of which are seabirds and shorebirds (resident and migratory) (May *et al*. 1983). Approximately 33 species of seabirds and shorebirds are found in the Ningaloo Marine Park with the main breeding areas at Mangrove Bay, Mangrove Point, Point Maud, the Mildura wreck site and Fraser Island (CALM & MPRA 2005a).

8.1.3 Muiron Islands and Exmouth Gulf Islands

Muiron Islands and Exmouth Gulf Islands are generally lacking in published bird observations data. Early indications from surveys commissioned by Santos in 2013/14 indicate that South and North Muiron Islands are regionally significant in terms of wedge-tailed shearwater (*Ardenna pacifica*) nesting, whilst Bessiers and Fly islands are also significant (Surman pers comm. 2013). Nine coastal/terrestrial species and 21 shorebirds were identified on the Muiron and Exmouth Gulf Islands during the first of these surveys and seven bird species were recorded nesting (Surman 2013).

8.1.4 Dampier Archipelago/Cape Preston Region

The Dampier Archipelago/Cape Preston region is a nesting area for at least 16 species of seabirds. Many of the islands and rocks in the area are known breeding grounds for birds, including wedge-tailed shearwaters (*Ardenna pacifica*), Caspian terns (*Sterna caspia*), bridled terns (*Onychoprion anaethetus*) and roseate terns (*Sterna dougallii*). Small islands and islets such as Goodwyn Island, Keast Island and Nelson Rocks provide important undisturbed nesting and refuge sites, and Keast Island provides one of the few nesting sites for pelicans in WA (CALM & MPRA 2005).

8.1.5 Barrow Island Group

Barrow Island and surrounding islands have a diverse avifauna comprising at least 110 species, including 11 resident land birds, eight resident seabirds, 17 seabirds, 22 species of migratory waders, six resident shorebirds and 43 irregular visitors (Surman 2003). The avifauna of Barrow Island is thus poor in terms of land birds and waterfowl compared to mainland areas of the Pilbara, but rich in migratory waders and seabirds. Compared to other nearby offshore islands, Barrow Island has substantially more migratory waders but fewer breeding seabirds (Surman 2003).

8.1.6 Lowendal Island Group and Airlie and Serrurier Islands

The Lowendal Island Group has a diverse avifauna comprising 89 recorded species (Dinara Pty Ltd. 1991, Burbidge *et al*. 2000). Six species of resident land birds and six species of raptors have been recorded at the Lowendal Islands (Surman & Nicholson 2012). Up to fourteen seabird species have been observed at any one time during annual surveys of the Lowendal Islands between 2004 and 2012. Surveys at the Montebello Islands have recorded 70 bird species. This includes 12 species of seabirds and 14 species of migratory shorebirds (Burbidge *et al*. 2000).

Wedge-tailed shearwaters have been identified to nest on Varanus, Airlie, Serrurier and Bridled Islands (Astron 2017a). Breeding participation on the islands appears to be largely influenced by pre-breeding oceanographic conditions (Astron 2017a). Monitoring in 2016/17 was undertaken by Santos and demonstrated the colony sizes for wedge-tailed shearwaters to be within or above previously reported ranges (Astron 2017a). This is informed though monitoring that has been undertaken under the Integrated Shearwater Monitoring Program (ISMP), established in 1994.

In 2016/17, areas of potential wedge-tailed shearwater nesting habitat were recorded on Varanus Island (5.53 ha) and Airlie Island (12.47 ha) and surrounding islands of Bridled (2.94 ha), Serrurier (130.89 ha), Abutilon (2.02 ha) and Parakeelya (1.66 ha) (Astron 2017a). The number of wedge-tailed shearwater breeding pairs was also estimated for each of Varanus (1,492 +/- 702), Airlie (600 +/- 124), Bridled (1,039 +/- 342), Serrurier (23,240 +/- 4,341), Abutilon (317 +/- 210) and Parakeelya (172 +/- 138) islands (Astron 2017a).

Other seabird species utilising Abutilon, Beacon, Bridled and Parakeelya islands for nesting include bridled terns, silver gulls, crested terns and lesser crested terns. Monitoring for these seabirds in 2016/17 was also completed by Santos, with monitoring results concluded to support previous trends for all species. Bridled terns mainly utilise Abutilon, Bridled and Parakeelya islands for breeding, with smaller numbers noted on Beacon and Varanus Islands. The bridled terns have not been recorded on Airlie Island and only in very small numbers on Varanus Island (Astron 2017b).

Silver gull numbers appear to be growing across the region (2010/2011). However, reasons for this are unknown but considered possibly to be due to greater prey availability or immigration from the mainland (Astron 2017b). Silver gulls have been found to utilise Bridled, Parakeelya, Abutilon and Beacon islands longer term for breeding. Silver gulls have not been identified to nest on Varanus island and were only recorded nesting on Airlie island for the first time in 2016/17 since monitoring commencement in 2004/05 (Astron 2017b).

The crested tern and lesser crested tern are noted as nomadic breeders that appear to use a consistent subset of islands for breeding. In 2016/17, Beacon Island was the favourable nesting site for the crested tern and lesser crested tern (Astron 2017b). Surveys in the vicinity of Port Hedland (Bennelongia 2011) recorded 23 species of migratory shorebird between 2002 and 2011. Terrestrial/coastal and seabird species were not targeted. A total of 4,248 migratory shorebirds of 18 species were observed during the field survey in April 2011.

8.2 Threatened Species

A Protected Matters search of the EMBA identified 55 bird species (**Appendix A**) listed as threatened under the EPBC Act.

An examination of the Species Profile and Threats database (DAWE 2020a) and The Action Plan for Australian Birds (Garnet 2011) showed that some listed bird species are not expected to occur in significant numbers in the marine and coastal environments in the EMBA due to their terrestrial or southern distributions. Hence, these species are not discussed further.

EPBC Act threatened species expected to occur in the area are listed in **Table 8-1** along with their WA conservation status (as applicable), and discussed below. There are an additional 44 migratory species listed under the EPBC Act, with these detailed in **Section 8.3** (**Table 8-3**). BIAs for birds are detailed in **Table 8-6** and depicted in **Figure 8-1** and **Figure 8-2**.

Table 8-1: Birds listed as threatened under the EPBC Act

Species	Conservation Status			Likelihood of occurrence in EMBA	BIAs in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code		
Shorebirds					
Red knot (*Calidris canutus)*	Endangered, Migratory	Endangered	-	Species or species habitat known to occur within area	None - No BIA defined
Curlew sandpiper (*Calidris ferruginea)*	Critically endangered, Migratory	Critically endangered	-	Species or species habitat known to occur within area	None - No BIA defined
Great knot (*Calidris tenuirostris)*	Critically endangered, Migratory	Critically endangered	-	Roosting known to occur within area	None - No BIA defined
Greater sand plover (*Charadrius leschenaultii)*	Vulnerable, Migratory	Vulnerable	-	Roosting known to occur within area	None - No BIA defined
Lesser sand plover (*Charadrius mongolus)*	Endangered, Migratory	Endangered	-	Roosting known to occur within area	None - No BIA defined
Western Alaskan bar-tailed godwit (*Limosa lapponica baueri)*	Vulnerable, Migratory[7]	Vulnerable, Specially protected (migratory)[7]	-	Species or species habitat known to occur within area	None - No BIA defined
Northern Siberian bar-tailed godwit (*Limosa lapponica menzbieri)*	Critically endangered, Migratory[7]	Critically endangered, Specially protected (migratory)[7]	-	Species or species habitat known to occur within area	None - No BIA defined
Eastern curlew (*Numenius madagascariensis)*	Critically endangered, Migratory	Critically endangered	-	Species or species habitat known to occur within area	None - No BIA defined
Australasian bittern (*Botaurus poiciloptilus)*	Endangered	Endangered	-	Species or species habitat known to occur within area	Yes – refer to **Table 8-6**
Australian painted snipe (*Rostratula australis)*	Endangered	Endangered	-	Species or species habitat may occur within area	None - No BIA defined

[7] Listed as migratory at species level

Species	Conservation Status			Likelihood of occurrence in EMBA	BIAs in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code		
Seabirds					
Australian lesser noddy (*Anous tenuirostris melanops)*	Vulnerable	Endangered	-	Breeding known to occur within area	Yes – refer to **Table 8-6**
Fairy prion (southern) (*Pachyptila tutur subantarctica)*	Vulnerable	-	-	Species or species habitat known to occur within area	None - No BIA defined
Southern royal albatross (*Diomedea epomophora)*	Vulnerable, Migratory	Vulnerable	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Northern royal albatross (*Diomedea sanfordi)*	Endangered, Migratory	Endangered	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Amsterdam albatross (*Diomedea amsterdamensis*)	Endangered, Migratory	Critically endangered	-	Species or species habitat may occur within area	None - No BIA defined
Antipodean albatross (*Diomedea antipodensis)*	Vulnerable	-	-	Foraging, feeding or related behaviour likely to occur within area	None - No BIA defined
Sooty Albatross (*Phoebetria fusca)*	Vulnerable, Migratory	Endangered	-	Species or species habitat may occur within area	None - No BIA defined
Tristan albatross (*Diomedea dabbenea)*	Endangered, Migratory	Critically endangered	-	Species or species habitat may occur within area	None - No BIA defined
Wandering albatross (*Diomedea exulans)*	Vulnerable, Migratory	Vulnerable	-	Foraging, feeding or related behaviour likely to occur within area	None - BIA not found in EMBA
Christmas island frigatebird (*Fregata andrewsi)*	Endangered, Migratory	Specially protected (migratory)	-	Foraging, feeding or related behaviour known to occur within area	Yes – refer to **Table 8-6**

Species	Conservation Status			Likelihood of occurrence in EMBA	BIAs in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code		
Southern giant petrel (*Macronectes giganteus)*	Endangered, Migratory	Specially protected (migratory)	-	Species or species habitat may occur within area	None - BIA not found in EMBA
Northern giant petrel (*Macronectes halli)*	Vulnerable, Migratory	Specially protected (migratory)	-	Species or species habitat may occur within area	None - BIA not found in EMBA
Abbott's booby (*Papasula abbotti)*	Endangered	-	-	Species or species habitat likely to occur within area	Yes – refer to **Table 8-6**
Soft-plumaged petrel (*Pterodroma mollis)*	Vulnerable	-	-	Foraging, feeding or related behaviour known to occur within area	Yes – refer to **Table 8-6**
Blue petrel (*Halobaena caerulea)*	Vulnerable	-	-	Species or species habitat may occur within area	None - No BIA defined
Australian fairy tern (*Sternula nereis nereis)*	Vulnerable	Vulnerable	-	Breeding known to occur within area	Yes – refer to **Table 8-6**
Indian yellow-nosed albatross (*Thalassarche carteri)*	Vulnerable, Migratory	Endangered	-	Foraging, feeding or related behaviour may occur within area	Yes – refer to **Table 8-6**
Shy albatross (*Thalassarche cauta)*	Endangered, Migratory	Vulnerable	-	Foraging, feeding or related behaviour likely to occur within area	None - BIA not found in EMBA
White-capped albatross (*Thalassarche steadi)*	Vulnerable, Migratory	Vulnerable	-	Foraging, feeding or related behaviour likely to occur within area	None - BIA not found in EMBA
Black-browed albatross (*Thalassarche melanophris)*	Vulnerable, Vulnerable	Endangered	-	Species or species habitat may occur within area	None - BIA not found in EMBA
Campbell albatross (*Thalassarche impavida)*	Vulnerable, Migratory	Vulnerable	-	Species or species habitat may occur within area	None - BIA not found in EMBA

Species	Conservation Status			Likelihood of occurrence in EMBA	BIAs in EMBA
	EPBC Act 1999	BC Act 2016	Other WA Conservation Code		
Christmas Island white-tailed tropicbird (*Phaethon lepturus fulvus)*	Endangered	-	-	Species or species habitat may occur within area	None - No BIA defined

8.2.1 Shorebirds

Red Knot (New Siberian Islands and north-eastern Siberia)

The red knot is a migratory shorebird, and the species includes five subspecies, including two found in Australia, *Calidris canutus piersmai* and *Calidris canutus rogersi*. The red knot breeds in Siberia and spends the non-breeding season in Australia and New Zealand. During the non-breeding season, the species spends the majority of its time on tidal mudflats or sandflats where they feed on intertidal invertebrates, especially shellfish (Garnet *et al.* 2011).

Curlew Sandpiper

This species is a migratory shorebird that breeds in north Siberia and spends the non-breeding season from western Africa to Australia (Bamford *et al.* 2008). The curlew sandpiper occurs around coastal Australia and preferred habitats include coastal brackish lagoons, tidal mud and sand flats, estuaries, saltmarshes and less often inland. Their diet is mainly comprised of polychaete worms, molluscs and crustaceans (Higgins & Davies 1996 in Garnet *et al.* 2011).

Great Knot

The great knot is a migratory shorebird with a global distribution, breeding in north-east Siberia and spending the non-breeding season along coasts from Arabia to Australia. Non-breeding birds migrate to inlets, bays, harbours, estuaries and lagoons with large intertidal mud and sand flats where they feed on bivalves, gastropods, crustaceans and other invertebrates (Higgins & Davies 1996 in Garnet *et al.* 2011).

Greater Sand Plover and Lesser Sand Plover

The greater sand plover and lesser sand plover are congeners that breed in China, Mongolia and Russia. The greater sand plover spends the non-breeding season along coasts from Japan through southeast Asia to Australasia, while the lesser sand plover spends the non-breeding season along coasts from Taiwan to Australasia (Banford *et al*. 2008). Non-breeding birds occur along all Australian coasts, especially in the north for the greater sand plover and in the east for the lesser sand plover (DAWE 2020a).

Non-breeding birds forage on beaches, salt-marshes, coastal bays and estuaries, and feed on marine invertebrates including molluscs, worms, crustaceans and insects (Marchant & Higgins 1993 in Garnet *et al*. 2011).

Bar-tailed Godwit (Western Alaskan and Northern Siberian Subspecies)

Two subspecies of the bar-tailed godwit exist, as determined by their breeding locations in Siberia and Alaska (Bamford *et al*. 2008). Non-breeding birds migrate to the coasts of Australia. The western Alaskan subspecies occurs especially on the north and east coasts of Australia whilst the northern Siberian subspecies occurs especially along the coasts of north Western Australia (DAWE 2020a).

Non-breeding birds are found on muddy coastlines, estuaries, inlets, mangrove-fringed lagoons and sheltered bays, feeding on annelids, bivalves and crustaceans (Higgins and Davies 1996 in Garnet *et al*. 2011).

Eastern Curlew

The eastern curlew is a migratory shorebird that breeds in Siberia, Kamchatka and Mongolia and migrates to coastal East Asia and Australia. The South Korean Yellow Sea is an important staging post for this species. Non-breeding birds occur around coastal Australia, are more common in the north and have disappeared or become much rarer at many sites along the south coast (Garnet 2011).

Non-breeding birds are present at estuaries, mangroves, saltmarshes and intertidal flats, particularly those with extensive seagrass (Zosteraceae), where they feed on marine invertebrates, especially crabs and small molluscs (Higgins & Davies 1996 in Garnet 2011).

Australian Painted Snipe

The Australian painted snipe has been recorded at wetlands in all states of Australia (DoE 2014g). The Australian painted snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum Muehlenbeckia or canegrass or sometimes tea-tree (*Melaleuca*). The Australian painted snipe sometimes utilises areas that are lined with trees, or that have some scattered fallen or washed-up timber (DoE 2014g).

Australasian Bittern

The Australasian bittern is found in coastal and sub-coastal areas of south-eastern and south-western mainland Australia and the eastern marshes of Tasmania (Birdlife Australia 2017). The Australasian Bittern occurs mainly in freshwater wetlands and, rarely, in estuaries or tidal wetlands (Marchant & Higgins 1990). It favours wetlands with tall dense vegetation, where it forages in still, shallow water up to 0.3 m deep, often at the edges of pools or waterways, or from platforms or mats of vegetation over deep water. It favours permanent and seasonal freshwater habitats, particularly those dominated by sedges, rushes and reeds (e.g. *Phragmites, Cyperus, Eleocharis, Juncus, Typha, Baumea, Bolboschoenus*) or cutting grass (*Gahnia*) growing over a muddy or peaty substrate (Marchant & Higgins 1990). The diet of the Australasian Bittern includes aquatic animals such as small fish, frogs, freshwater crayfish, spiders, insects and small reptiles at night. Breeding occurs during summer from October to January.

All remaining natural habitat (including constructed wetlands) is considered critical habitat for this species. This species is known to occur on the western coastal plain between Lancelin and Busselton and the southern coastal region from Augusta to east of Albany within the EMBA (**Table 8-6**).

8.2.2 Seabirds

Australian Lesser Noddy

This species is usually found only around its breeding islands in the Houtman Abrolhos Islands in Western Australia (Storr *et al*. 1986). The Australian lesser noddy occupies coral-limestone islands that are densely fringed with white mangrove *Avicennia marina*, and it occasionally occurs on shingle or sandy beaches (Higgins & Davies 1996 in DAWE 2020a). This species is thought to be sedentary or resident, staying near to its breeding islands in the non-breeding season. It may leave nesting islands for short periods during the non-breeding season, and probably forages widely (Higgins & Davies 1996 in DAWE 2020a).

Breeding apparently occurs only on Morley, Wooded and Pelsaert Islands at the Houtman Abrolhos Islands (Higgins and Davies 1996 in DoE 2014b). Mangrove stands support approximately 68,000 breeding pairs spread over the three islands (Surman & Nicholson 2006). Breeding may also occur on Ashmore Reef (Stokes & Hinchey 1990). The breeding season extends from mid-August to early April (Higgins & Davies 1996 in DoE 2014b).

The National Conservation Values Atlas identifies BIAs for this species in the area of the Houtman Abrolhos islands (**Table 8-6**). The Species Group Report Card – Seabirds (DSEWPaC 2012b) states that the entire Australian population of this species breeds in the South-west Marine Region, south of Busselton.

Albatrosses

A Protected Matters search of the waters in the EMBA (**Appendix A**) identified several albatross species that may occur in the area, comprising of the southern royal albatross, northern royal albatross, Amsterdam albatross, Antipodean albatross, Tristan albatross, sooty albatross, wandering albatross, Indian yellow-nosed albatross, shy albatross, white-capped albatross, black-browed albatross and Campbell albatross. All these species predominantly occur in subantarctic to subtropical waters and breed on islands in the southern oceans (DAWE 2020a).

The National Conservation Values Atlas (DAWE 2020b) and the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC 2011) do not identify any BIAs for these species in the area from Busselton to the NT border. However, a BIA for the Indian yellow-nosed albatross is identified for foraging north to Shark bay and extending east into Bass Strait.

Christmas Island Frigatebird

The Christmas Island frigatebird is a very large seabird. Breeding colonies of the Christmas Island frigatebird is currently confined to Christmas Island in the Indian Ocean (Birdlife International 2019) but forages and roosts widely in south-east Asia and Indian Ocean No breeding colonies have ever been found away from Christmas Island. The Christmas Island Frigatebird predominantly nests in forests on shore terraces that are protected from prevailing south-east trade winds (TSSC 2020a). All forest containing nesting and roosting sites, including currently known nesting and roosting colonies and any other smaller groups of nests and roosts on Christmas Island is considered critical habitat (TSSC 2020a).

Southern Giant Petrel

The southern giant petrel is a highly migratory bird with a large natural range. This species occurs from Antarctic to subtropical waters and breeds on the Antarctic continent, peninsular and islands and on subantarctic islands and South America. Breeding occurs annually between August and March (DAWE 2020a).

The National Conservation Values Atlas (DAWE 2020b) and the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC 2011) do not identify any BIAs for this species in the area from Busselton to the NT border.

Northern Giant Petrel

The northern giant petrel occupies the Antarctic Polar Front. In summer, it occurs predominantly in sub-Antarctic to Antarctic waters, usually between 40 and 64° The northern giant-petrel breeds on sub-Antarctic islands. Its breeding range extends into the Antarctic zone at South Georgia. It nests in coastal areas where vegetation or broken terrain offers shelter, on sea-facing slopes, headlands, in the lee of banks, under or against vegetation clumps, below cliffs or overhanging rocks, or in hollows. On Campbell Island, it nests on the edge of the coastal plateau. Tussock-grass is widespread at many breeding sites. Its nests are built in secluded, coastal sites, sheltered by heavy vegetation. On Antipodes Island, it nests under *Senecio antipoda* (DoE 2014d).

The National Conservation Values Atlas (DAWE 2020b) does not identify any BIAs for this species in the area spanning SW WA to the NT border.

Soft-Plumaged Petrel

The soft-plumaged petrel is generally found over temperate and subantarctic waters in the South Atlantic, Southern Indian and western South Pacific Oceans. The species breeds colonially on islands in the southern oceans. Breeding occurs from August to May (Marchant & Higgins 1990 in DAWE 2020a).

A BIA for this species is identified for foraging in seas north to 21°30'S off WA.

Blue Petrel

The blue petrel is marine species of the Sub Antarctic and Antarctic seas. In summer, it occurs mainly over waters of -2 to 2° C in surface temperature, but it also ranges south to the edge of the pack-ice and north to approximately 30° south, or further north over cool currents (DoE 2014e). In the Antarctic, it generally avoids the pack-ice, and only occasionally approaches the edge of the ice. Given the location of the EMBA, this species is unlikely to occur.

The National Conservation Values Atlas (DAWE 2020b) does not identify any BIAs for this species in the area spanning SW WA to the NT border.

Abbott's Booby

Currently, Abbott's booby is only known to breed on Christmas Island and to forage in the waters surrounding the island and south-east Asia (TSSC 2020b). Within Christmas Island, most nests are found in the tall plateau forest on the central and western areas of the island, and in the upper terrace forest of the northern coast.

The National Conservation Values Atlas (DoEE 2019b) does not identify any BIAs for this species in the area spanning SW WA to the NT border. Critical habitat is considered all known nesting trees and all forest vegetation within a 200m radius of known nesting trees on Christmas Island (TSSC 2020).

Australian Fairy Tern

The Australian fairy tern is distributed in a large geographic range between Australia, New Zealand and New Caledonia. Three subspecies have been identified, one of which is found in Australia. The Australian fairy tern occurs along the coasts of Victoria, Tasmania, South Australia and WA; occurring as far north as the Dampier Archipelago (DAWE 2020a). The subspecies has been found in embayments of a variety of habitats including offshore, estuarine or lacustrine islands, wetlands and mainland coastline (Higgins & Davies 1996 in DoE 2014b, Lindsey 1986).

Australian fairy terns nest on sheltered sandy beaches, spits and banks above the high tide line and below vegetation. The Australian fairy tern breeds from August to February depending on the location of the breeding colony (Higgins & Davies 1996 in DAWE 2020a). They generally nest in small colonies of up to 100 birds, although larger colonies of more than 1400 pairs have been reported in Western Australia (Hill *et al*. 1988).

The National Conservation Values Atlas (DAWE 2020b) identifies the vicinity of the lower north-west coast (north to Dampier Archipelago) and west coast (south to Peel inlet) as BIAs for foraging. Biologically important breeding areas were also identified scattered along the coast between Shark Bay and the Pilbara (**Table 8-6**).

Christmas Island White-tailed Tropicbird

The Christmas Island white-tailed tropicbird is endemic to Christmas Island and leaves the island to forage in the warm waters of the Indian Ocean (Garnett 2011). The white-tailed tropicbird roots at sea; only incubating or brooding adults remain on nests on the island at night (Stokes 1988).

The National Conservation Values Atlas (DAWE 2020b) does not identify any BIAs for this species within the EMBA.

Fairy Prion (southern)

The fairy prion is distributed off the cold-water coasts of Antarctica and southern Australia and New Zealand. The southern subspecies is known to breed on Macquarie Island, Langdon Point, Davis Point and Bishop and Clerk islands (Garnett & Crowley 2000). It is estimated that the population of the fairy piron (southern) is a little over 50 pairs (Brothers 1984).

The National Conservation Values Atlas (DAWE 2020b) does not identify any BIAs for this species within the EMBA.

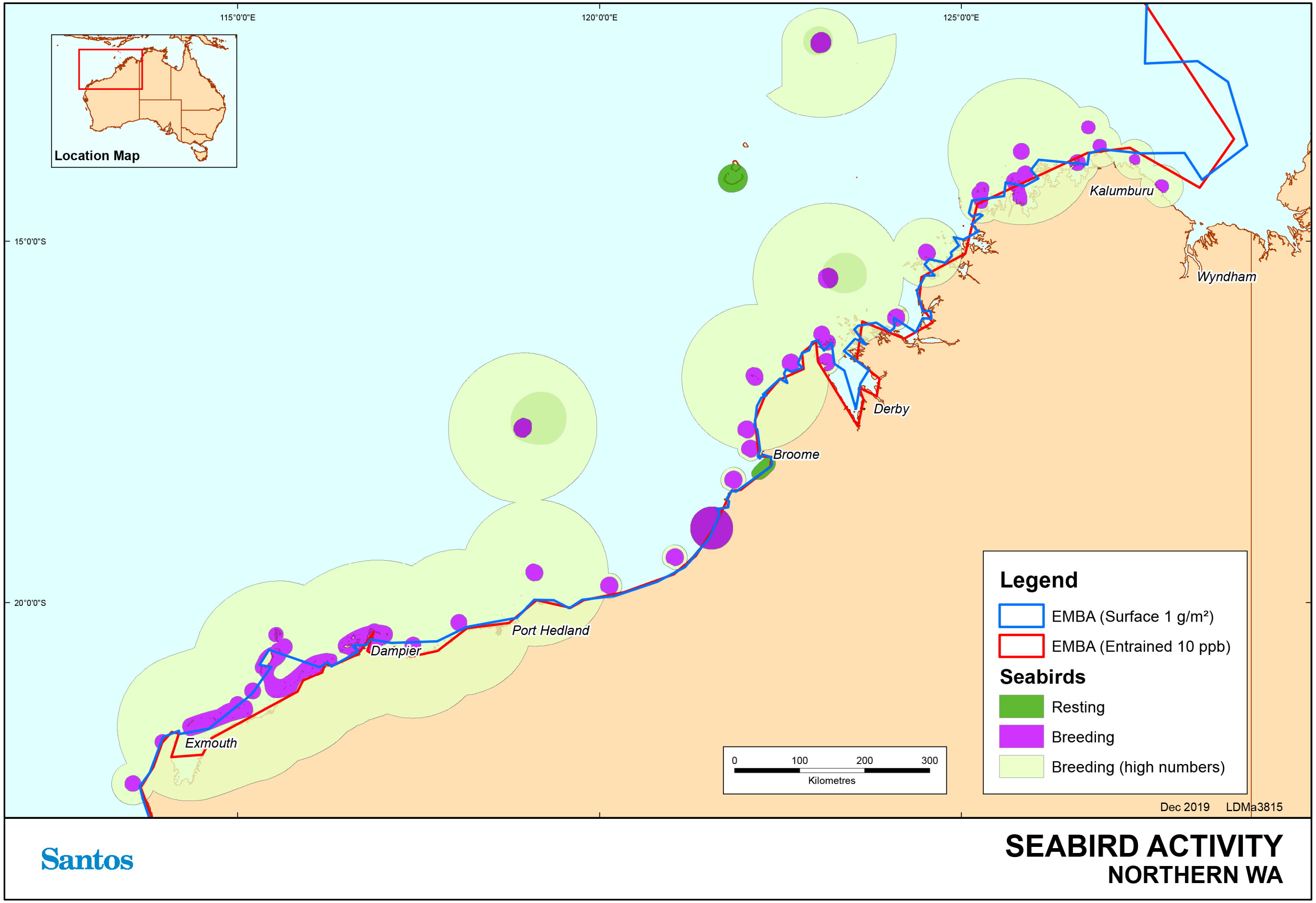

Figure 8-1: Biological important areas – birds – Northern WA

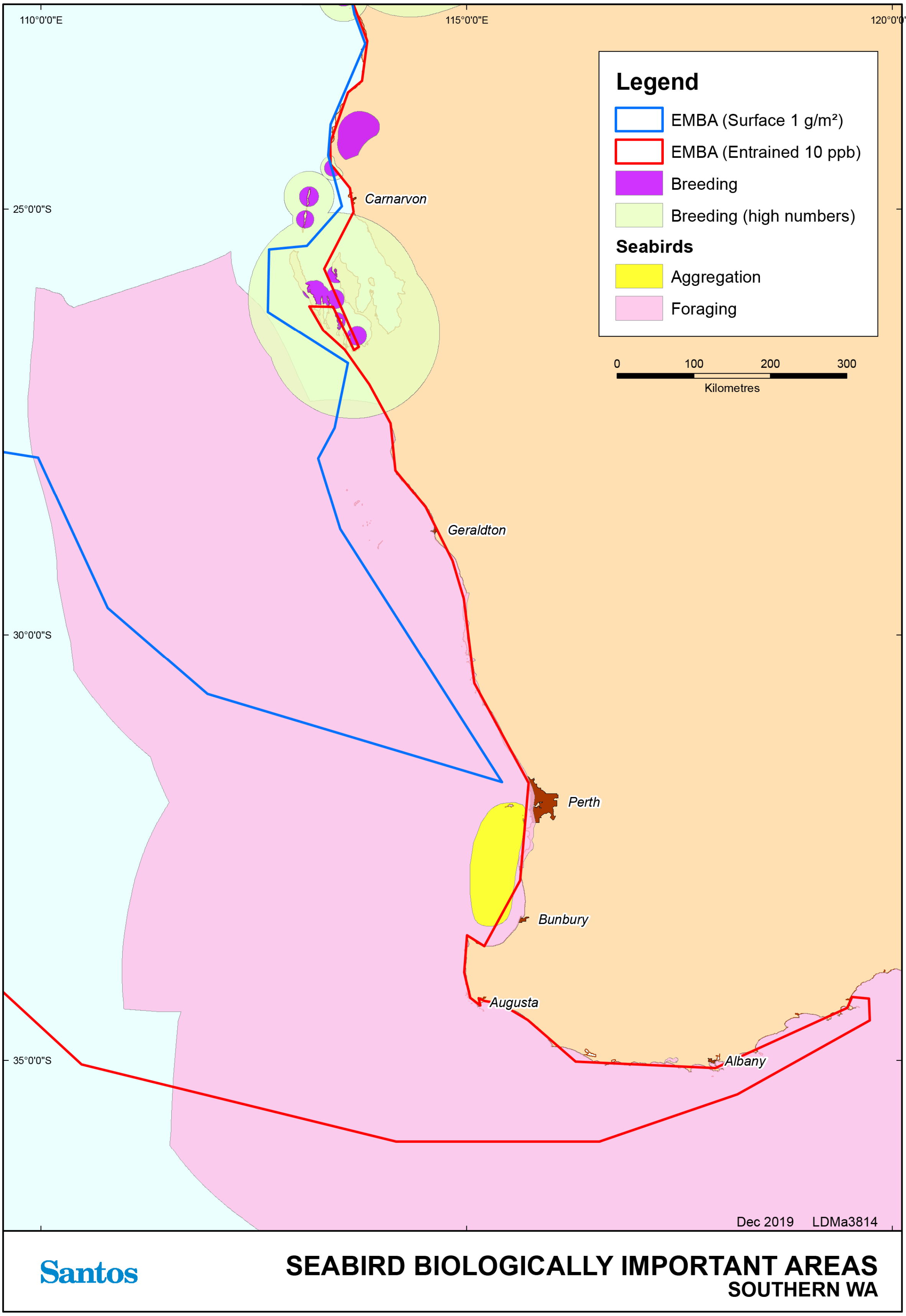

Figure 8-2: Biologically important areas – birds – Southern WA

Table 8-2: Summary of information for birds listed as threatened under the EPBC Act that may be in the EMBA

Species	Species Expected in EMBA	Breeding in the Area /Seasonality	Foraging
Shorebirds			
Red knot	Yes	No	Intertidal invertebrates
Curlew sandpiper	Yes	No	Polychaete worms, molluscs and crustaceans taken from shorelines
Great knot	Yes	No	Bivalves, gastropods, crustaceans and other invertebrates taken from shorelines
Greater sand plover/lesser sand plover	Yes	No	Marine invertebrates taken from shorelines
Bar-tailed godwit	Yes	No	Annelids, bivalves and crustaceans taken from shorelines
Eastern curlew	Yes	No	Marine invertebrates associated with seagrass
Australasian bittern	Yes	No	Other small animals, insects, snails and spiders
Australian painted snipe	Yes	No	Seeds and small invertebrates
Western Alaskan bar-tailed godwit	Yes	No	Worms, molluscs, crustaceans, insects
Northern Siberian bar-tailed godwit	Yes	No	Worms, molluscs, crustaceans, insects and some plant material
Seabirds			
Australian lesser noddy	May forage from Kalbarri to Shark Bay	No	Small fish taken from marine and coastal waters (DoE 2014b)
Amsterdam albatross	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters.
Antipodean albatross	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters.
Black-browed albatross	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters.
Campbell albatross	Low densities	No	Cephalopods, fish, salps, jellyfish and crustaceans taken from marine and coastal waters.
Indian yellow-nosed albatross	Low densities	No	Cephalopods, and fish taken from marine and coastal waters.
Northern royal albatross	Low densities	No	Cephalopods, fish, salps and crustaceans taken from marine and coastal waters.
Shy albatross	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters.
Sooty Albatross	Low densities	No	Cephalopods, fish, crustaceans, siphonophores and penguin carrion taken from marine waters.

Species	Species Expected in EMBA	Breeding in the Area /Seasonality	Foraging
Southern royal albatross	Low densities	No	Cephalopods, and fish taken from marine and coastal waters.
Tristan albatross	Low densities	No	Cephalopods, fish and crustaceans taken from marine waters.
Wandering albatross	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters.
White-capped albatross	Low densities	No	Cephalopods and fish taken from marine and coastal waters.
Southern & Northern giant petrel	Low densities	No	Scavenges penguin, seal and whale carcasses. Hunts live birds, penguin chicks' cephalopods and krill. Marine and coastal waters (DoE 2014b)
Soft-plumaged petrel	Low densities	No	Cephalopods, fish and crustaceans taken from marine and coastal waters (DoE 2014b)
Australian fairy tern	Yes	Yes Aug to Feb	Bait fish taken from coastal waters
Fairy prion (southern)	Very low densities	No	Small pelagic crustaceans, small fish and squid
Christmas Island frigatebird	Low densities	No	Planktonic crustaceans, fish and squid
Abbott's booby	Low densities	No	Fish and squid
Blue petrel	Low densities	No	Crustaceans, small fish and squid
Christmas Island white-tailed tropicbird	Very low densities	No	Squid and flying fish

8.3 Migratory Species

The EPBC PMST search identified an additional 44 species listed as migratory under the EPBC Act that may occur within the EMBA. These species are listed in **Table 8-3**. All of these species are also listed as migratory under the BC Act, with the exception of the flesh-footed shearwater, which is listed as vulnerable under the BC Act. Those species that are listed as both migratory and threatened under either the EPBC Act and/or BC Act are outlined in **Table 8-1** and are not repeated within **Table 8-3**.

Table 8-3: Summary of migratory birds that may occur within the EMBA

Species	Common Name	Likelihood of occurrence in EMBA
Limnodromus semipalmatus	Asian dowitcher	Roosting known to occur within area
Limosa lapponica	Bar-tailed godwit	Species or species habitat known to occur within area
Limosa limosa	Black-tailed godwit	Roosting known to occur within area
Onychoprion anaethetus	Bridled tern	Breeding known to occur within area
Limicola falcinellus	Broad-billed sandpiper	Roosting known to occur within area
Sula leucogaster	Brown booby	Breeding known to occur within area
Hydroprogne caspia	Caspian tern	Breeding known to occur within area

Species	Common Name	Likelihood of occurrence in EMBA
Tringa nebularia	Common greenshank	Species or species habitat known to occur within area
Anous stolidus	Common noddy	Breeding known to occur within area
Tringa totanus	Common redshank	Roosting known to occur within area
Actitis hypoleucos	Common sandpiper	Species or species habitat known to occur within area
Thalasseus bergii	Crested tern	Breeding known to occur within area
Charadrius bicinctus	Double-banded plover	Roosting known to occur within area
Ardenna carneipes	Flesh-footed shearwater	Breeding known to occur within area
Apus pacificus	Fork-tailed swift	Species or species habitat likely to occur within area
Fregata minor	Greater frigatebird	Breeding known to occur within area
Pluvialis squatarola	Grey plover	Roosting known to occur within area
Tringa brevipes	Grey-tailed tattler	Roosting known to occur within area
Fregata ariel	Lesser frigatebird	Breeding known to occur within area
Tringa stagnatilis	Little greenshank	Roosting known to occur within area
Sternula albifrons	Little tern	Breeding known to occur within area
Calidris subminuta	Long-toed stint	Species or species habitat known to occur within area
Sula dactylatra	Masked booby	Breeding known to occur within area
Charadrius veredus	Oriental plover	Roosting known to occur within area
Glareola maldivarum	Oriental pratincole	Roosting known to occur within area
Pandion haliaetus	Osprey	Breeding known to occur within area
Pluvialis fulva	Pacific golden plover	Roosting known to occur within area
Calidris melanotos	Pectoral sandpiper	Species or species habitat known to occur within area
Sula sula	Red-footed booby	Breeding known to occur within area
Phalaropus lobatus	Red-necked phalarope	Roosting known to occur within area
Calidris ruficollis	Red-necked stint	Roosting known to occur within area
Phaethon rubricauda	Red-tailed tropicbird	Breeding known to occur within area
Sterna dougallii	Roseate tern	Breeding known to occur within area
Arenaria interpres	Ruddy turnstone	Roosting known to occur within area
Philomachus pugnax	Ruff (reeve)	Roosting known to occur within area
Calidris alba	Sanderling	Roosting known to occur within area
Calidris acuminata	Sharp-tailed sandpiper	Roosting known to occur within area
Ardenna grisea	Sooty shearwater	Species or species habitat may occur within area
Calonectris leucomelas	Streaked shearwater	Species or species habitat known to occur within area
Xenus cinereus	Terek sandpiper	Roosting known to occur within area
Ardenna pacifica	Wedge-tailed shearwater	Breeding known to occur within area
Numenius phaeopus	Whimbrel	Roosting known to occur within area
Phaethon lepturus	White-tailed tropicbird	Breeding known to occur within area

Species	Common Name	Likelihood of occurrence in EMBA
Tringa glareola	Wood sandpiper	Roosting known to occur within area

Australia is signatory to three international treaties with China, Japan and the Republic of Korea to safeguard migratory bird species, predominantly shorebirds. To facilitate observance of the three agreements, 36 species of migratory shorebirds have been listed as specially protected under both the Commonwealth EPBC Act and the WA BC Act.

Three internationally recognised areas that support shorebird migrations are protected as wetlands of international importance; Ashmore Reef, Eighty-mile Beach and Roebuck Bay. These wetlands are discussed further in **Section 9.2**.

The EPBC Act Policy Statement 3.21 sets out criteria for determining the significance of sites to migratory shorebirds based on the number of migratory species and the proportion of a species population that is supported by the site (Commonwealth of Australia 2017b). Site significance can be difficult to assess, particularly for ephemeral inland wetlands. These areas may be used rarely, depending weather conditions, but still provide important habitat for migratory shorebird species.

Migratory shorebirds require a particular conservation approach due to their migration patterns that take them across international boundaries (Bamford *et al*. 2008). These species and their habitats are sensitive to threats due to their high site fidelity, tendency to aggregate, high energy demands and the need for habitat networks containing both roosting and foraging sites (Commonwealth of Australia 2017b). Migratory shorebirds are known to use networks of connected sites (also known as site complexes). They move within these networks depending on the time of day, availability of resources and environmental conditions at the site (Commonwealth of Australia 2017b).

The types of habitat used by migratory shorebirds in Australia vary across the species identified in the PMST search. Migratory shorebirds use both coastal and inland habitats that most commonly include:

+ Coastal habitats: coastal wetlands, estuaries, mudflats, rocky inlets, reefs and sandy beaches, sometimes supporting mangroves; and
+ Inland habitats: inland wetlands, floodplains and grassland areas, often with ephemeral water sources (Commonwealth of Australia 2017b).

Feeding guilds provide an explanation for much of the shorebird distribution pattern in the north Western Australia. For example, Rogers (1999) classified shorebirds (and others) in Roebuck Bay as belonging to seven guilds on the basis of prey choice and foraging method. In order of abundance, these are summarised in **Table 8-4**.

Table 8-4: Feeding guilds based on prey choice and foraging method (Rogers 1999) adapted from DEC (2003) and Bennelongia (2008)

Feeding habitat	Feeding guild	Species
Sea edge	Tactile hunters of macrobenthos	Great knot, red knot, bar-tailed godwit, black-tailed godwit, Asian dowitcher
Along sandy sea edges or near tidal creeks	Tactile hunters of microbenthos	Curlew sandpiper, red-necked stint, broad-billed sandpiper, marsh sandpiper, sharp-tailed sandpiper
Reefs or mangrove fringes	Visual hunters of slow surface-dwelling prey	Common sandpiper, sooty oystercatcher, pied oystercatcher, silver gull, ruddy turnstone
Sandier western parts of Roebuck Bay, often near-shore	Visual hunters of small fast prey	Grey plover, red-capped plover, greater sand plover, lesser sand plover, grey-tailed tattler, terek sandpiper

Feeding habitat	Feeding guild	Species
Soft mudflats in north-east Roebuck Bay	Visual hunters of fast large prey	Eastern curlew, whimbrel, greenshank, striated heron and black-necked stork
Soft mudflats in north-east Roebuck Bay	Kleptoparasites	Gull-billed tern (robs large crabs from whimbrels)
Creek-lines in eastern Roebuck Bay	Pelagic hunters of nekton (animals of the pelagic zone) and neuston (animals that live on the surface film)	Black-winged stilt, red-necked avocet, reef egret, little egret, great white egret, white-faced heron, royal spoonbill

The Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015) provides a framework to guide the conservation of migratory shorebirds and their habitat in Australia and, in recognition of their migratory habits, outlines national activities to support their appreciation and conservation throughout the East Asian-Australasian Flyway.

The following migratory shorebird species are subject to the Wildlife Conservation Plan for Migratory Shorebirds 2015 (DoE 2015).

Table 8-5: Birds subject to the Wildlife Conservation Plan for Migratory Shorebirds 2015

Migratory species	DoEE SPRAT information on distribution within the area of interest
Asian dowitcher	The Asian dowitcher is a regular visitor to the north-west between Port Hedland and Broome. Elsewhere they are sporadic and rare. In the NT, the Asian dowitcher is found in Darwin and Arnhem Land. In WA, the species has been recorded at Albany, Lake McLarty, Lake McLeod, north-east Pilbara and the south-west Kimberley division. It has also been recorded at the Port Hedland Saltworks, Roebuck Bay, Ashmore Reed and Eighty Mile Beach.
Bar-tailed godwit	The bar-tailed godwit has been recorded in the coastal areas of all Australian states. In WA, it is widespread around the coast, from Eyre to Derby, with a few scattered records elsewhere in the Kimberley.
Black-tailed godwit	The black-tailed godwit is found in all states and territories of Australia; however, it prefers coastal regions and the largest populations are found on the north coast between Darwin and Weipa. The population that inhabitats Roebuck Bay is approximately 7,374 (>1% of the species total population).
Broad-billed sandpiper	In WA, few records occur in the south-west, but the broad-billed sandpiper may be regular in small numbers at scattered locations, from Warden Lake Nature Reserve and Coramup Creek to Guraga Lake Nature Reserve and Hurstview Lake. Individuals mostly occur on the coasts of the Pilbara and Kimberley between Onslow and Broome but are also recorded north to the mouth of Lawley River, and inland at Lake Daley.
Common greenshank	The common greenshank occurs around most of the coast from Cape Arid in the south to Carnarvon in the north-west. In the Kimberley region, it is recorded in the south-west and the north-east, with isolated records from the Bonaparte Archipelago. WA has three sites of international importance for the common greenshank which include: + Eighty Mile Beach (2,240 individuals); + Wilson Inlet (568 individuals); and + Roebuck Bay (560 individuals).
Common redshank	In Western Australia (WA), the species is vagrant to the south-west with records at Peel Inlet, Coodanup, the Gascoyne region, Coral Bay and Carnarvon.
Common sandpiper	WA distribution includes: + Roebuck Bay; and + Nuytsland Nature Reserve.
Double-banded plover	The double-banded plover can be found in both coastal and inland areas. There are no nationally significant sites within WA.

Migratory species	DoEE SPRAT information on distribution within the area of interest
Fork-tailed swift	In WA, there are sparsely scattered records of the fork-tailed swift along the south coast, ranging from near the Eyre Bird Observatory and west to Denmark. They are widespread in coastal and subcoastal areas between Augusta and Carnarvon, including some on nearshore and offshore islands. They are scattered along the coast from south-west Pilbara to the north and east Kimberley region, near Wyndham. There are sparsely scattered inland records, especially in the Wheatbelt, from Lake Annean and Wittenoom. They are found in the north and north-west Gascoyne Region, north through much of the Pilbara Region, and the south and east Kimberley (Higgins 1999).
Great knot	The great knot has been recorded around the entirety of the Australian coast, with a few scattered records inland. The greatest numbers are found in northern Australia; where the species is common on the coasts of the Pilbara and Kimberley, from the Dampier Archipelago to the Northern Territory border. Important sites for great knot in Western Australia include: + Eighty Mile Beach (169,044 individuals); and + Roebuck Bay (22,600 individuals).
Greater sand plover	In Australia, the greater sand plover occurs in coastal areas in all states, though the greatest numbers occur in northern Australia, especially the north-west. In northern Australia, the species is especially widespread between North West Cape and Roebuck Bay in Western Australia and are sparsely scattered records from the largely inaccessible area between Roebuck Bay and Darwin. Internationally important sites within Western Australia include: + Eighty Mile Beach (64,548 individuals); + Roebuck Bay (26,900 individuals); and + Ashmore Reef (1,196 individuals).
Grey plover	In Australia, the grey plover has been recorded in all states, where it is found along the coasts and are recorded frequently between Albany and the northern Kimberley coast. Internationally important sites include: + Eighty Mile Beach (1,650 individuals); + Roebuck Bay (1,300 individuals); + Peel Inlet (600 individuals); and + Nuytsland Nature Reserve (409 individuals).
Grey-tailed tattler	There are a few scattered records for the species along the south coast near the Eyre Bird Observatory, Point Malcolm, Rossiter Bay, Shark Lake Nature Reserve and surrounding swampland. It is found in the south-west between Augusta and Cervantes. The grey-tailed tattler is widespread from Houtman Abrolhos and the mainland adjacent to the Kimberley Division. It has also been recorded inland at Lake Argyle and on islands off the coast.
Lesser sand plover	Within Australia, the lesser sand-plover is widespread in coastal regions and has been recorded in all states. It mainly occurs in northern and eastern Australia, in south-eastern parts of the Gulf of Carpentaria, western Cape York Peninsula and islands in Torres Strait, and along the entire east coast, though it occasionally also occurs inland. In Western Australia, the following are important sites: + Eighty Mile Beach (1,575 individuals); + Roebuck Bay (1,057 individuals); + Broome (745 individuals); and + Port Hedland Saltworks (668 individuals).
Little greenshank	The marsh sandpiper is found on coastal and inland wetlands throughout Australia found mainly on the coast in Western Australia. National sites of importance within Western Australia include:

Migratory species	DoEE SPRAT information on distribution within the area of interest
	+ Port Hedland Saltworks (500 individuals); + Peel inlet (276 individuals); and + Eighty Mile Beach (140 individuals).
Long-toed stint	In Western Australia, the species is found mainly along the coast, with a few scattered inland records. On the south coast the Long-toed Stint is found from Esperance to Albany and inland to Lake Cassencarry and Dumbleyung. On the south-west coast the species is known from the Vasse River estuary, Guraga Lake and the Namming Nature Reserve. The species has occasionally been recorded in the Gascoyne Region, around Lake Wooleen, Meeberrie Station and McNeill Claypan. It is widespread around the Pilbara region and the Kimberley Division between Karratha and Wyndham-Kununurra. Inland records include Lake Brown, Hannan Lake, Lake Biolet, Newman Sewage Farm and Lake Gregory.
Oriental plover	Internationally important marine sites: + Eighty Mile Beach (approximately 60,000 birds); and + Roebuck Bay (Approximately 8,500 birds).
Oriental pratincole	Internationally important site: + Eighty Mile Beach (2.88 million birds). The species occurs at numerous and widespread sites in northern Australia, especially near the Pilbara and Kimberley coasts of northern WA.
Pacific golden plover	In Western Australia, the species is seldom recorded along the southern or south-western coasts but is more widespread along the Pilbara and Kimberley coasts between North-West Cape. Internationally important sites include Eighty Mile Beach with 440 individuals.
Pectoral sandpiper	In Australasia, the pectoral sandpiper prefers shallow fresh to saline wetlands. The species is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. The species is usually found in coastal or near coastal habitat but occasionally found further inland. It prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation, such as grass or samphire.
Red knot	The red knot large numbers are regularly recorded in north-west Australia, with 80 Mile Beach and Roebuck Bay being particular strongholds.
Red-necked phalarope	The red-necked phalarope is a regular at the Port Hedland Saltworks and Rottnest Island, Western Australia. The species is also found at the ICI Saltworks in South Australia.
Red-necked stint	The red-necked stint has been recorded in all coastal regions and found inland in all states when conditions are suitable. The red-necked stint probably travels in flocks and has been observed to feed in dense flocks. The Australian population was estimated at 353,000. Internationally important sites include: + Eighty Mile Beach (60,000 individuals); + Port Hedland Salt Works (23,000 individuals); + Roebuck Bay (19,800 individuals); + Wilson Inlet (15,252 individuals) + Alfred Cove Nature Reserve (10,000 individuals); + Lake Macleod (8,312 individuals); and + Peel Inlet (8,063 individuals).
Ruddy turnstone	The ruddy turnstone is widespread within Australia during its non-breeding period of the year. Australian sites of international importance include: + Eighty Mile Beach (3,480 individuals); + Ashmore Reef (2,230 individuals); + Roebuck Bay (2,060 individuals);

Migratory species	DoEE SPRAT information on distribution within the area of interest
	+ Barrow Island (1,733 individuals); and + Lacepede Islands (1,050 individuals).
Ruff (reeve)	In Western Australia, the species has been recorded at the lower King River and it is mostly found in the south-west region of the state. It has been sighted at the Vasse River estuary, north to Namming Lake and Lake McLarty. It has been periodically recorded at Port Hedland, Kununurra and the Argyle Diamond Mine. There are unconfirmed reports at Curlewis Camp, Millstream Chichester, Broome and Roebuck Bay.
Sanderling	They occur on most of the coast from Eyre to Derby, and also around Wyndham. They are more often recorded on the south and southwest coasts, north to around southern Shark Bay, with more sparsely scattered records further north in Gascoyne and Pilbara Regions and the Kimberley Division. Important sites include: + Eighty Mile Beach (2,230 individuals); + Ashmore Reef (1,132 individuals); and + Roebuck Bay (1,510 individuals).
Sharp-tailed sandpiper	They are widespread from Cape Arid to Carnarvon, around coastal and subcoastal plains of Pilbara Region to south-west and east Kimberley Division (Higgins & Davies 1996).
Streaked shearwater	Exmouth Gulf to the north.
Terek sandpiper	In Western Australia (WA), the terek sandpiper is rarely seen on the south coast: occasionally around Eyre and several records around Albany. On Swan River plain, it has been recorded between Bunbury and the mouth of the Moore River. The species is widespread in the Pilbara region and Kimberley Division, from Dampier to Wyndham, with occasional records around Shark Bay. Internationally important sites include: + Eighty Mile Beach (8,000 individuals); and + Roebuck Bay (1,840 individuals).
Whimbrel	It is common and widespread from Carnarvon to the north-east Kimberley Division, Western Australia. It is occasionally seen on the south coast of Western Australia and has occasionally been recorded in south-west Western Australia and further north to Shark Bay.
Wood sandpiper	The wood sandpiper has its largest numbers recorded in north-west Australia, with all areas of national importance located in Western-Australia: + Parry Floodplain (Wyndham) (355 individuals) + Camballin (185 individuals) + Lake Argyle (90 individuals) + Shark Bay area, (80 individuals) + Vasse-Wonnerup estuary (61 individuals) + Lake McLarty (64 individuals) + Kogolup Lakes (60 Individuals)

Shorebird migration patterns are seasonal and vary according to species (DSEWPaC 2012). Generally, shorebirds migrate to northern Australia in August to November. Many birds remain in northern Australia but others disperse southwards (Bennelongia 2011). Migratory shorebird numbers on northern beaches peak in November then again in March as the majority of birds begin their return to the northern hemisphere between March and May. Most migratory shorebirds do not breed in Australia and juvenile birds may spend several years in Australia before reaching maturity and returning north to breed (DEWHA 2009).

8.4 Biologically Important Areas / Critical Habitat– Birds

Table 8-6 below provides an overview of BIAs in the EMBA for birds. The DAWE may make recovery plans for threated fauna listed under the EPBC Act. The EPBC Act requires that 'habitat critical to the survival of the listed threatened species' is identified in recovery plans, relevant recovery plans are listed in **Section 13.2**[8].

In addition, both the EPBC Act and WA BC Act and associated regulations (2018) provide for the listing of critical habitat - habitat 'critical to the survival of the threatened species'.

Table 8-6: Critical habitat/ biologically important areas - birds

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
Abbott's booby	*Papsula abbotti*	All known nesting trees and all forest vegetation within a 200m radius of known nesting trees for Abbott's booby	Christmas Island
Australasian bittern	*Botaurus poiciloptilus*	All natural habitat (including constructed wetlands with suitable habitat)	Western coastal plain between Lancelin and Busselton Southern coastal region from Augusta to east of Albany
Australian fairy tern	*Sternula nereis*	Foraging – Kimberley, Pilbara and Gascoyne coasts and islands	Found in the vicinity of lower north-west coast (north to Dampier Archipelago), west coast (south to Peel Inlet) and south coast (from Flinders Bay east to Israelite Bay), including islands (as far offshore as Trimouille Island and Houtman Abrolhos. Pilbara and Gascoyne coasts and islands
Australian lesser noddy	*Anous tenuirorstris melanops*	Foraging - Houtman Abrolhos Islands	Houtman Abrolhos Islands
Bridled tern	*Onychoprion anaethetus*	Foraging - West coast of Western Australia and around to Recherche Archipelago	West coast of WA and around to Recherche Archipelago including offshore waters
Brown Booby	*Sula leucogaster*	Breeding, foraging - Kimberley and northern Pilbara coasts and islands also Ashmore Reef.	Kimberley and northern Pilbara coasts and islands also Ashmore Reef.
Caspian tern	*Sterna caspia*	Foraging - mainly islands (as far offshore as Adele, Bedout, Trimouille and the Houtman Abrolhos)	In WA found on most coasts, mainly islands (as far offshore as Adele, Bedout, Trimouille and the Houtman Abrolhos) and at Lake Argyle, Lake Gregory and Lake MacLeod; accidental elsewhere in the interior.
Common noddy	*Anous stolidus*	Foraging	Around Houtman Abrolhos Around Lancelin Island
Flesh footed shearwater	*Ardenna carneipes*	Foraging, aggregation (pre-migration) - Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef	Foraging from Cape Naturaliste to Eyre, 1-150 km offshore. Pre-departure zone in some years from Rottnest Island to Bunbury.

[8] Further background information on BIA and identification of critical habitat in recovery plans is provided in Section 5.4.

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
Christmas Island frigatebird	*Fregeta andrewsii*	All forest containing nesting and roosting sites, including currently known nesting and roosting colonies and any other smaller groups of nests and roosts	Christmas Island
Greater frigatebird	*Fregata minor*	Breeding, foraging - Kimberley and Ashmore Reef	Kimberley and Ashmore Reef
Great-winged petrel	*Pterodroma macroptera*	Foraging - Offshore south of Shark Bay	Offshore south of Shark Bay, extending around south-west corner of WA and east past Kangaroo Island
Indian Yellow-nosed Albatross	*Thalassarche carteri*	Foraging - south-west marine region, north to Shark Bay and extending east into Bass Strait	Throughout offshore waters of south-west marine region, north to Shark Bay and extending east into Bass Strait
Lesser crested tern	*Sterna bengalensis*	Breeding, foraging - Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef	Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef
Lesser frigatebird	*Fregata ariel*	Breeding, foraging – Kimberley and Pilbara coasts and islands also Ashmore Reef.	Kimberley and Pilbara coasts and islands also Ashmore Reef.
Little penguin	*Eudyptula minor*	Foraging - Perth to Bunbury	Perth to Bunbury
Little shearwater	*Puffinus assimilis*	Foraging - From Kalbarri to Eucla	From Kalbarri to Eucla including offshore waters
Little tern	*Sternula albifrons*	Breeding, foraging, resting - Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef Resting - Roebuck Bay	Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef Roebuck Bay Ramsar site
Pacific gull	*Larus pacificus*	Foraging –west coast and islands	West coast and islands from Point Quobba (24º30'S) south to Wedge Island (formerly south to Warnbro Sound and at Cape Naturaliste); casual further north (Point Cloates and Lake MacLeod).
Red-footed Booby	*Sula sula*	Breeding, foraging - north west Kimberley and Ashmore reef	North west Kimberley and Ashmore reef
Roseate tern	*Sterna dougallii*	Breeding, foraging – Islands and coastline in the Kimberley, Pilbara and Gascoyne regions Resting – Eighty Mile Beach	Eighty Mile Beach (northern end) Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef Low Rocks and Stern Island in Admiralty Gulf North-east and North-west Twin Islets near the mouth of King sound North-western and west coasts and islands from Sir Graham Moore Is (13º50'S), south to Mandurah (32º32'S) and as far offshore as

Species	Scientific name	Aggregation area and use	Specific geographic locations for species
			Ashmore Reef, Bedout Island and the Houtman Abrolhos.
Soft plumage petrel	*Pterodroma mollis*	Foraging - seas north to 21º30'S	In WA found in seas north to 21º30'S.
Sooty tern	*Sterna fuscata*	Foraging – Timor sea	Timor Sea S to 14º30, off northwest coast from Lacepede I SW to 117ºE including Abrolhos, Fisherman & Lancelin Is, accidental on lower west coast to Hamelin Bay. Breeding visitor (late Aug - early May) Abrolhos & Lancelin Is; casual winter (Nov - Apr) to Fisherman
Wedge-tailed shearwater	*Ardenna pacifica*	Breeding, foraging – west coast from Ashmore Reef to Carnac I. Kimberley, Pilbara, Gascoyne coasts, Ashmore reef	Breeding (in hundreds of thousands) off west coast from Ashmore Reef (12º15'S) to Carnac Island (32º07'S), and ranging in western seas between 12º00'S and 33º20'S. Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef
White-faced storm petrel	*Pelagodroma marina*	Foraging (in high numbers) - Offshore areas of the south-west marine region and into the adjacent south-east marine region and the north-west marine region to north of Shark Bay	Offshore areas of the south-west marine region and into the adjacent south-east marine region and the north-west marine region to north of Shark Bay
White-tailed tropic bird	*Phaethon lepturus*	Breeding, foraging - Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef	Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef

9. Protected Areas

A number of areas in the EMBA are protected under state and federal legislation. Protected areas include World Heritage Areas, Wetlands of International Importance (Ramsar), Wetlands of National Importance, National and Commonwealth Heritage Places, and terrestrial conservation reserves (National Parks, Nature Reserves and Conservation Parks) that bound marine waters. These areas are listed in **Table 9-1**, and shown in **Figure 9-1**, **Figure 9-2** and **Figure 9-3**, and discussed below. Other protected areas include Key Ecological Features (discussed in **Section 10**) and State and Commonwealth Marine Parks/Reserves (discussed in **Section 11** and **Section 12**). A Protected Matters search of the EMBA (**Appendix A**) identified several protected areas which were deemed to be irrelevant to Santos' petroleum activities due to their terrestrial location (e.g. Forrestdale and Thomsons Lakes – Ramsar wetland).

The Register of the National Estate (RNE) provides a listing of more than 13,000 natural, historic and indigenous sites of significance. However, in 2012 all references to the RNE were removed from the EPBC Act and the *Australian Heritage Council Act 2003*.The RNE is now maintained on a non-statutory basis as a publicly available archive and educational resource. A protected matters search of the area from the South Australian border to the NT border listed 197 places on the RNE, although it is recognised that not all indigenous sites may be listed (**Appendix A**). The RNE places are not discussed further here but are listed in **Appendix A**.

Table 9-1: Summary of protected areas in waters within the EMBA

Area type	Title
World Heritage Area	Shark Bay
	The Ningaloo Coast
Wetland of International Importance (Ramsar)	Eighty Mile Beach
	Roebuck Bay
	Ashmore Reef National Nature Reserve
	Becher Point wetlands
	Peel-Yalgorup System
	Vasse-Wonnerup System
	Hosnies Spring
	The Dales
Wetlands of National Importance	Ashmore Reef
	Mermaid Reef
	Vasse-Wonnerup Wetland System
	"The Dales", Christmas Island
	Eighty Mile Beach System
	Exmouth Gulf East
	Hosnies Spring, Christmas Island
	Hutt Lagoon System
	Lake Macleod
	Lake Thetis
	Learmonth Air Weapons Range – Saline Coastal Flats
	Leslie (Port Hedland) Saltfields System
	Prince Regent River System

Area type	Title
	Roebuck Bay
	Rottnest Island Lakes
	Shark Bay East
	Cape Leeuwin System
	Doggerup Creek System
	Cape Range Subterranean Waterways
	Yalgorup System
National Heritage Place	HMAS Sydney II and HSK Kormoran Shipwreck Sites (Historic)
	Batavia Shipwreck Site and Survivor Camps Area 1629- Houtman Abrolhos (Historic)
	Dirk Hartog Landing Site 1616 - Cape Inscription Area (Historic)
	Dampier Archipelago (including Burrup Peninsula) (Indigenous)
	The West Kimberley (Natural)
	The Ningaloo Coast (Natural)
	Shark Bay (Natural)
	Fitzgerald River National Park (Natural)
	Lesueur National Park (Natural)
Commonwealth Heritage Place	Scott Reef and Surrounds – Commonwealth Area
	Ningaloo Marine Area - Commonwealth Waters
	Mermaid Reef - Rowley Shoals
	Ashmore Reef National Nature Reserve
	Garden Island
	Christmas Island Natural Areas
	Yampi Defence Area
	Learnmonth Air Weapons Range Facility
	Lancelin Defence Training Area
Threatened Ecological Communities	Monsoon Vine Thickets on the Ridge on the Coastal Sand Dunes of Dampier Peninsula
	Roebuck Bay mudflats
	Subtropical and Temperate Coastal Saltmarsh
	Trombolite (microbialite) Community of a Coastal Brackish Lake (Lake Clifton)
Terrestrial Conservation Reserves e.g. national parks, nature reserves, and conservation parks.	Numerous bounding marine waters – refer to **Section 9.6.**

9.1 World Heritage Areas

There are two World Heritage Areas located in marine waters of WA, both of which occur in the waters from the South Australian border to the NT border: the Ningaloo Coast and Shark Bay (DEC 2012).

9.1.1 Shark Bay

Shark Bay was included on the World Heritage List in 1991 and is one of the few properties inscribed for all four outstanding natural universal values:

- An outstanding example representing the major stages in the earth's evolutionary history;
- An outstanding example representing significant ongoing ecological and biological processes;
- An example of superlative natural phenomena; and
- Containing important and significant habitats for in situ conservation of biological diversity.

Since 1997, an agreement established the joint management of the Shark Bay WHA by the Australian Commonwealth government and the Western Australian state government, with the operational responsibility by the Western Australian agencies (DEWHA 2008a). This agreement also created a Community Consultative Committee and a Scientific Advisory Committee, both of which provide advice as required. The entire WHA encompasses islands and peninsulas, with an area of approximately 2.2 million hectares (70% of which is marine waters), and includes the following areas (UNESCO 2020):

- Hamelin Pool Marine Nature Reserve;
- Francois Peron National Park;
- Shell Beach Conservation Park;
- Monkey Mia Reserve;
- Monkey Mia Conservation Park;
- Zuytdorp Nature Reserve;
- Bernier, Dorre and Koks Islands Nature Reserves;
- Dirk Hartog Island National Park; and
- Various pastoral leases.

The marine environment of the Shark Bay World Heritage Area is protected as a State Marine Reserve and is discussed further in **Section 11.1.3**.

9.1.2 The Ningaloo Coast

The Ningaloo Coast was included on the World Heritage List in 2011 and was inscribed for outstanding natural universal values as follows:

- An example of superlative natural phenomena and areas of exceptional natural beauty and aesthetic importance;
- outstanding examples representing major stages of Earth’s history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features; and
- the most important and significant natural habitats for in situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

The Ningaloo Coast WHA includes (DEWHA 2010b):

- Ningaloo Marine Park (Commonwealth waters);
- Ningaloo Marine Park (Western Australia state waters);
- Muiron Island Marine Management Area (including the Muiron Islands);

- Jurabi Coastal Park;
- Bundegi Coastal Park;
- Cape Range National Park; and
- Learmonth Air Weapons Range.

The Ningaloo Coast World Heritage Area (including the Muiron Islands) is managed under a plan that is consistent with the World Heritage Convention and Australia's World Heritage management principles. World Heritage Management principles are set out in regulations and cover matters relevant to the preparation of management plans, the environmental assessment of actions that may affect the property and community consultation processes.

The Australian World Heritage management principles are outlined under Schedule 5 of the EPBC regulations (2000). The objective is to ensure that any likely impact of an action on the World Heritage values of the property should be considered. Any action should be consistent with the protection, conservation, presentation or transmission to future generations of the World Heritage values of the property.

The marine environment of the Ningaloo Coast World Heritage Area is protected as a State Marine Park, a Commonwealth Marine Park, and is discussed further in **Section 11.1.4** and **Section 12.3.4**, respectively.

9.2 Wetlands of International Importance (Ramsar)

There are nine wetlands of international importance (Ramsar wetlands) in waters from the South Australian border to the NT border; all were listed in 1990 with the exception of Becher Point which was listed in 2001 and The Dales which was listed in 2002. The Ashmore Reef National Nature Reserve (listed in 2002) is also a Commonwealth Marine Park and is discussed further in **Section 12.3.12.**

9.2.1 Eighty Mile Beach

The Eighty Mile Beach Ramsar site comprises a 220 km beach between Port Hedland and Broome with extensive intertidal mudflats and Mandora Salt Marsh, located 40 km east (Hale & Butcher 2009) totalling 175,487 ha. Eighty Mile Beach is characterised by extensive mudflats supporting an abundance of macroinvertebrates which provide food for large numbers of shorebirds.

Eighty Mile Beach is one of the most important sites for migratory shorebirds in the East Asian Australasian Flyway, with 42 migratory shorebird species recorded at this location. It is estimated that 500,000 shorebirds use Eighty Mile Beach as a migration terminus annually (Hale and Butcher 2009), and more than 472,000 migratory waders have been counted on the mudflats during the September to November period. The location of Eighty Mile Beach makes it a primary staging area for many migratory shorebirds on their way to and from Alaska and eastern Siberia (Hale & Butcher 2009). Although many birds move further on their journey, others remain at the site for the non-breeding period.

Eighty-mile Beach supports more than one per cent of the flyway population (or one per cent of the Australian population for resident species) of 21 waterbirds, including 17 migratory species and four Australian residents. It is one of the most important sites in the world for the migration of Great Knot.

Eighty Mile Beach also supports a high diversity and abundance of wetland birds. A total of 97 wetland bird species have been recorded within the beach portion of the Ramsar site (Hale & Butcher 2009). This includes 42 species that are listed under international migratory agreements CAMBA (38), JAMBA (38) and ROKAMBA (32) as well as an additional 22 Australian species that are listed under the EPBC Act. In addition, there is a single record for Nordmann's Greenshank (*Tringa guttifer*) from the beach, which is listed as endangered under the IUCN Red List (IUCN 2019).

The Mandora Salt Marsh area contains an important and rare group of wetlands (Lake Walyarta and East Lake), including raised peat bogs, a series of small permanent mound springs and the most inland occurrence of mangroves in WA (Hale & Butcher 2009). A small number of tidal creeks dissect the beach, including Salt Creek which is fed partly from groundwater and has permanent surface water. The Mandora Salt Marsh lakes fill predominantly from rainfall and runoff in the wet season then dry back to clay beds. The mound springs likely come from water deep within the Broome sandstone aquifer rising through fractures in the rock, and resulting in permanent mostly freshwater surface water. Flatback turtles (*Natator depressus*), listed as vulnerable under the EPBC Act, regularly nest at scattered locations along Eighty Mile Beach.

Eighty Mile Beach is used for beach based recreation, including four-wheel driving, motorcycling, fishing and shell collecting. Mandora Salt Marsh is mainly used for cattle grazing. The site is traditionally part of Karajarri Country in the north, Nyangumarta Country in the south and Ngarla Country in the southern end of Eighty Mile Beach. The site has artefacts such as middens, pinka (large baler shells used to scoop and carry water for drinking), wilura (used for sharpening spear heads), axes, and flakes, and kurtanyanu and jungari (grinding stones).

9.2.2 Roebuck Bay

The Roebuck Bay Ramsar site is located at Roebuck Bay near Broome in northern WA totalling 34,119 ha. Roebuck Bay has a large tidal range which exposes around 160 km^2 of mudflat, covering most of the Ramsar site (DoE 2014c). Waters more than 6 m deep at low tide are excluded from the site (Bennelongia 2009). The eastern edge of the site is made up of microscale linear tidal creeks (DoE 2014c).

The intertidal mud and sand flats support a high abundance of bottom dwelling invertebrates (between 300—500 benthic invertebrate species), which are a key food source for waterbirds (Bennelongia 2009). The site is one of the most important migration stop-over areas for shorebirds in Australia and globally. For many shorebirds, Roebuck Bay is the first Australian landfall they reach on the East Asian Australasian Flyway. The total numbers of waders using the site each year is estimated at over 300,000 (DoE 2014c). The northern beaches and Bush Point provide important high tide roost sites.

The site receives tidal seawater as well as fresh surface and groundwater, and the balance between the two influences the residual groundwater salinity and the distribution of plants and animals (DoE 2014c). Mangrove swamps line the eastern and southern edges of the site and extend up into the linear tidal creeks (DoE 2014c). They are important nursery areas for marine fishes and crustaceans, particularly prawns.

Extensive seagrass beds occur in the bay, providing an important feeding ground for dugongs and loggerhead and green turtles (Bennelongia 2009). Flatback turtles nest in small numbers, while marine fish (including sawfish) regularly breed in the tidal creeks and mangroves. Dolphins also regularly use the site (DoE 2014c).

The site is used for recreational or tourism activities such as fishing, crabbing, sightseeing and bird watching. Broome Bird Observatory, a small reserve at the northern end of the site, engages in shorebird research and public education.

Roebuck Bay lies in the traditional estate of Indigenous people belonging to both Jukun and Yawuru groups. The site was an important area for seasonal meetings, exchanging gifts, arranging marriages and settling disputes. Numerous shellfish middens, marking former camping places, can still be seen along coastal cliffs and dunes. Indigenous people continue to make extensive use of Roebuck Bay's natural resources for activities such as gathering shellfish, fishing and hunting.

9.2.3 Ashmore Reef National Nature Reserve

In addition to being listed as a National Nature Reserve, Ashmore Reef has been designated a Ramsar Wetland of International Importance due to the importance of the islands in providing a resting place for migratory shorebirds and supporting large breeding colonies of seabirds (Hale and Butcher, 2013). The reserve provides a staging point for many migratory wading birds from October to November and March to April as part of the migration between Australia and the northern hemisphere (Commonwealth of Australia, 2002). Migratory shorebirds use the reserve's islands and sand cays as feeding and resting areas during their migration.

Ashmore is the largest of the atolls in the Timor Province bioregion. The three islands within the site are also the only vegetated islands in the bioregion. Each of the wetland types present are in near natural condition and the site has the largest seagrass coverage in the bioregion. The reserve supports 64 species of internationally and nationally threatened species. This includes 41 species of hard reef forming coral, eight fish, six reptiles (including endangered and critically endangered sea turtles and seasnakes), five sea cucumbers, two giant clams, one soft coral and the dugong.

Ashmore Reef plays a primary role in the maintenance of biodiversity in reef systems in the region. The Reserve supports 275 species of reef building coral, 13 species of sea cucumbers, and high numbers of mollusc species. There are over 760 fish species, 13 species of sea snake, 99 species of decapod crustacean and 47 species of waterbird listed as migratory under international treaties. It supports breeding of 20 species of waterbirds including the brown booby, lesser frigatebird, crested tern, bridled tern, sooty tern and common noddy. The Ramsar site is also important for feeding for green turtles, hawksbill turtle and loggerhead turtle and critical nesting and inter-nesting habitats for green and hawksbill turtles.

Ashmore Reef regularly supports more than 20,000 waterbirds and has been known to support more than 65,000 waterbirds. The Ramsar site regularly supports more than one per cent of at least six species of waterbird including the sooty tern, bar-tailed godwit, grey-tailed tattler, ruddy turnstone, sanderling and greater sand plover.

9.2.4 Becher Point

The Becher Point Wetlands Ramsar site is a system of about sixty small wetlands located near Rockingham in south-west Western Australia and covers 677 ha. The wetlands are made up of chains of small, linear ovoid or irregular shaped basins arranged in five groups, each roughly parallel to the coast and separated by sand ridges (DoE 2014l). The wetlands are an example of shrub swamps and seasonal marshes that have formed in an extensive sequence of inter-dunal depressions that have arisen from seaward advancement of the coastline over recent millennia.

The wetlands in the site are shallow and fill seasonally. Rainfall in winter and spring recharges the groundwater, which rise up to waterlog the wetland basins. The wetlands then dry out again for summer to autumn. When flooded the wetlands are mainly freshwater (DoE 2014l).

The wetlands support sedgelands, herblands, grasslands, open-shrublands and low open-forests. The sedgelands that occur within the linear wetland depressions of the Ramsar site are a nationally listed threatened ecological community. At least four species of amphibians and 21 species of reptiles have been recorded within the wetlands, as well as the Southern Brown Bandicoot (DoE 2014l).

9.2.5 Peel-Yalgorup System

The Peel-Yalgorup System located adjacent to the city of Mandurah in Western Australia, is a large and diverse system of shallow estuaries, coastal saline lakes and freshwater marshes. The site includes the Peel Inlet, Harvey Estuary, Lake McLarty, Lake Mealup and ten Yalgorup National Park wetlands and covers an area of 26, 530 ha (DoE 2014m). Lake Clifton, which is part of the wetlands is one of the few locations in the word where thrombolites occur in inland, hyposaline waters. Thrombalites are underwater rock-like structures that are formed by the activities of microbial communities.

The Peel-Yalgorup System Ramsar site is the most important area for waterbirds in south-western Australia, supporting in excess of 20,000 waterbirds annually (DoE 2014m). It also supports a wide variety of invertebrates and estuarine and marine fish.

9.2.6 Vasse-Wonnerup System

The Vasse-Wonnerup System Ramsar wetland is situated in the Perth Basin, south-western Western Australia and covers an area of 1,115 ha. It is an extensive, shallow, nutrient-enriched wetland system of highly varied salinities. The site is located on a narrow, flat plain separated from the ocean by a narrow system of low dunes. The system is comprised of two former estuaries – the Vasse and Wonnerup lagoons (DoE 2014n).

The system supports tens of thousands of resident and migrant waterbirds of a wide variety of species. More than 33,000 waterbirds have been counted at the Vasse-Wonnerup System and more than 80 species have been recorded in the System including Red-necked Avocets and Black-winged Stilts, Wood Sandpiper, Sharp tailed Sandpiper, Long-toed Stint, Curlew Sandpiper and Common Greenshank (DoE 2014n).

9.2.7 Hosnies Spring

The Hosnies Spring Ramsar site is located on Christmas Island and is a small area of shallow freshwater streams and seepages, 20–45 metres above sea-level on the shore terrace of the east coast of the island covering an area of approximately 199 ha. The site includes surrounding terrestrial areas with rainforest grading to coastal scrub and includes an area of shoreline and coral reef (DoEE 2019).

The Hosnies Spring Ramsar site supports a unique wetland of Christmas Island with the mangrove forest present at the site unique within the bioregion and possibly worldwide. The two species of mangroves that make up the stand, which normally grow intertidally, grow to a height of 24–37 m above sea level that have been estimated to have persisted for 120,000 years. Additionally, the site is important to blue crabs which rely on the freshwater provided by the spring and as a likely migratory route for the endemic red crab during breeding migrations (DoEE 2019).

9.2.8 The Dales

The Dales Ramsar site is located on Christmas Island and is comprised of a near-pristine system of seven watercourses collectively known as The Dales and covers an area of 585 ha. The Dales includes permanent and perennial streams, permanent springs, and include the majority of surface water on the Island. Most rainfall on Christmas Island filters down through the soil and limestone, and surface runoff only occurs after heavy rain. The Dales contain numerous wetland types including surface and karst features, and inland and coastal wetlands (DoEE 2019a).

The Dales support a number of unique ecological and geomorphic features including anchialine cave communities, surface karst including the unique stepped tufa deposits at Hugh's waterfall, a stand of Tahitian chestnuts, a large number of endemic terrestrial species and a significant number of seabirds including Abbott's booby, red-footed booby and the brown booby, all of which breed at the site, and provide essential habitat for the Christmas Island frigatebird (DoEE 2019a).

9.3 Wetlands of National Importance

9.3.1 Ashmore Reef

See the Ashmore Reef National Nature Reserve (**Section 9.2.3**) and Ashmore Reef Marine Park (**Section 12.3.12**).

9.3.2 Mermaid Reef

See the Mermaid Reef Marine Park (**Section 12.3.9**).

9.3.3 Vasse-Wonnerup Wetland System

See the Vasse-Wonnerup Wetland System (**Section 9.2.6**).

9.3.4 "The Dales", Christmas Island

See The Dales Ramsar site (**Section 9.2.8**).

9.3.5 Eighty Mile Beach System

See Eighty Mile Beach Ramsar site (**Section 9.2.1**).

9.3.6 Exmouth Gulf East

The Exmouth Gulf East wetlands are located in the eastern section of Exmouth Gulf from Giralia Bay to Urala Creek Locker Point. The wetland comprises of numerous tidal creeks, indentations and islands of dry land, mudflats, saline coastal flats and extensive mangroves (DAWE 2020a).

The site is one of the major population centres for dugongs in WA and its seagrass beds and extensive mangroves provide nursery and feeding areas for marine fishes and crustaceans in the Gulf. In addition, there are at least 29 species of birds which utilise the wetland, including 16 migratory shorebirds and several terns (DAWE 2020a).

9.3.7 Hosnies Spring, Christmas Island

See Hosnie's Spring Ramsar site (**Section 9.2.7**).

9.3.8 Hutt Lagoon System

The Hutt Lagoon System wetlands (3,000 ha) are located within the Geraldton Sandplains and comprises of Hutt Lagoon and the lakes and marshes immediately north-west and south-east of the lagoon, notably Utcha Swamp. The system is a coastal brine lake which runs parallel to the coast (DAWE 2020b).

Hutt Lagoon is a migratory stop-over for migratory waders, however numbers using the area vary greatly between years and are likely to be lower when northern and inland waterbodies are extensively flooded. Breeding shorebirds include the Australasian grebe (*Tachybaptus novaehollandiae*), grey teal (*Anas gibberifrons*) and eurasian coot (*Fulica atra*) at Utcha Swamp (DAWE 2020b).

9.3.9 Lake Macleod

The Lake Macleod wetland (150,000 ha) is located in the Carnarvon bioregion and includes distinct "inner wetlands" (sinkholes, channels, lakes, marshes) in the west and "floodout marshes" at river mouths in the north-east. The wetland also includes a lakebed that is infrequently inundated. The lake lies parallel to the Indian Ocean, north of the Gascoyne River and located 30 km away from Shark Bay East wetland (DAWE 2020c).

The Lake Macleod is a major migration stop-over and drought refuge area for shorebirds; it is one of the most important non-tidal stop-over sites in Australia. It also supports Australia's largest inland community of mangroves and associated fauna. Fifty-eight species have been identified within the wetland with 29 being shorebirds and eight gulls and terns, with seven species found breeding (DAWE 2020c).

9.3.10 Lake Thetis

The Lake Thetis wetland (7 ha) is located in the Swan bioregion and comprises of seasonal marshes that form in interdunal areas to the south of the lake. Lake Thetis is distinguished by the presence of both a variety of benthic microbial communities (mats) and stromatolites. No threatened species or migratory species have been observed to utilise this wetland (DAWE 2020d).

9.3.11 Learmonth Air Weapons Range – Saline Coastal Flats

The Learmonth Air Weapons Range – Saline Coastal Flats wetland (300 ha) represents typical saline coastal flats subject to inundation and ponding. The vegetation typically has a low species richness, but its floristic composition and structure is highly distinctive and supports habitat specific fauna (DAWE 2020e).

Species composition of the wetland has little information however it is likely to possess a relatively diverse community (DAWE 2020e).

9.3.12 Leslie (Port Hedland) Saltfields System

The Leslie (Port Hedland) Saltfields System (13,000 ha) comprises a large saltfield, fringing coastal flats, tidal creeks and mudflats between the saltfields and the Indian Ocean.

The wetland is likely a major migration stop-over area for shorebirds in the East Asia-Australasia Flyway. It is possibly the most important stop-over site in the Flyway for the broad-billed sandpiper (*Limicola falcinellus*) and an important site for oriental plover (*Charadrius veredus*). It is also likely to be the most important site in Australia for Asian dowitcher (*Limnodromus semipalmatus*) and red-necked phalarope (*Phalaropus lobatus*) (DAWE 2020f).

9.3.13 Prince Regent River System

The site comprises of the entire Prince Regent River system and large areas of mangrove on either side of the river mouth in Saint George Basin (14,300 ha). The site is a tropical estuary and river system incised in a plateau and is characterised by mangrove-fringed embayments (DAWE 2020g).

The site comprises of a diverse assemblage of flora and fauna, and includes mangroves, riverine vegetation, waterbirds, frogs, reptiles and fish. The site includes some of the most suitable and extensive breeding habitat for the saltwater crocodile in WA, well developed river banks with thick stands of reed and grasses (DAWE 2020g).

9.3.14 Roebuck Bay

See Roebuck Bay Ramsar site (**Section 9.2.2**).

9.3.15 Rottnest Island Lakes

The Rottnest Island Lakes wetland site comprises of a cluster of 18 lakes and swamps on the north-east part of Rottnest Island (180 ha). The site is a breeding area for Australian shelduck (*Tadorna tadornoides*) and major breeding area for Australian fairy tern (*Sterna nereis nereis*). The lakes are also a major migration stop-over area for shorebirds in south-western Australia and provide a significant drought refuge area for shorebirds, notably the banded stilt (*Cladorhynchus leucocephalus*) (DAWE 2020h).

9.3.16 Shark Bay East

The Shark Bay East wetland site extends along 250 km of coastline in the east arm of Shark Bay, from the mouth of the Gascoyne River (Carnarvon) south to latitude 26 S. The site comprises tidal wetlands and marine waters that are less than 6 m deep at low tide (up to approximately 10 km from shore). The wetland is a large, shallow marine embayment that support extensive seagrass beds and substantial areas of intertidal mud/sand-flats and mangrove swamp (DAWE 2020i).

The mangroves, algae and seagrasses present at the side are important for both dugongs and green turtles. A total of 69 species have been identified within the wetland including the threatened little tern (*Sterna albifrons*) and 33 shorebirds. A total of six species have been identified to be breeding within the wetland (Australian pelican, great egret, little egret, unidentified cormorants and striated herons). The site is also a stop-over for 24 species of migratory shorebirds (DAWE 2020i).

9.3.17 Cape Leeuwin System

The Cape Leeuwin System site is a small coastal valley, approximately 20 ha in size. Seepage from a series of freshwater springs feed an elongate swamp on the floor of the valley and moistens areas of the limestone and granite coastline to the west (DAWE 2020j). The site has been identified as the habitat for the largest known population of the rare aquatic gastropod mollusc; the Cape Leeuwin freshwater snail (*Austroassiminea letha* (Sr)) (DAWE 2020j).

9.3.18 Doggerup Creek System

The Doggerup Creek System site (2,500 ha) supports extensive flats subject to inundation in the north and east of its catchment. The site includes lakes (e.g. Doggerup, Samuel and Florence Lakes) and many small unnamed swamps. The site is an example of an `acid peat flat' with small permanent lakes and river (DAWE 2020k).

The wetland plant communities include 32 species at Doggerup Lake, 19 at Lake Samuel and 35 at Lake Florence. The site is a major habitat for two aestivating inland fishes, *Galaxiella nigrostriata* and *Lepidogalaxias salamandroides*, that are endemic to the far south coast of WA. No threatened species have been identified within the site and it is not considered to be an important wetland for migratory shorebirds (DAWE 2020k).

9.3.19 Cape Range Subterranean Waterways

The Cape Range Subterranean Waterways wetland site comprises of the subterranean waterways, sinkholes, general groundwater and artificial wells of the coastal plain and foothills of Cape Range north of a line between Norwegian Bay, at the foot of the peninsula on the west coast, and the Bay of Rest in Exmouth Gulf (DAWE 2020l).

The site is one of the only examples of subterranean karst wetland system (apart from Barrow Island) in arid north-western Australia. Two threatened species have been identified within the wetland and include the blind cave eel and the blind gudgeon (DAWE 2020l).

9.3.20 Yalgorup System

See Peel-Yalgorup System Ramsar site (**Section 9.2.5**).

9.4 National Heritage Places

Natural, historic and indigenous places that are of outstanding heritage value to the Australian nation are recorded as National Heritage Places. Eleven National Heritage Places are found in waters from the South Australian border to the NT border, with nine of these occurring within the EMBA. Shark Bay and The Ningaloo Coast are listed as both World Heritage Areas and National Heritage Places, and are discussed in **Section 9.1**.

9.4.1 HMAS Sydney II and HSK Kormoran Shipwreck Sites

The naval battle fought in 1941 between the Australian warship HMAS Sydney II and the German commerce raider HSK Kormoran off the Western Australian coast during World War II was a defining event in Australia's cultural history. The loss of HMAS Sydney II, along with its entire crew of 645 following the battle with HSK Kormoran, remains Australia's worst naval disaster (DoE 2014d).

The shipwreck sites are comprised of two areas located approximately 290 km west-southwest of Carnarvon. The shipwrecks of the HMAS Sydney II and HSK Kormoran are located on the seabed approximately 22 km apart (DoE 2014d).

9.4.2 Batavia Shipwreck site and Survivor Camps Area 1629 - Houtman Abrolhos

The Batavia was included on the National Heritage List in 2006. This shipwreck is the oldest of the known Verenigde Oost-Indische Compagnie (VOC) wrecks on the WA coast and has a unique place in Australian shipwrecks. Because of its relatively undisturbed nature the archaeological investigation of the wreck itself has revealed a range of objects of considerable value to the artefact specialist and historian. The recovered sections of the hull of the Batavia that have been reconstructed in the Western Australian Maritime Museum and provides information on 17th century Dutch ship building techniques, while the remains of the cargo carried by the vessel have provided economic, and social evidence of the operation of the Dutch port at Batavia (now Jakarta) in the early 17th century (DoE 2014d).

9.4.3 The West Kimberley

The West Kimberley was included on the National Heritage List in 2011 and has numerous values which contribute to the significance of the property, including indigenous, historic, aesthetic, cultural and natural heritage values (DoE 2014d). Of these values, the most relevant to the marine environment is Roebuck Bay as a migratory hub for shorebirds. These values are discussed in **Section 9.2.2**. The area is characterised by a diversity of landscapes and biological richness found in its cliffs, headlands, sandy beaches, rivers, waterfalls and islands.

9.4.4 The Ningaloo Coast

See the Ningaloo Coast World Heritage Area (**Section 9.1.2**).

9.4.5 Shark Bay

See Shark Bay World Heritage Area (**Section 9.1.1**).

9.4.6 Dirk Hartog Landing Site 1616 - Cape Inscription Area

Cape Inscription is the site of the oldest known landings of Europeans on the Western Australian coastline (from Dirk Hartog of the Dutch East India Company's ship the Eendracht in October 1616), and is associated with a series of landings and surveys by notable explorers over a 250-year period (DoEE 2019b). The landing site forms part of the Dirk Hartog Island and is about 1,110 ha located 100 km south west of Carnarvon (DoEE 2019b).

9.4.7 Dampier Archipelago (including Burrup Peninsula)

The Dampier Archipelago (including the Burrup Peninsula) contains one of the densest concentrations of rock engravings in Australia, with some sites containing thousands or tens of thousands of images. At a national level it has an exceptionally diverse and dynamic range of schematised human figures and provides an unusual and outstanding visual record of the Aboriginal responses to the rise of sea levels at the end of the last Ice Age (DoEE 2019c).

The site is about 36,860 ha at Dampier and comprises of nine distinct areas of the Burrup Peninsula Areas and part of the following surrounding islands: West Intercourse Island, West Mid Intercourse Island, Enderby Island, Goodwin Island, West Lewis Island and East Lewis Island, Rosemary Island, Brigadier Island, Miller Rocks, Lady Nora Island and Elphick Nob, Malus Islands, Angel Island, Gidley Island, Cohen Island, Keast Island and Collier Rocks, Tozer Island, Dolphin Island, and Unnamed Island (DoEE 2019c).

9.4.8 Fitzgerald River National Park

The Fitzgerald River National Park contains an exceptional concentration of plant species richness and endemism. At an international level it is recognised as a biodiversity hotspot of south western Australia and at a national level it has an exceptional endemism and diversity for plant species. The diversity is considered high due to a wide range of landforms, geology and soil types that supports a diverse community of shrublands and heath, often dominated by eucalypt mallee species (DoEE 2019d).

The national park is approximately 297,244 ha located between Bremer Bay and Hopetoun in the south west of Western Australia. The park contains extensive marine plain sediments deeply incised by several rivers, creating valleys and tablelands. The park's coastline is diverse, consisting of long beaches, quartzite cliffs, extensive sand drifts and inlets. Along the Hamersley and Fitzgerald River valleys are spongolite cliffs that were formed more than 36 million years ago (Eocene period) and consist of sea sponge fossils (DoEE 2019d)

9.4.9 Lesueur National Park

The Lesueur National Park contains an exceptional concentration of plant species richness and endemism. At an international level it is recognised as a biodiversity hotspot of south western Australia and at a national level it has an exceptional endemism and diversity for plant species. The diversity is considered high due to a wide range of landforms, geology and soil types that supports a diverse community of shrublands and heath (DoEE 2019e).

The national park is approximately 27,235 ha located near the towns of Green Head and Jurien Bay. Coastal areas consist of recent (Holocene) sand deposits and mobile dunes extending inland for approximately two kilometres. The dunes are bordered by a series of mainly saline lakes with some freshwater springs and swamps on the eastern margins. Further inland are older (Quaternary) dune systems that have been compacted in places to form limestone. The park supports approximately 122 birds, including a diverse range of honeyeaters, fairy wrens and thornbills (DoEE 2019e).

9.5 Commonwealth Heritage Places

The Commonwealth Heritage Places List comprises natural, indigenous and historic heritage places which are either entirely within a Commonwealth area, or outside the Australian jurisdiction and owned or leased by the Commonwealth or a Commonwealth Authority. Nine natural Commonwealth Heritage Places are found in or adjacent to the EMBA. Three of these places (Ashmore Reef, Mermaid Reef and the Ningaloo Marine Area – Commonwealth Waters) are found in Marine Parks and are discussed further in **Section 12**. The HMAS Sydney II and HSK Kormoran Shipwreck Sites is listed under both National and Commonwealth Heritage Lists and discussed in **Section 9.4.1**.

9.5.1 Scott Reef and Surrounds – Commonwealth Area

Scott Reef is a large, emergent shelf atoll located on the edge of the broad continental shelf, about 300 km from mainland north-western Australia. The listing comprises the areas of Scott Reef that are within Commonwealth waters to the 50 m BSL bathymetric contour. This includes North Reef, an annular reef, 16.3 km long and 14.4 km wide and parts of the lagoon of South Reef, a crescent shaped reef 17 km across (DoE 2014d).

The place is regionally significant both because of its high representation of species not found in coastal waters off Western Australia and for the unusual nature of its fauna which has affinities with the oceanic reef habitats of the Indo-West Pacific as well as the reefs of the Indonesian region (DoE 2014d).

9.5.2 Mermaid Reef – Rowley Shoals

See the Mermaid Reef Marine Park (**Section 12.3.9**).

9.5.3 Ningaloo Marine Area – Commonwealth Waters

See the Ningaloo Coast World Heritage Area (**Section 9.1.2**).

9.5.4 Ashmore Reef National Nature Reserve

See the Ashmore Reef Marine Park (**Section 12.3.12**).

9.5.5 Garden Island

Garden Island is located to the south of Perth, 5 km northwest of Rockingham. It was registered in 2004 based on various fauna, geological, European and Aboriginal heritage and vegetation values. It was the original first site occupied by Governors Stirling's Party in 1829, with prior use by Aborigines and the French (being called Ile de Buache by the French in 1801). The island is virtually free from widespread feral animal colonisation, providing important habitat for various species that have reduced on the mainland. The island provides breeding habitat for bridled tern (*Onychoprion anaethetus*), rainbow bee-eaters (*Merops ornatus*) and osprey (*Pandion haliaetus*), which nest on the rocks surrounding the island. Important feeding habitat for the Sanderling (*Calidris alba*) is provided by sandy beaches on the west coast of the island.

The island provides nesting habitat on beaches for the breeding migrant fairy tern (*Sterna nereis*), which requires undisturbed nesting periods. The mature relatively undisturbed heath, scrub and low forest communities unburnt since the 1920's in the northern section of the island are especially important as a reference site for natural history. The least disturbed examples of calcaronite reef structures dune and tamate landscapes in the metropolitan region are present on the western side of the island (DoEE 2016b).

9.5.6 Christmas Island Natural Areas

Christmas Island is located is approximately 1,500 km from Exmouth and is approximately 2,200 ha above Low Water and 3,600 ha below Low Water in the Indian Ocean. The island is an uplifted coral atoll with its characteristic steep series of rainforest-covered terraces and sheer limestone cliffs. It was registered in 2004 based on various fauna, vegetation, geological and cultural heritage values. The evolutionary significance of Christmas Island is demonstrated both by its high level of endemism and by its unique assemblage of plant and animal species. The island hosts seventeen endemic plant species and rich endemic fauna includes three mammal species, ten bird species, five reptile species, one crab species, two insects, three marine fish species and several marine sponge species (DoEE 2019f).

The rainforests of Christmas Island are biogeographically significant; species have evolved from being either shoreline forest or early rainforest succession species to those that fill a tall climax rainforest role. The Island contains unique plant communities of high conservation and scientific interest including a variety of elevated and relict cycad and back-mangrove communities of international significance (DoEE 2019f).

The island is also one of the world's most significant seabird islands, both for the variety and numbers of sea-birds, with over 100 species of bird having been recorded, including eight species that breed on the island. The island rainforest provides significant habitat for two endemics the nationally endangered Abbott's booby and the nationally vulnerable Christmas Island frigate bird (DoEE 2019f).

The fringing simple reefs and adjacent waters of Christmas Island support provides habitat for two nationally vulnerable species of turtle, the green and hawksbill which nest on two of the Island's beaches and two nationally vulnerable shark species (DoEE 2019f).

9.5.7 Yampi Defence Area

The Yampi Defence Area is located at the confluence of the Dampierland, Central and Northern Kimberley biogeographic regions and has a diverse range of ecosystems of landforms, soils and vegetation representative of the transition from the sandstone plateaux of the wetter north-west Kimberley, to the broad plains and pindan scrub of the drier south-west Kimberley (DoEE 2019g).

The diversity of landforms in the place and the resultant high concentration of small refugial habitats support a regionally rich vertebrate fauna. The bird fauna is significant as it represents a suite of species which are at or near the southern edge of their range in the semi-humid zone of the Kimberley. The place is also an important zone of overlap between many northern and southern species and sub-species. The vertebrate fauna shows its closest similarity to those recorded from the wetter areas of the west Kimberley that lie further to the north. The place supports several fauna and flora species that are listed as specially protected, threatened or having priority status in Western Australia in addition to four fauna species that are nationally vulnerable and one nationally endangered (DoEE 2019g).

9.5.8 Learmonth Air Weapons Range Facility

The Learmonth Air Weapons Range Facility is located 30 km south west of Learmonth within Cape Range and Adjacent Coastal Plain, which is listed on the Register of the National Estate. As the Learmonth Air Weapons Range Facility is located within Cape Range it is of considerable importance of showing he sea level and landform changes for the past 1.8 million years (DoEE 2019h).

The area is important to a number of cave fauna of Cape Range and is considered of exceptional biogeographical importance. It hosts a high number of endemic aquatic stygofauna with ecosystems found within this area are considered rare within Western Australia and are considered to be of considerable scientific interest. The area also supports several species of terrestrial fauna that are isolated populations, populations at the extent of their range and a number of fauna and flora species that are endemic to southern WA and restricted to sandy coastal habitats along the western coast (DoEE 2019h).

9.5.9 Lancelin Defence Training Area

The Lancelin Defence Training Area is located approximately 11 k north of Lancelin township situated on the Swan Coastal Plain and consists of three main land systems that include Quindalup and Spearwood Dune Systems (together making up the Coastal Belt), and the Bassendean Dunes (DoEE 2019i).

The area supports a high diversity of vegetation types, flora species, fauna habitat types and a high diversity of terrestrial fauna.

9.6 Coastal Terrestrial Conservations Reserves – bound by marine waters

Conservation reserves are created under the Land Administration Act 1997, and once reserved and set aside for conservation purposes are regulated under the *Conservation and Land Management Act (CALM) 1984*. Most conservation reserves in WA are vested in (owned) by the WA Conservation and Parks Commission, an independent statutory body established by the CALM Act 1984, and most are managed by the Department of Biodiversity, Conservation and Attractions – Parks and Wildlife Service.

In WA there are three main types of terrestrial conservation reserves with legislative protection:

+ Nature reserves – established for wildlife and landscape conservation; scientific study; and preservation of features of archaeological, historic or scientific interest;
+ National parks – as above but also to be used for enjoyment by the public. Have national or international significance; and
+ Conservation parks – as above but have local or regional significance.

Nature reserves can have an extra classification applied to them and become ‘A class’ reserves, which generally require an Act of Parliament to alter.

There are numerous terrestrial conservation reserves located adjacent to the coast in the EMBA. The oceanward boundary of the reserves varies. In some cases, the reserves extend to the low water mark, i.e. including the inter-tidal zone (particularly applicable to older gazetted reserves and terrestrial reserves not surrounded by a marine reserve). While in other cases, the terrestrial reserves extend to the high-water mark e.g. Lowendal Islands Nature Reserve (particularly applicable to terrestrial reserves adjacent to more recently gazetted marine parks). In other cases, the seaward boundary of the reserves is not defined. Management plans also contain the caveat for further consideration of the most appropriate tenure for intertidal areas and management arrangements.

Further information on coastal terrestrial reserves is provided below in **Section 9.6.1** (national parks) and **Section 9.6.2** (nature reserves and conservations parks).

9.6.1 Coastal National Parks

Protected coastal national parks managed under the CALM Act 1984 in the EMBA are listed in **Table 9-2**. The table also includes: any applicable management plan; whether the park includes the inter-tidal area; and the name of any adjacent state marine reserve. All National Parks are WA Class A reserves and IUCN Class 2.

Table 9-2: Coastal National Parks – coastal boundary in relation to inter-tidal zone

National Park	IBRA bioregion[9]	Management plan	Includes inter-tidal zone	Adjacent Marine Management Park (see Section 11)
Reserves of Northern WA (see Figure 9-4)				
Lawley River	Northern Kimberley	-	No [10]	Kimberley Marine Park
Mitchell River		-		
Prince Regent		-		
Reserves of North-West WA (see Figure 9-5)				
Murujuga	Pilbara	Murujuga National Park management plan 78 (DEC 2013)	Yes [11]	-
Cape Range	Carnarvon	Cape Range National Park Management Plan (DEC 2010a)	No	Ningaloo Marine Park
Reserves of Southern WA – (see Figure 9-6)				
Francois Peron	Carnarvon	Shark Bay Terrestrial Reserves and Proposed Reserve Additions Management Plan (2012)	No	Shark Bay Marine Park and Hamelin Pool Marine Nature Reserve
Dirk Hartog	Yalgoo		Yes – intertidal zone on western side of Dirk Hartog is included (as no marine park on western side of island)	
Houtman Abrolhos Islands	Geraldton Sandplains	-	No - extends to the high water mark only.	Abrolhos Commonwealth Marine Park
Kalbarri	Geraldton Sandplains	Kalbarri National Park Management Plan (DPAW 2015)	Yes [11]	-
Namburg	Geraldton Sandplains	Namburg National Park Management Plan (1998)	Yes	-
Yalgorup	Swan Coastal Plain	Yalgorup National Park Management Plan (CALM 1995)	Yes [11]	-

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[9] IBRA classifies Australia's landscapes into large geographically distinct bioregions based on common climate, geology, landform, native vegetation and species information (DoEE 2012).

National Park	IBRA bioregion[9]	Management plan	Includes inter-tidal zone	Adjacent Marine Management Park (see Section 11)
Leeuwin - Naturaliste	Warren	Leeuwin-Naturaliste Capes Area Parks and Reserves Management Plan (DPAW 2015)	No	Ngari Capes Marine Park
Torndirrup	Warren	Albany coast draft management plan 2016 (DPaW 2016b)	Yes[11]	
Walpole-Nornalup	Warren	Walpole Wilderness and Adjacent Parks and Reserves Management Plan (DEC 2008) Walpole and Nornalup Inlets Marine Park Management Plan No 62 (DEC 2009b)	Yes[11]	Walpole and Nornalup Inlets Marine Park
Waychinicup	Southern Jarrah Forest and Fitzgerald	Albany coast draft management plan 2016 (DPAW 2016)	Yes[11]	
West Cape Howe	Warren	Albany coast draft management plan 2016 (DPaW 2016)	Yes[11]	
D'Entrecasteaux	Warren	Shannon and D'Entrecasteaux National Parks Management Plan No. 71 (DEC 2012b)	Yes[11]	
Fitzgerald River	Fitzgerald	Fitzgerald River National Park Management Plan 1991 – 2001 No. 15 (CALM 1991)	Yes[11]	

9.6.2 Coastal Nature Reserves and Conservation Parks

Protected coastal nature reserves and conservation parks managed under the CALM Act 1984 in the EMBA are listed in **Table 9-3** and shown in **Figure 9-4**, **Figure 9-5** and **Figure 9-6** for the north, north-west and south of WA respectively. The table also includes reserve class; IUCN classification; any applicable management plan; whether the reserve includes the inter-tidal area; and the name of any adjacent state marine reserve (may also describe inter-tidal areas values).

The CALM Act does not require management plans to be in place for conservation reserves at all time, instead they are required to be made as is reasonably practicable regarding resources. This means some conservation reserves do not have a management plan, or do not have a recent management plan.

Table 9-3: Nature Reserves (NR) and Conservation Parks (CP) in EMBA

Reserve name and type	Reserve class (WA)	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
Reserves of Northern WA (see Figure 9-4)					
Ord River NR	-	1a	-	No [10]	North Kimberley Marine Park
Pelican Island NR	-	1a			
Lesueur Island NR	A	1a			
Low Rocks NR	A	1a			
Browse Island NR	A	1a	-	Yes [11]	-
Scott Reef NR	-	1a	-	Yes [11]	-
Adele Island NR	A	1a	-	Yes [11]	-
Tanner Island NR	A	1a	-	Yes [11]	-
Lacepede Islands NR		1a	-	Yes [11]	-
Coulomb Point NR	A	1a	-	Yes [11]	-
Yawaru Birragun CP; Yawuru Northern Intertidal Area	- & A	2 & 6	Yawaru Birragun Conservation Park Management Plan (DPaW 2016). *Yawuru Intertidal Area management plan is not yet available.*	Yes	-
Jinmarnkur CP	C	-	Parks and reserves of the south-west Kimberley and north-west Pilbara Draft Management Plan (DPAW 2016). *Covers 80 Mile Beach coastal reserves.*	No	Eighty Mile Beach Marine Park
Jinmarnkur Kulja NR	A	-			
Kujungurru Warrarn NR	A	1a			
Kujungurru Warrarn CP	C	-			
Unnamed	A	-			
Jarrkunpungu NR	A				
Bedout Island NR	A	1a	-	Yes [11]	-
North Turtle Island NR	A	1a	-	Yes [11]	-
Reserves of North-West WA (see Figure 9-5)					
Unnamed (Dampier Archipelago) NR	A	1a	Dampier Achipelago Management Plan (CALM 1990). *Covers 25 of the islands*	Yes	-
Swan Island NR	A	1a	-	Yes[11]	Kimberly Marine Park
Unnamed NR		1a	-	Yes [11]	-
North Sandy Island NR	A	1a	-	Yes [11]	-

[10] Inferred as adjacent marine park boundary is the high water mark and dual tenure cannot exist.

[11] Conservatively inferred as no adjacent Marine Park.

Reserve name and type	Reserve class (WA)	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
Montebello Islands CP	A	2	-	Partially [12]	Montebello Islands Marine Park
Lowendal Island NR		1a	-	No	Barrow Island Marine Management Area and Marine Park. Lowendal Island NR only partially bounded
Barrow Island NR	A	1a	Barrow Island Group Nature Reserves (DPAW 2015)	Yes	
Boodie, Double and Middle Islands NR	-	1a		Yes	
Great Sandy Island NR	B	1a	-	Yes	Barrow Island Marine Management Area
Weld Island NR	-	1a	-	Yes [11]	-
Little Rocky Island NR	A	1a	-	Yes [11]	-
Airlie Island NR	-	1a	-	Yes [11]	-
Thevenard Island Nature	-	1a	-	Yes [11]	-
Bessieres Island NR	A	1a	-	Yes [11]	-
Serrurier Island NR	-	1a	-	Yes [11]	-
Round Island NR	-	1a	-	Yes [11]	-
Locker Island NR	A	1a	-	Yes [11]	-
Rocky Island NR	-	1a	-	Yes [11]	-
Gnandaroo Island NR	A	1a	-	Yes [11]	-
Victor Island NR	-	1a	-	Yes [11]	-
Y Island NR	-	1a	-	Yes [11]	-
Tent Island NR	-	1a	-	Yes [11]	-
Burnside and Simpson Island NR	-	1a	-	Yes [11]	-
Whalebone Island NR		1a	-	Yes [11]	-
Whitmore, Roberts, Doole Islands & Sandalwood Landing NR	-	1a	-	Yes [11]	-
Muiron Islands NR	-	1a	Jarabi and Bundegi Coastal Parks and Muiron Islands (CALM 1999)	No [10]	Muiron Islands Marine Management Area
OneTree Point NR	A	1a	-	Yes [11]	
Reserves of Southern WA – (see Figure 9-6)					
Koks Island NR	A	1a	Shark Bay Terrestrial Reserves and Proposed Reserve Additions	Yes [11]	-
Bernier and Dorre Islands NR	A	4			

[12] Reserve R42197 includes the inter-tidal zone and reserve R42196 does not.

Reserve name and type	Reserve class (WA)	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
Shell Beach CP	-	3	Management Plan (DPAW 2012)	No	Shark Bay Marine Park
Freycinet, Double Islands etc NR	A	1a			Shark Bay Marine Park
Zuytdorp NR	-	1a		Yes [11]	-
Beekeepers NR	-	1a	-	Yes [11]	-
Beagle Islands NR	A	1a	Turquoise Coast Nature Reserve Management Plan (CALM 2004). *Covers chain of approximately 40 protected islands lying between Lancelin and Dongara.*	Yes	-
Lipfert, Milligan, etc Islands NR	A	1a			-
Fisherman Islands NR	A	1a			Jurien Bay Marine Park: extends from Greenhead south to Wedge Island
Sandland Islands NR	A	1a			
Boullanger, Whitlock, Favourite, Tern and Osprey Islands NR	A	1a			
Escape Island NR	A	1a			
Essex Rocks NR	A	1a			
Outer Rocks NR	A	1a			
Ronsard Rocks NR	A	1a			
Cervantes Islands NR	A	1a			
Buller, Whittell and Green Islands NR	A	1a			
Wedge Island NR	A	1a			
Lancelin and Edwards Islands NR	A	1a			-
Southern Beekeepers NR	-	1a	Namburg National Park Management Plan (CALM 1998)	No	-
Wanagarren NR	-	1a		Yes	
Nilgen NR	-	1a		Yes	
Unnamed CP (R 49994) west of Wilbinga	-	2	-	Yes [11]	-
Unnamed CR (R 42469) at Woodman Point	-	-	Woodman Park Regional Park Management Plan (DEC 2010b)	No	-
Unnamed CP at Woodman Point (R 49220)	-	2		No	-
Carnac Island NR	A	1a	Carnac Island Nature Reserve Management Plan (CALM 2003)	Yes	-
Penguin Island CP	A	3	Shoalwater Islands Management Plan (CALM 2002)	No	Shoalwater Islands Marine Park
Shoalwater Islands NR	A	1a		Yes	

Reserve name and type	Reserve class (WA)	IUCN	Management Plan	Includes inter-tidal zone	Adjacent Marine Park (see Section 11)
Port Kennedy Scientific Park	A	1a	Rockingham Lakes Regional Park (DEC 2015)	No	-
Leschenault Peninsula CP	A	2	Leschenault Peninsula Management Plan (CALM 1998)	Yes	-
Sugar Loaf Rock NR	A	1a	Leeuwin-Naturaliste Capes Area Parks and Reserves Management Plan (DPAW 2015)	Yes	Ngari Capes Marine Park
Hamelin Island NR	A	1a		Yes	
Seal Island NR	A	1a		Yes	
St Alouarn Island NR	A	1a		Yes	
Flinders Bay NR	A	1a		Yes	
Quagering NR	A	1a	-	Yes[11]	-
Doubtful Islands NR	A	1a	-	Yes	Bremer Marine Park
Quarram NR	A	1a	-	Yes	South-west corner Marine Park
Chatham Island NR	A	1a	-	Yes	
Two Peoples Bay NR	A	4	Albany coast draft management plan 2016 (DPAW 2016b)	Yes[11]	-
Breaksea Island NR	A	1a		Yes[11]	-
Bald Island NR	A	1a		Yes[11]	-
Eclipse Island NR	A	1a		Yes[11]	-
Michaelmas Island NR	A	1a		Yes[11]	-
Glasse Island NR	A	1a	-	Yes[11]	-
Arpenteur NR	-	1a	-	No	-

Further information is provided below in relation to Varanus Island and Airlie Island Nature Reserves. Santos' Varanus Island Processing Hub and Airlie Island (operations ceased) co-exist with the reserves.

Lowendal Islands Nature Reserve - Varanus Island

Varanus Island is part of the Lowendal Islands group, a Nature Reserve (Class C). The Lowendal Islands comprise more than 40 limestone islands, islets and rocky stacks. There is not currently a DBCA Management Plan covering the Lowendal Islands Nature Reserve. Varanus Island is the largest island in the Lowendal Islands and is approximately 2.5 km long and 600m wide at its widest point. Its highest point is approximately 30m above sea level.

Described ecological conservation values of marine relevance include: Wedge-tailed Shearwater nesting (see **Section 8.1.6**); Loggerhead and Hawksbill Turtle nesting (see **Section 6.1.1** and **Section 6.1.3**), Flatback Turtle nesting (Section 6.1.4). The Lowendal Islands are described as particularly important for tern breeding (DEC 2002), further information on terns is provided in **Section 8.2.1**.

Airlie Island Nature Reserve

Airlie Island Nature Reserve is an ungazetted 'C' class nature (Reserve identifier: 40323, Crown Lease 1901/100) located on Airlie Island. Airlie Island is a small sand cay (26 Ha) located 35 km NNE of Onslow. It is part of the Pilbara Inshore Islands chain. A management plan for the nature reserves of the Pilbara Inshore Islands is currently under development (DBCA 2019) i.e. there is not currently a DBCA Management Plan covering Airlie Island Nature Reserve.

Described ecological conservation values of marine relevance include: a wedge-tailed shearwater nesting (see **Section 8.1.6**); silver gull nesting (see **Section 8.1.6**) and low levels of green turtle and hawksbill turtle nesting (see **Section 6.1.2** and **6.1.3**).

9.7 Threatened Ecological Communities

An ecological community is a naturally occurring group of plants, animals and other organisms interacting in a unique habitat. Ecological communities are listed under the EPBC Act as threatened if the community is at risk of extinction.

Similarly, ecological communities can be listed under the WA BC Act as threatened if facing a risk of becoming a collapsed ecological community. To date no ecological communities are listed as threatened under the WA Act, however several ecological communities are currently endorsed by the WA Minister of Environment as Threatened Ecological Communities (TECs) through the previous non-statutory process.

TECs of relevance (likely to exist in marine water inter-tidal areas) in the EMBA are listed in **Table 9-1** and further described below.

Table 9-4: Relevant TEC in the marine EMBA

Species	Conservation Status		
	EPBC Act 1999 (Cwth)	BC Act 2016 (WA)	Otherwise endorsed by the WA Minister for Environment
Monsoon Vine Thicket on the Ridge on the Coastal Sand Dunes of Dampier	Endangered	-	Vulnerable
Roebuck Bay mudflats	-	-	Vulnerable
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	-	-

9.7.1 Monsoon Vine Thicket on the Ridge on the Coastal Sand Dunes of Dampier

Monsoon vine thicket occurs as semi - deciduous and evergreen vine thicket communities on and behind landward slopes of coastal sand dunes on the Dampier Peninsula in the Kimberley Region. This community is closely associated with coastal dunes elsewhere on the Dampier Peninsula and is listed as Endangered under the EPBC Act (Government of Western Australia 2010; DoEE 2016b). The community is also endorsed by the WA Minister for Environment as a threatened ecological community (non-statutory process).

9.7.2 Roebuck Bay Mudflats

Roebuck Bay mudflats (Kimberley region) have been endorsed by the WA Minister for Environment as a threatened ecological community (non-statutory process). The TEC is not listed under the EPBC Act.

Roebuck Bay mudflats (Kimberley region) are described as a ‘species rich faunal community of the intertidal mudflats of Roebuck Bay’ in the Kimberley region. Classed as Vulnerable (B). Roebuck Bay is a tropical marine embayment with extensive, biologically diverse, intertidal mudflats.

Roebuck Bay is protected as a designated Ramsar Wetland of International Importance (**Section 9.2.2**) and Marine Park (see **Sections 11.1.17** and **12.3.10**).

9.7.3 Subtropical and Temperate Coastal Saltmarsh

Subtropical and Temperate Coastal Saltmarsh occurs within the subtropical and temperate climatic zones and is present in coastal areas under regular or intermittent tidal influences and occurs over six State jurisdictions (Queensland, New South Wales, Victoria, Tasmania and WA). In WA it occurs from the south coast up to the southern part of Shark Bay. The community is made up of mainly salt tolerant vegetation which include halophytes as well as a number of non-vascular plant species. The community is listed as vulnerable under the EPBC Act (DoE 2014k).

9.7.4 Thrombolite (microbialite) Community of a Coastal Brackish Lake (Lake Clifton)

The Lake Clifton thrombolite community is restricted to Lake Clifton, which occurs on the Swan Coastal Plain region of WA. Lake Clifton is situated within the Yalgorup National Park and is the northernmost lake in the Peel-Yalgorup Lakes System, which consists of several hypersaline and brackish lakes (Moore 1990). The Lake Clifton thrombolite community occurs on a relict foredune plain of Holocene age sands. The main known occurrence of the ecological community is a stretch, approximately 15 km long and up to 15 m wide, along the north-eastern shoreline of Lake Clifton. There are other small clusters of thrombolites within the Lake, also at the northern end. The thrombolites cover a total area of approximately four square kilometres (Moore 1990). This structure is the largest known example of a living, non-marine microbialite reef in the southern hemisphere.

The Thrombolite (microbialite) Community of a Coastal Brackish Lake (Lake Clifton) is listed as critically endangered under the EPBC Act because it has a very restricted distribution and recent investigations indicate that *Scytonema*, a key cyanobacterium for thrombolite formation has gone from being a dominant species to no longer being found in Lake Clifton thrombolites.

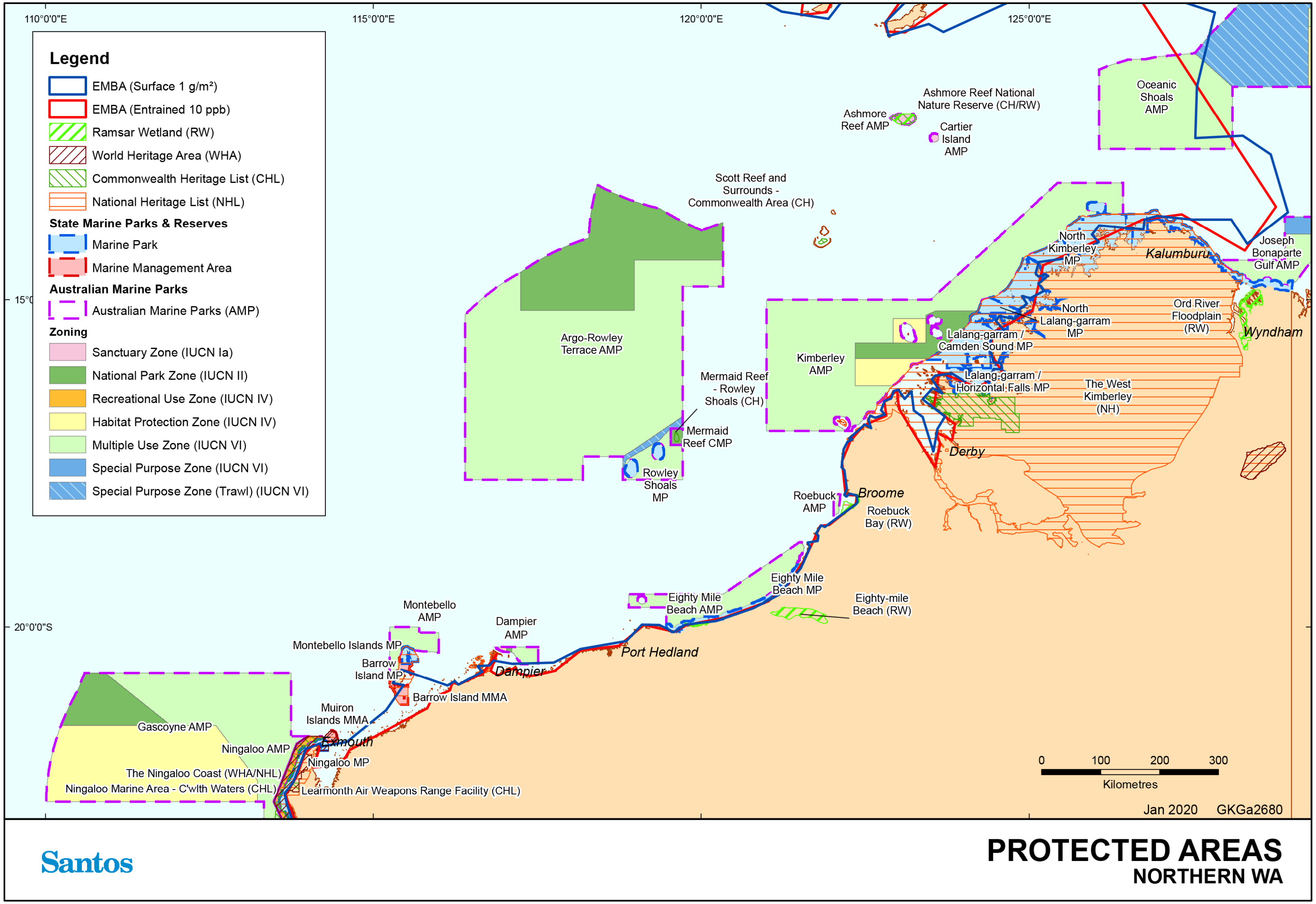

Figure 9-1: Protected areas in Northern WA

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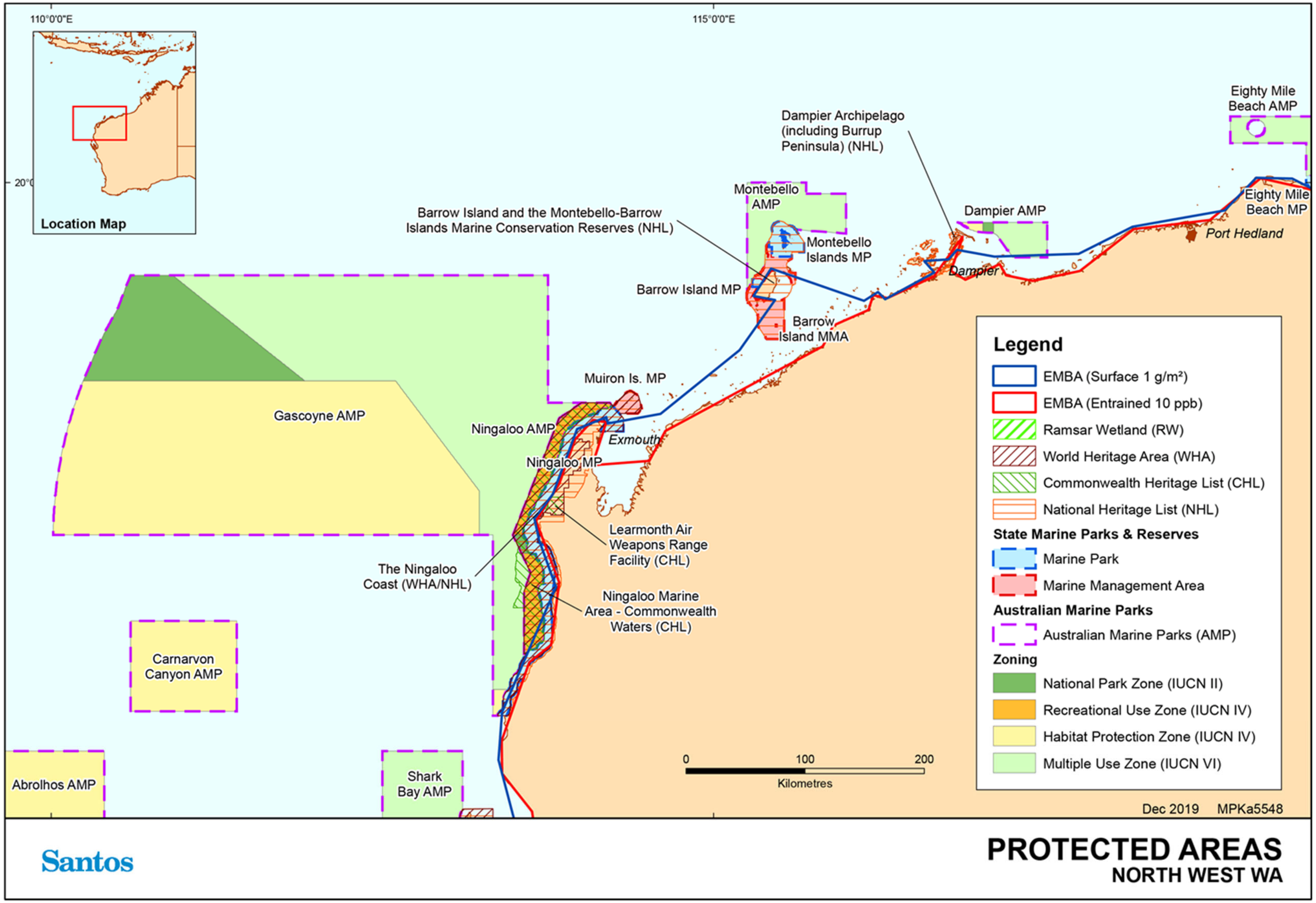

Figure 9-2: Protected areas in North-West WA

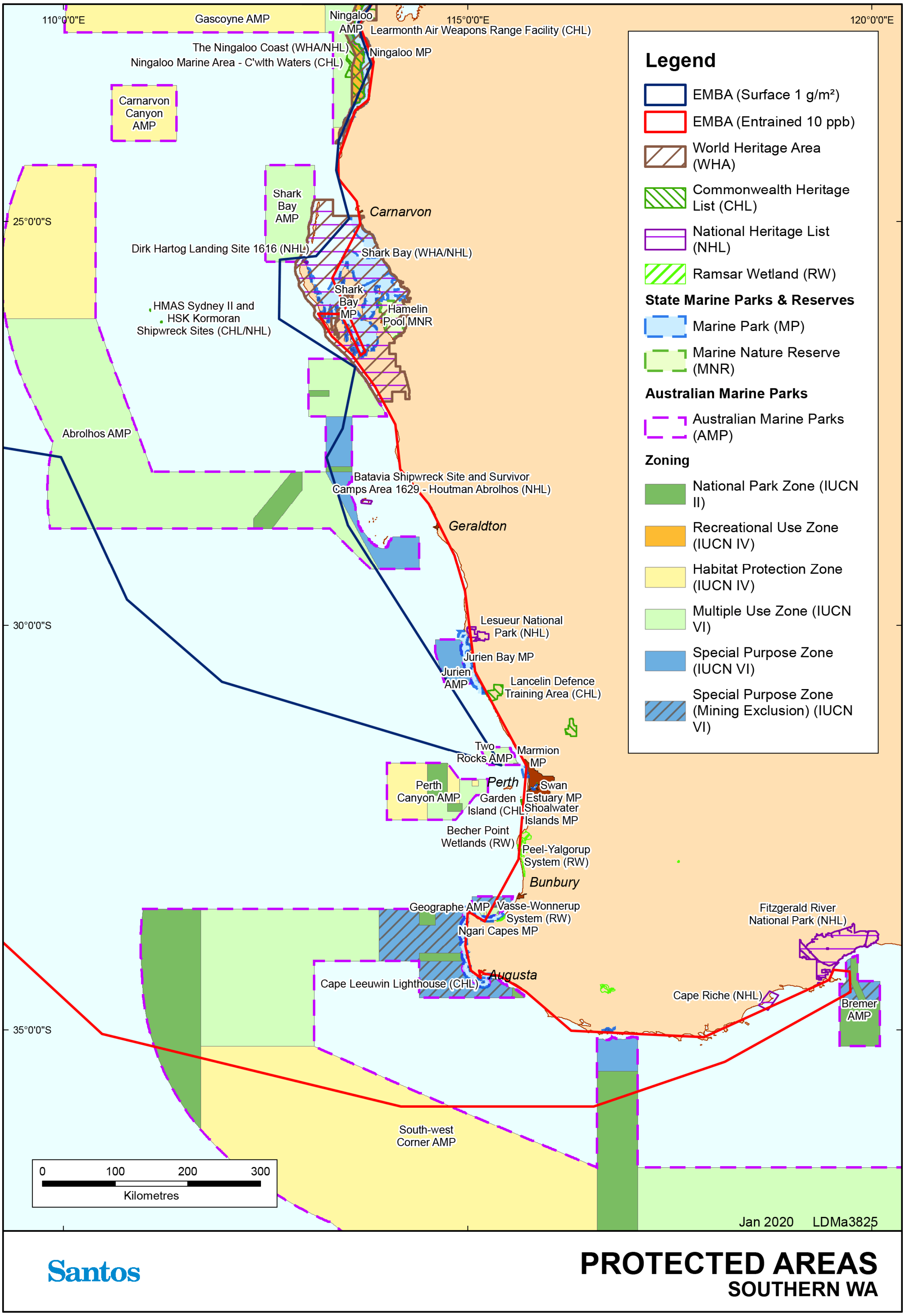

Figure 9-3: Protected areas in Southern WA

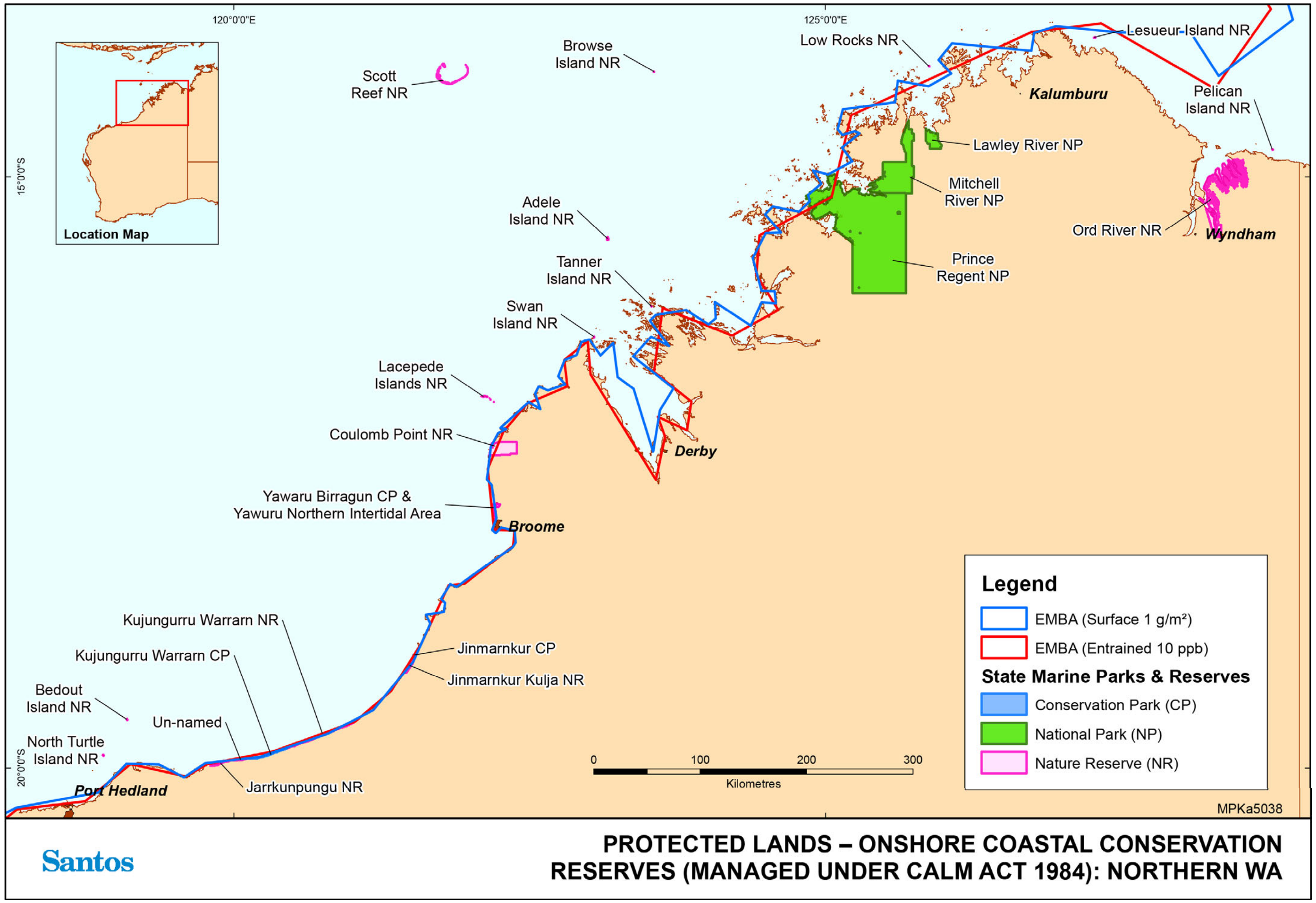

Figure 9-4: Protected Lands (CALM Act 1984) – terrestrial conservation reserves bounding marine waters in northern WA[13]

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[13] Yawaru Minyirr Buru Conservation Reserve (adjacent to Roebuck Bay) not shown as exact spatial extent unavailable, however the adjacent inter-tidal waters are managed under adjacent Roebuck Bay Marine Park (described in **Section 11.1.17**).

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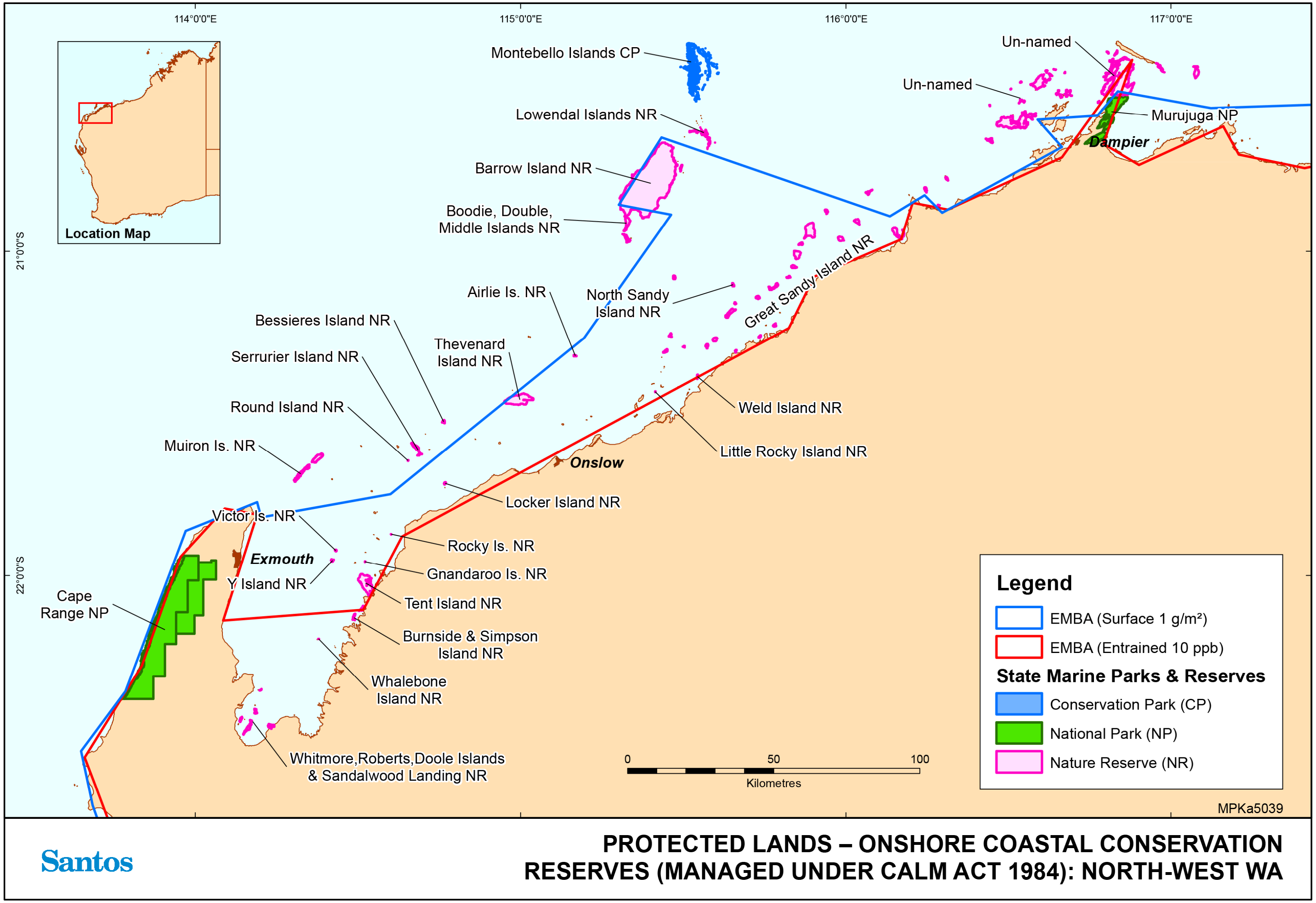

Figure 9-5: Protected Lands (CALM Act 1984) – terrestrial conservation reserves bounding marine waters in North-West WA

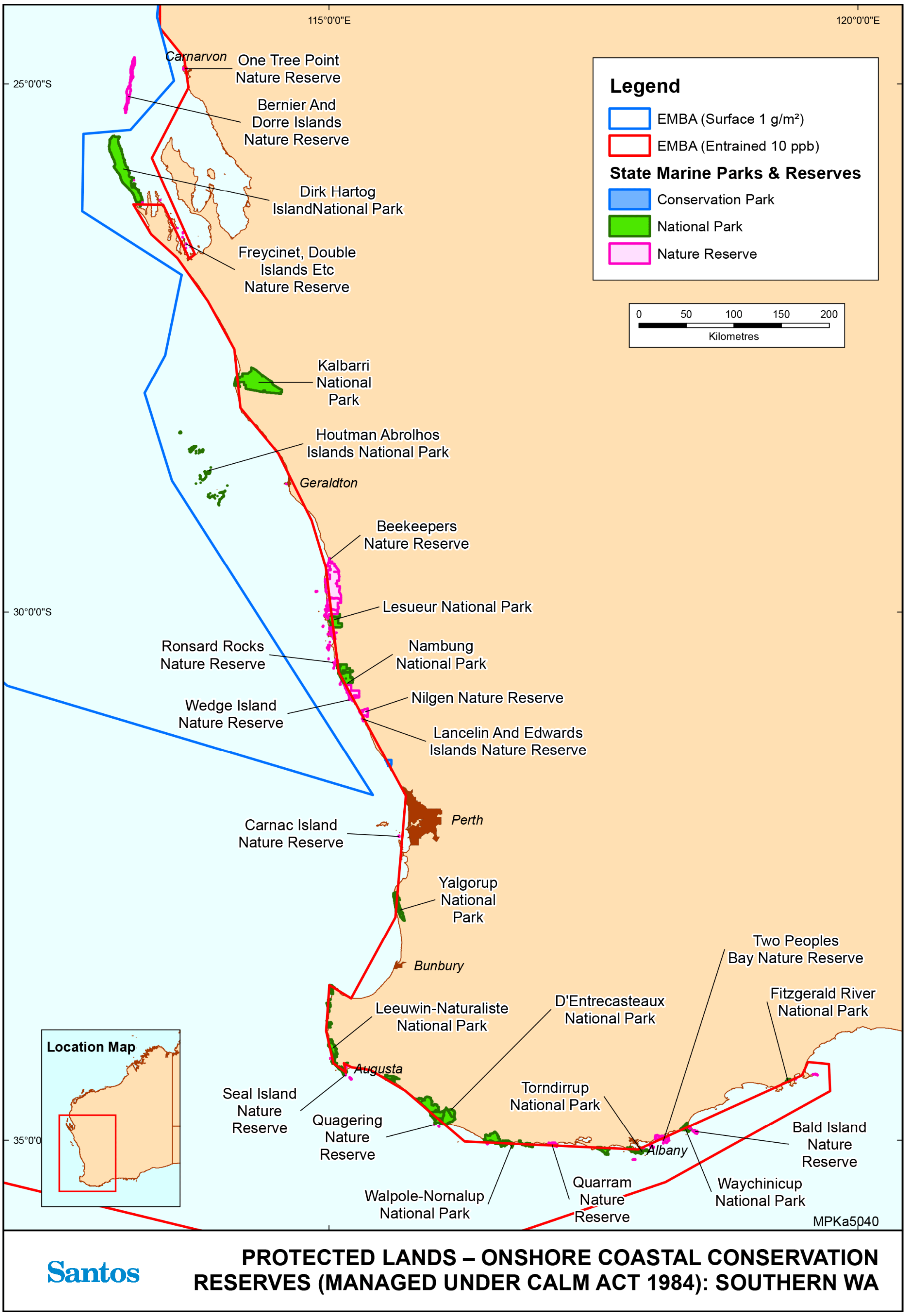

Figure 9-6: Protected Lands (CALM Act 1984) – terrestrial conservation reserves bounding marine waters in Southern WA[14]

[14] Rottnest Islands Conservation Park Conservation Park is not shown (managed under Rottnest Island Authority Act 1987).

9.8 International Protected Areas

There are 53 National Parks in Indonesia, six are World Heritage Sites, nine are part of the World Network of Biosphere Reserves and five are wetlands of international importance under the Ramsar convention. A total of nine parks are largely marine (ADB 2014). Of these protected areas only the Laut Sawu Marine National Park (including the Tirosa Batek Marine Area and the Sumba Strait Marine Area) intersects with the EMBA.

The Laut Sawu Marine National Park located within the Lesser Sunda Ecoregion in the Savu Sea and covers a reported 35,211 km^2 (Protected Planet 2017). It was established in 2009 and has an IUCN Category II status (Protected Planet 2017). The marine park area is a known migration route for several cetacean species, including the blue whale and sperm whale. Other cetacean species such as pygmy killer whales, melon-head whale, short-finned pilot whales and numerous dolphin species (including Risso's dolphin, Fraser's dolphin, common dolphin, bottlenose dolphin and spinner dolphin) are known to frequent the marine park area. Several species of marine turtle, including the green turtle, hawksbill turtle and leatherback turtle have also been recorded in the marine park area.

The marine park area covers a range of habitats and species diversity, including:

+ 532 corals species which include 11 endemic and sub endemic species;
+ 350 reef fish species;
+ fifteen mangrove species are recorded that represented 9 families of mangrove;
+ ten seagrass species;
+ deep-water habitats such as seamounts, deep-water canyons, straits (migratory corridors);
+ large persistent pelagic habitats;
+ main migratory corridors and habitats for 14 whale species, seven dolphin's species, and dugong; and
+ habitats for five sea turtle species (green, leatherback, olive ridley, loggerhead, and flatback) as well as for large marine fauna such as sharks, napoleon, parrotfish and groupers (Savu Sea National Marine Conservation Area undated).

10. Key Ecological Features

10.1 Introduction

Key ecological features (KEFs) 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. KEFs meet one or more of the following criteria (DSEWPaC 2012a):

- A species, group of species or a community with a regionally important ecological role;
- A species, group of species or a community that is nationally or regionally important for biodiversity;
- An area or habitat that is nationally or regionally important for:
  - Enhanced or high biological productivity;
  - Aggregations of marine life; or
  - Biodiversity and/or endemism
- A unique seafloor feature with ecological properties of regional significance.

Twenty four key ecological features of the Commonwealth waters in the EMBA (covering the NMR, the NWMR and the SWMR) have been identified in the protected matters search (**Figure 10-1** and **Figure 10-2**) and are discussed in this section.

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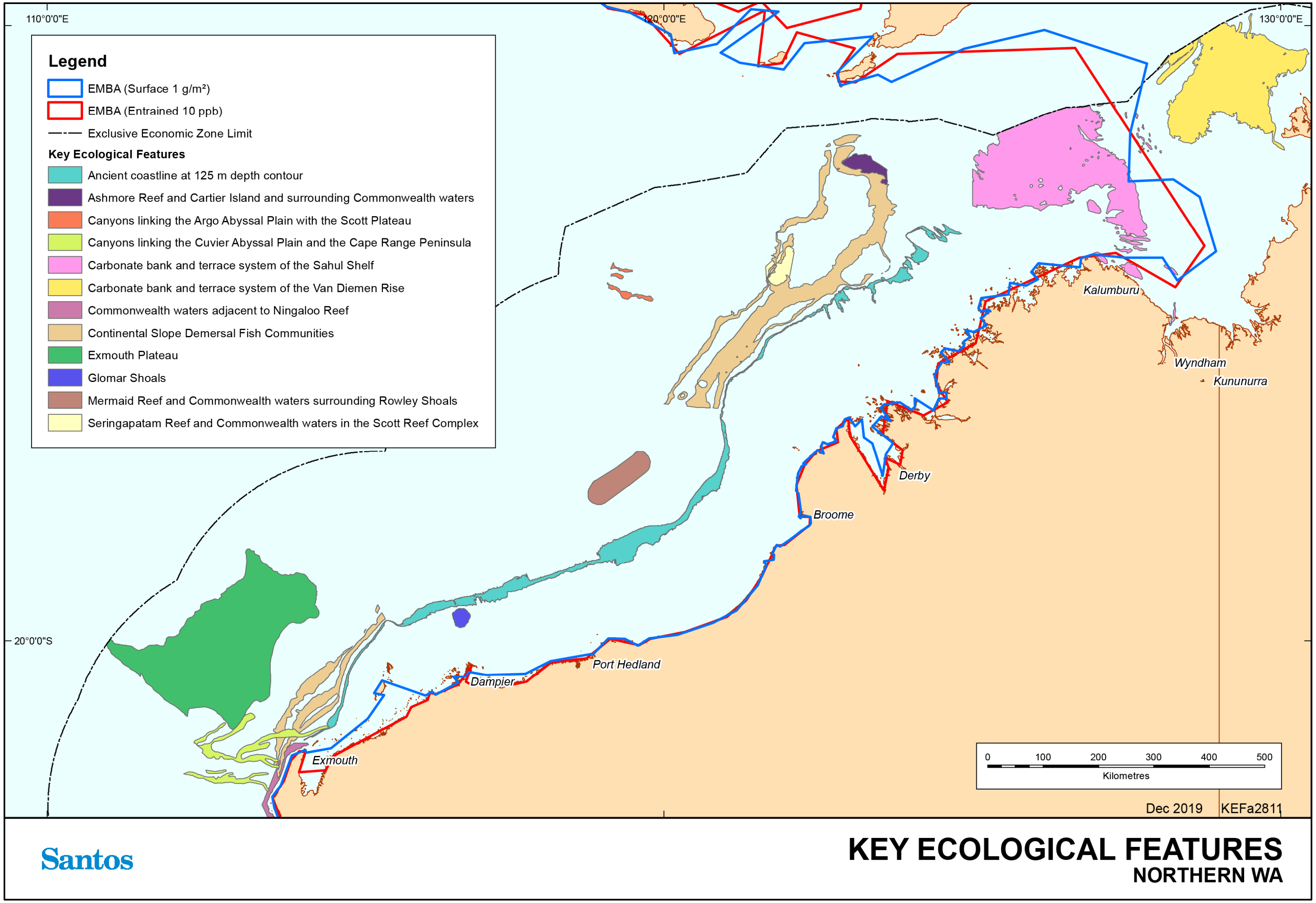

Figure 10-1: Key ecological features of Northern WA

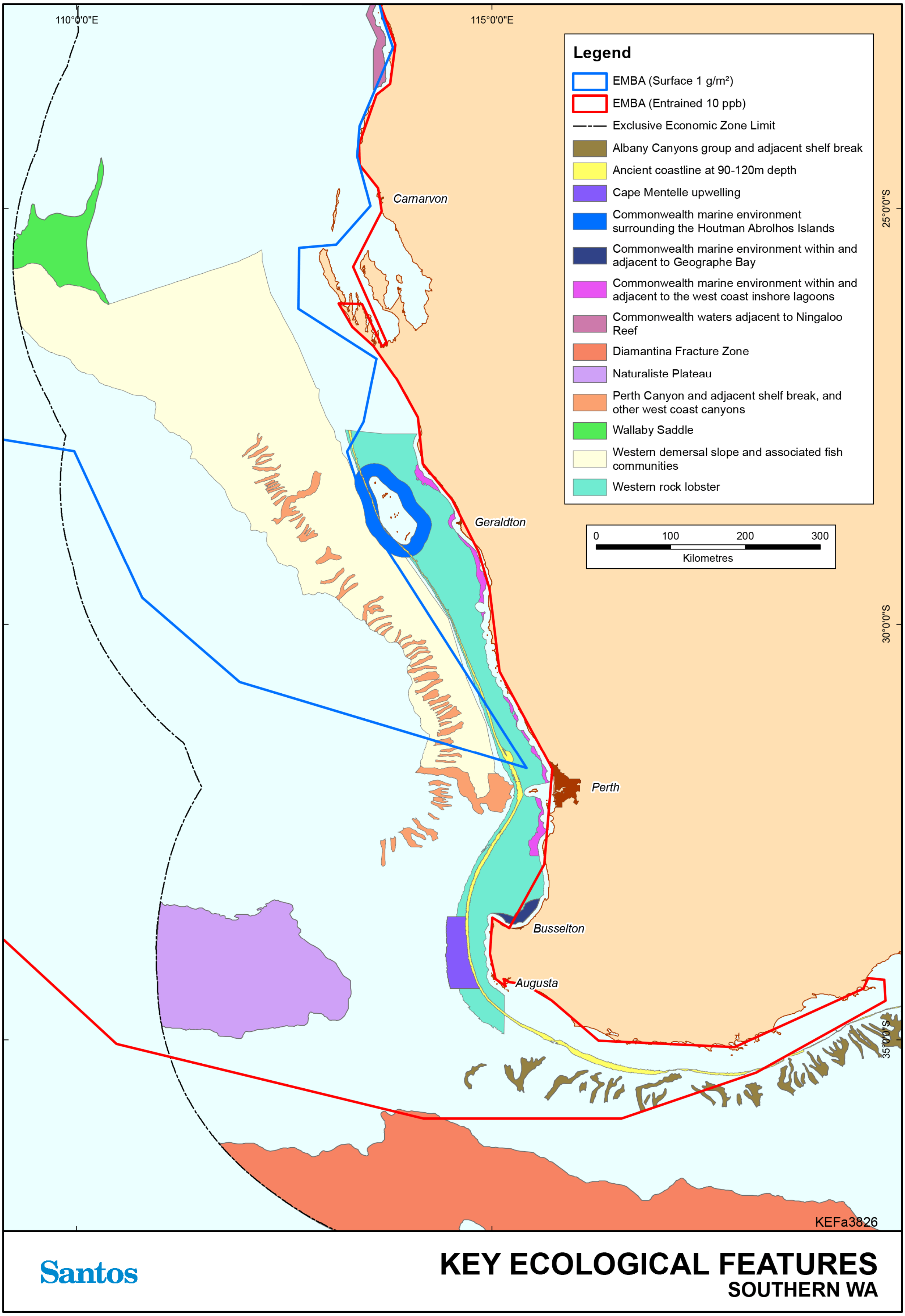

Figure 10-2: Key ecological features of Southern WA

10.1.1 Commonwealth Marine Environment Surrounding the Houtman Abrolhos Islands (and Adjacent Shelf Break)

The Commonwealth marine environment surrounding the Houtman Abrolhos Islands (and adjacent shelf break) is defined as a KEF for its high levels of biodiversity and endemism in benthic and pelagic habitats. The Houtman Abrolhos Islands and surrounding reefs support a unique mix of temperate and tropical species, resulting from the southward transport of species by the Leeuwin Current over thousands of years. The reefs are composed of 184 known species of corals that support about 400 known species of demersal fish, 492 known species of molluscs, 110 known species of sponges, 172 known species of echinoderms and 234 known species of benthic algae (DEWHA 2008b). The Houtman Abrolhos Islands are the largest seabird breeding station in the eastern Indian Ocean (DSEWPaC 2012a). They support more than one million pairs of breeding seabirds. The Houtman Abrolhos Islands and surround waters are also BIAs for Australian sea lions for foraging and breeding (DEWHA 2010b).

10.1.2 Perth Canyon and Adjacent Shelf Break, and other West-Coast Canyons

The Perth Canyon is defined as a KEF for its high biological productivity and aggregations of marine life and unique seafloor features with ecological properties of regional significance. The Perth Canyon is the largest known undersea canyon in Australian waters. In the Perth Canyon, interactions between the Leeuwin Current and the Canyon topography induce clockwise-rotating eddies that transport nutrients upwards in the water column from greater depths (DoEE 2019a). Due to the Canyon's depth and Leeuwin Current's barrier effect, this remains a subsurface upwelling which supports ecological complexity that is typically absent from canyon systems in other areas (Pattiaratchi 2007). This nutrient-rich cold-water habitat attracts feeding aggregations of deep-diving mammals, such as pygmy blue whales and large predatory fish that feed on aggregations of small fish, krill and squid (DSEWPaC 2012a). The Perth Canyon also marks the southern boundary for numerous tropical species groups on the shelf, including sponges, corals, decapods and xanthid crabs (DoEE 2017a).

10.1.3 Commonwealth Marine Environment within and adjacent to the West-Coast Inshore Lagoons

This key ecological feature is composed by a chain of inshore lagoons of limestone reef (as deep as 30 m) extending along the Western Australian coast from south of Mandurah to Kalbarri. The mix of sheltered and exposed seabeds form a complex mosaic of habitats. The lagoons are dominated by seagrass and epiphytic algae (Dambacher et al. 2009). Although macroalgae (principally Ecklonia spp.) and seagrass appear to be the primary source of production, scientists suggest that groundwater enrichment may supplement the supply of nutrients to the lagoons. The lagoons are associated with high biodiversity and endemism, containing a mix of tropical, subtropical and temperate flora and fauna.

The inshore lagoons are important areas for the recruitment of the commercially and recreationally important western rock lobster, dhufish, pink snapper, breaksea cod, baldchin and blue gropers, abalone and many other reef species. The area includes breeding and nursery aggregations for many temperate and tropical marine species (Goldberg & Collings 2006 in McClatchie et al. 2006). Extensive schools of migratory fish visit the area annually, including herring, garfish, tailor and Australian salmon.

10.1.4 Commonwealth Marine Environment within and Adjacent to Geographe Bay

The Commonwealth marine environment within and adjacent to Geographe Bay is defined as a KEF for its high productivity and aggregations of marine life and high levels of biodiversity and endemism. Geographe Bay is known for its extensive beds of tropical and temperate seagrass that account for about 80 % of benthic primary production in the area (DEH 2006). This habitat supports a diversity of species, many of them not found anywhere else (DSEWPaC 2012a). The bay provides important nursery habitat for many species, including juvenile dusky whaler sharks. It is also an important resting area for migrating for humpback whales (McCauley *et al.* 2000).

10.1.5 Cape Mentelle Upwelling

The Cape Mentelle upwelling is defined as a KEF for its high productivity and aggregation soft marine life. The Cape Mentelle upwelling draws relatively nutrient-rich water from the base of the Leeuwin Current, up the continental slope and onto the inner continental shelf, where it results in phytoplankton blooms at the surface. The phytoplankton blooms provide the basis for an extended food chain characterised by feeding aggregations of small pelagic fish, larger predatory fish, seabirds, dolphins and sharks (DSEWPaC 2012a). The Cape Mentelle upwelling has a disproportionate influence on the overall-nutrient poor nature of the region's water.

10.1.6 Naturaliste Plateau

The Naturaliste Plateau is defined as a KEF for its unique seafloor feature with ecological properties of regional significance. The Naturaliste Plateau is Australia's deepest temperate marginal plateau and occurs an area where numerous water bodies and currents converge. It is also the only seafloor feature in the region that interacts with the subtropical convergence front (DoEE 2019b). Although there is very little known about the marine life of the plateau, it is speculated that the combination of its structural complexity, mixed water dynamics and relative isolation indicate that it supports deep-water communities with high species diversity and endemism (DEWHA 2008b; DSEWPaC 2012a). The Plateau acts as an underwater 'biogeographical island' on the edge of the abyssal plain, providing habitat for fauna unique to these depths (Richardson et al. 2005). The Plateau is also within a deep eddy field that is thought to be associated with high productivity and aggregations of marine life (Pattiaratchi 2007). Proximity to the nearby subtropical convergence front is thought to have a significant influence on the biodiversity of the Plateau (DEWHA 2008b).

10.1.7 Western Demersal Slope and associated Fish Communities

The Western Demersal Slope and associated Fish Communities, also known as the Demersal Slope and associated Fish Communities of the Central Western Province, is defined as a key ecological community for its high levels of biodiversity and endemism. It is located on the edge of the shelf to the limit of the exclusive economic zone from Perth to the northern boundary of the SWMR. The western demersal slope provides important habitat for demersal fish communities, with a high level of diversity and endemism. A diverse assemblage of demersal fish species below a depth of 400 m is dominated by relatively small benthic species such as grenadiers, dogfish and cucumber fish. Unlike other slope fish communities in Australia, many of these species display unique physical adaptations to feed on the sea floor (such as a mouth position adapted to bottom feeding), and many do not appear to migrate vertically in their daily feeding habits (DSEWPaC 2012a, Williams *et al.* 2001). A total of 480 fish species have been described that inhabit the slope of this bioregion with 31 considered to be endemic to the bioregion (DoEE 2019a). Demersal fish communities within the area have recorded higher diversity when compared to other oceanic regions which have been more intensively sampled. The increased diversity within the area has been attributed to the overlap of ancient and extensive Indo-west Pacific and temperate Australasian fauna (Williams et al. 2001).

10.1.8 Western Rock Lobster

The Western Rock Lobster KEF is defined due to its presumed ecological role on the West Coast Continental Shelf. This species is the dominant large benthic invertebrate in the region. The lobster plays an important trophic role in many of the inshore ecosystems of the South-west Marine Region. Western rock lobsters are an important part of the food web on the inner shelf, particularly as juveniles as they are preyed upon by octopus, cuttlefish, baldchin groper, dhufish, pink snapper, wirrah cod and breaksea cod (DEWHA 2008b, DSEWPaC 2012a). The high biomass of western rock lobsters and their vulnerability to predation suggest that they are an important trophic pathway for a range of inshore species that prey upon juvenile lobsters (DEWHA 2008b).

10.1.9 Wallaby Saddle

The Wallaby Saddle is defined as a KEF for its high productivity and aggregations of marine life. The Wallaby Saddle is an abyssal geomorphic feature located on the upper continental slope at a depth of 4,000–4,700 m (DSEWPaC 2012a). The feature connects the north-west margin of the Wallaby Plateau with the margin of the Carnarvon Terrace (Falkner *et al*. 2009 in DSEWPaC 2012a). The Wallaby Saddle is situated within the Indian Ocean water mass and is thus differentiated from systems to the north that are dominated by transitional fronts or the Indonesian Throughflow (DSEWPaC 2012a). Little is known about the Wallaby Saddle; however, the area is considered one of enhanced productivity and low habitat diversity (Brewer *et al*. 2007). The Wallaby Saddle is associated with historical aggregations of sperm whales (DEWHA 2008c).

10.1.10 Commonwealth Waters Adjacent to Ningaloo Reef

The Commonwealth Waters adjacent to Ningaloo Reef KEF is defined for high productivity and aggregations of marine life. The Ningaloo Reef extends almost 300 km along the Cape Range Peninsula to the Red Bluff and is globally significant as the only extensive coral reef in the world that fringes the west coast of a continent. Commonwealth waters adjacent to the reef are thought to support the rich aggregations of marine species at Ningaloo Reef through upwellings associated with canyons on the adjacent continental slope and interactions between the Ningaloo and Leeuwin currents (Brewer *et al*. 2007, DEWHA 2008d, DSEWPaC 2012a). The narrow continental shelf (10 km at its narrowest) means that the nutrients channelled to the surface via canyons are immediately available to reef species. Terrestrial nutrient input is low, hence this deep-water source is a major source of nutrients for Ningaloo Reef and therefore very important in maintaining this system (DEWHA 2008c).

The reef is known to support an extremely abundant array of marine species including over 200 species of coral and more than 460 species of reef fish, as well as molluscs, crustaceans and other reef plants and animals (DEWHA 2008c). Marine turtles, dugongs and dolphins frequently visit the reef lagoon. The Commonwealth waters around Ningaloo include areas of potentially high and unique sponge biodiversity (DEWHA 2008c). Upwellings on the seaward side support aggregations such as whale sharks and manta rays (these waters are the main known aggregation area for whale sharks in Australian waters). Humpback whales are seasonal visitors to the outer reef edge and seasnakes, sharks, large predatory fish and seabirds also utilise the reef and surrounding waters.

The Ningaloo Marine Park includes this Key Ecological Feature and is discussed in **Section 12.3.4**.

10.1.11 Canyons Linking the Cuvier Abyssal Plain with the Cape Range Peninsula

The Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula are defined as a KEF as they are unique seafloor features with ecological properties of regional significance.

Cape Range Peninsula and the Cuvier Abyssal Plain are linked by canyons, the largest of which are the Cape Range Canyon and Cloates Canyon. These two canyons are located along the southerly edge of Exmouth Plateau adjacent to Ningaloo Reef and are unique due to their close proximity to the North West Cape (DSEWPaC 2012a). The Leeuwin Current interacts with the heads of the canyons to produce eddies resulting in delivery of higher nutrient, cool waters from the Antarctic intermediate water mass to the shelf (Brewer *et al*. 2007). Strong internal tides also create upwelling at the canyon heads (Brewer *et al*. 2007). Thus the canyons, the Exmouth Plateau and the Commonwealth waters adjacent to Ningaloo Reef interact to create the conditions for enhanced productivity seen in this region (Sleeman *et al*. 2007 in DSEWPaC 2012a). The canyons are also repositories for particulate matter deposited from the shelf and sides of the canyons and serve as conduits for organic matter between the surface, shelf and abyssal plains (DSEWPaC 2012a).

The soft bottom habitats within the canyons themselves are likely to support important assemblages of epibenthic species. Biological productivity at the head of Cape Range Canyon in particular, is known to support species aggregations, including whale sharks, manta rays, humpback whales, sea snakes, sharks, large predatory fish and seabirds. The canyons are thought to be significant contributors to the biodiversity of the adjacent Ningaloo Reef, as they channel deep water nutrients up to the reef, stimulating primary productivity (DEWHA 2008c).

10.1.12 Exmouth Plateau

The Exmouth Plateau is defined as a KEF as it is a unique seafloor feature with ecological properties of regional significance. The Exmouth Plateau covers an area of 49,310 km^2 and is located approximately 150 km northwest of Exmouth. The plateau ranges in water depths from 800 to 4,000 m (Heap & Harris 2008 in DSEWPaC 2012a). The plateau’s surface is rough and undulating at 800–1,000 m depth. The northern margin is steep and intersected by large canyons (e.g. Montebello and Swan canyons) with relief greater than 50 m.

The western margin is moderately steep and smooth and the southern margin is gently sloping and virtually free of canyons (Falkner *et al*. 2009 in DSEWPaC 2012a).

The Exmouth Plateau is a regionally and nationally unique tropical deep sea plateau. It that may serve an important ecological role by acting as a topographic obstacle that modifies the flow of deep waters that generate internal tides, causing upwelling of deeper water nutrients closer to the surface (Brewer *et al.* 2007). Sediments on the plateau suggest that biological communities include scavengers, benthic filter feeders and epifauna. Whaling records from the 19th century suggest that the Exmouth Plateau may have supported large populations of sperm whales (Bannister *et al*. 2007). Fauna in the pelagic waters above the plateau are likely to include small pelagic species and nekton (Brewer *et al.* 2007).

10.1.13 Mermaid Reef and Commonwealth Waters surrounding Rowley Shoals

Mermaid Reef and Commonwealth waters surrounding Rowley Shoals is defined as a KEF for its enhanced productivity and high species richness. The Rowley Shoals are a group of three atoll reefs—Clerke, Imperieuse and Mermaid reefs—located about 300 km north-west of Broome. Mermaid Reef lies 29 km north of Clerke and Imperieuse reefs and is totally submerged at high tide. Mermaid Reef and Commonwealth Waters surrounding Rowley Shoals are regionally important in supporting high species richness, higher productivity and aggregations of marine life associated with the adjoining reefs themselves (Done et al. 1994). Rowley shoals contain 214 coral species and approximately 530 species of fishes (Gilmour et al. 2007), 264 species of molluscs and 82 species of echinoderms (Done et al. 1994; Gilmour et al. 2007). Both coral communities and fish assemblages differ from similar habitats in eastern Australia (Done et al. 1994).

Mermaid Reef falls under Commonwealth jurisdiction and forms the Mermaid Reef Commonwealth Marine Park. Clerke and Imperieuse reefs constitute the Rowley Shoals Marine Park, which falls under Western Australian Government jurisdiction (EA 2000). The Rowley Shoals are discussed with the Commonwealth and State Marine Park (**Sections 11.1.9** and **12.3.9**).

10.1.14 Glomar Shoals

The Glomar Shoals are a submerged feature situated at a depth of 33–77 m, approximately 150 km north of Dampier on the Rowley Shelf (Falkner *et al*. 2009 in DSEWPaC 2012a). They consist of a high percentage of marine-derived sediments with high carbonate content and gravels of weathered coralline algae and shells (McLoughlin & Young 1985 in DSEWPaC 2012a). The area’s higher concentrations of coarse material compared to surrounding areas are indicative of a high energy environment subject to strong seafloor currents (Falkner *et al*. 2009 in DSEWPaC 2012a).

Biological communities found at the Glomar Shoals have not been comprehensively studied, however the shoals are known to be an important area for a number of commercial and recreational fish species such as rankin cod, brown striped snapper, red emperor, crimson snapper, bream and yellow-spotted triggerfish. Catch rates at the Glomar Shoals are high, indicating that the area is a region of high productivity (Falkner *et al*. 2009, Fletcher & Santoro 2009 in DSEWPaC 2012a). It is unclear if the removal of non-target species due to the commercial fishing over the shoals is having an impact on its value (DSEWPaC 2012a).

The Glomar Shoals are regionally important for their potentially high biological diversity and localised productivity. Biological data specific to the Glomar Shoals is limited, however the fish of the shoals are probably a subset of reef-dependent species and anecdotal evidence suggests they are particularly abundant (DSEWPaC 2012a).

10.1.15 Ancient Coastline at 125 m Depth Contour

The shelf of the North-west Marine Region contains several terraces and steps which reflect changes in sea level that occurred over the last 100,000 years. The most prominent of these features occurs at a depth of 125m as an escarpment along the North West Shelf and Sahul Shelf (DSEWPaC 2012a). Where the ancient submerged coastline provides areas of hard substrate it may contribute to higher biological diversity. Little detailed knowledge is available, but the hard substrate of the escarpment is likely to support sponges, crinoids, molluscs, echinoderms (DSEWPaC 2012a). It is understood that changes in topography at these depths are critical points for the generation of internal waves (Holloway *et al.* 2001 cited in DEWHA 2008c), playing a minor role in aiding localised upwelling or at least regional mixing associated with the seasonal changes in currents and winds. It is also believed that this prominent floor feature could be important as a migratory pathway for cetaceans and pelagic species such as the whale shark and humpback whale, as they move north and south between feeding and breeding grounds (DEWHA 2008c).

Parts of the ancient coastline are thought to provide biologically important habitats in areas otherwise dominated by soft sediments. The topographic complexity of these escarpments may also facilitate vertical mixing of the water column providing a relatively nutrient-rich environment for species present on the escarpment (DSEWPaC 2012a). This enhanced productivity could potentially be attracting baitfish, which in turn provide food for the migratory species. The pressures of potential concern on the biodiversity value of this feature generally include ocean acidification as a result of climate change (DoEE 2019a).

10.1.16 Ancient Coastline at 90-120 m Depth

This coastline is found in the South-west Marine Region and contains several terraces and steps reflecting a gradual increase in sea level across the shelf that occurred during the Holocene. Some of these features create escarpments of distinct elevation, creating topographic complexity through the exposure of rocky substrates. The most prominent of these occurs close to the middle of the continental shelf off the Great Australian Bight at a depth of 90-120 m, which provides a complex habitat for a number of species (DSEWPaC 2012c). The area has important conservation value due to its potential for high productivity, biodiversity and aggregations of marine life. Benthic biodiversity and productivity occur where the ancient coastline forms a prominent escarpment of exposed hard substrates, where it is dominated by sponge communities of significant biodiversity and structural complexity (DSEWPaC 2012c). These sponge communities have been recorded to contain sponges up to one metre across, which implies that some of the sponges in this region are likely to be many decades old (DSEWPC 2012c). It has been suggested that in certain places, the area may support some demersal fish species, travelling to the upper continental slope from across the continental shelf. The transportation of fine grained sediments off shelf occurs as a physical process down to depths of approximately 120 m, and influence the benthic invertebrate communities of the Great Australian Bight (DSEWPaC 2012c). Both species richness and biomass in the area, has been associated as declining with increasing depth and percentage of fines in sediment (Ward *et al.* 2006 cited in DSEWPaC 2012c).

10.1.17 Canyons Linking the Argo Abyssal Plain with Scott Plateau

The Scott Plateau connects with the Argo Abyssal Plain via a series of canyons, the largest of which are the Bowers and Oates canyons (DSEWPaC 2012a). The canyons are believed to be up to 50 million years old and excavated during the evolution of the region through sediment and water movements (DEWHA 2008d). The canyons cut deeply into the south-west margin of the Scott Plateau and act as conduits for transport of sediments from an approximate depth of 2,000–3,000 m to depths of more than 5,500 m (DSEWPaC 2012a). The water masses at these depths are deep Indian Ocean water on the Scott Plateau and Antarctic bottom water on the Argo Abyssal Plain. Both water masses are cold, dense and nutrient-rich (Lyne *et al*. 2006 in DSEWPaC 2012a). The high productivity of the region is believed to be led by topographically induced water movements through the canyons and the action of internal waves in these canyons as well as around islands and reefs. The canyons are therefore thought to be linked to small and periodic upwellings that enhance this biological productivity (DEWHA 2008d).

The Canyons linking the Argo Abyssal Plain and Scott Plateau are likely to be important features due to their historical association with sperm whale aggregations (DSEWPaC 2012a). Historical records of whaling in the Timor region indicate that the number of sperm whales was high in the region in the past. Though current numbers are unknown, it is possible that they congregate around the canyon heads adjacent to the Scott Plateau, encouraged by the high biological productivity, supporting stocks of their prey (DEWHA 2008d). There is anecdotal evidence that supports the idea that the Scott Plateau itself may be a breeding ground for sperm and beaked whales. It is also likely that important demersal communities occur in the canyons, as they do in the Scott Plateau supported by the localised upwelling, which in turn attract larger predatory fish, sharks and cetaceans (DEWHA 2008d).

10.1.18 Continental Slope Demersal Fish Communities

The Australian Continental Slope provides important habitat for demersal fish communities, characterised by high endemism and species diversity. Specifically, the continental slope between North West Cape and the

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Montebello Trough is the most diverse slope bioregion in Australia with more than 500 fish species, 76 of which are endemic (Last *et al*. 2005 in DSEWPaC 2012).

The Continental Slope consists of two distinct community types, associated with the upper and mid slope, 225 – 500 m and 750 – 1000 m respectively. The Timor Province and Northwest Transition bioregions are the second-richest areas for demersal fish across the entire continental slope (DSEWPaC 2012). The bacteria and fauna that is present in the system on the Continental Slope are the basis for the food web for demersal fish and higher order consumers in the system. Further information of this system has been poorly researched, though it has been suggested that it is a detritus-based system, where infauna and epifauna become prey for a range of teleost fish, molluscs and crustaceans (Brewer *et al.* 2007). The higher order consumers supported by this system are likely to be carnivorous fish, deep water sharks, large squid and toothed whales (Brewer *et al.* 2007). The pelagic production is known to be phytoplankton based, with hotspots located around oceanic reefs and islands (Brewer *et al.* 2007).

It is believed that the loss of the benthic habitat along this continental shelf region would likely lead to a decline in the species diversity and endemism that this feature is associated with (DoEE 2019a). The endemism of the region is not supported by large data sets and is scarce. It is consequently not well understood what interactions exist between the physical processes and trophic structures that lead to this high diversity of fish and the suggested presence of endemic species in the region (DoEE 2019a).

10.1.19 Seringapatam Reef and Commonwealth Waters in the Scott Reef Complex

Scott and Seringapatam reefs are part of a series of submerged reef platforms that rise steeply from the sea floor between the 300–700 m contours on the north-west continental slope and lie in the Timor Province (Falkner et al. 2009). Scott Reef consists of two separate reef formations, North Reef and South Reef. The total area of the key ecological feature is approximately 2,418 km². As two of the few offshore reefs in the north-west, they provide an important biophysical environment in the region.

Scott and Seringapatam reefs and the waters surrounding them attract aggregations of marine life including humpback whales on their northerly migration, Bryde’s whales, pygmy blue whales, Antarctic minke whales, dwarf minke whales, minke whales, dwarf sperm whales and spinner dolphins (Jenner et al. 2008; Woodside 2009). Whale sharks and several species of sea snakes have also been recorded in this area (Donovan et al. 2008). Green and hawksbill turtles nest during the summer months on Sandy Islet on South Scott Reef. These species also internest and forage in the surrounding waters (Guinea 2006). Scott Reef is a particularly biologically diverse system and includes more than 300 species of reef-building corals, approximately 400 mollusc species, 118 crustacean species, 117 echinoderm species and around 720 fish species (Woodside 2009). Corals and fish at Scott Reef have higher species diversity than the Rowley Shoals (Done et al. 1994).

Scott Reef is listed as Commonwealth Heritage Places and is discussed in **Section 9.5.1**.

10.1.20 Ashmore Reef and Cartier Island and Surrounding Commonwealth Waters

Ashmore Reef and Cartier Island are situated on the shallow upper slope of the Sahul Shelf, north of Scott and Seringapatam reefs. Rising from a depth of more than 100 m, the reef platform is at the edge of the North West Shelf and covers an area of 239 km². Ashmore Reef Commonwealth Marine Reserve encloses an area of about 583 km² of seabed (EA 2002). Cartier Island lays about 350 km off Australia’s Kimberley coast, 115 km south of the Indonesian island of Roti and 45 km south-east of Ashmore Reef Commonwealth Marine Reserve. Cartier Island Commonwealth Marine Reserve covers 167 km² (EA 2002). Species at Ashmore Reef and Cartier Island include more than 225 reef-building corals, 433 molluscs, 286 crustaceans, 192 echinoderms, and the most diverse variety of fish of any region in Western Australia with 709 species (EA 2002).

Sandy beaches provide important habitat for nesting green and hawksbill turtles throughout the year. Seagrass present at Ashmore Reef provides critical breeding (April–May) and foraging (throughout the year) habitat for a genetically distinct population of dugong with their range probably extending to other submerged shoals within the area (Brown & Skewes 2005; Whiting 1999). The emergent habitat at Ashmore also provides important nesting sites for seabirds, many of which are migratory. Ashmore’s islands are regarded as supporting some of the most important seabird rookeries on the North West Shelf seasonally supporting up to 50,000 seabirds (26 species) and up to 2,000 waders (30 species, representing almost 70% of wader species that regularly migrate to Australia) (Milton 2005). Large colonies of sooty terns, crested terns, bridled terns and common noddies breed on the east and middle islands. Smaller breeding colonies of little egrets, eastern reef egrets, black noddies and possibly lesser noddies also occur. Migratory wading birds include eastern curlews, ruddy turnstones, whimbrels, bar-tailed godwits, common sandpipers, Mongolian plovers, red-necked stints and tattlers, during October–November and March–April as part of the migration between Australia and the Northern Hemisphere (Milton 2005).

10.1.21 Carbonate Bank and Terrace System of the Sahul Shelf

The Carbonate Banks and Terrace System of the Sahul Shelf are located in the western Joseph Bonaparte Gulf and to the north of Cape Bougainville and Cape Londonderry. The banks consist of a hard substrate and flat tops at depths of 150–300 m. Each bank occupies an area generally less than 10 km^2 and is separated from the next bank by narrow sinuous channels with depths up to 150 m. The origin of the banks is uncertain, though the area contains predictably high levels of productivity, in comparison to the generally low productivity of the region (DSEWPaC 2012).

The banks are foraging areas for loggerhead, olive ridley and flatback turtles and provide habitat for humpback whales, and green and freshwater sawfish (Donovan *et al*. 2008 in DSEWPaC 2012). The hard substrate of the banks is thought to support diverse organisms including sessile benthic invertebrates such as sponges, soft and hard corals, gorgonians, bryozoans, ascidians and associated reef fish and elasmobranchs (Brewer *et al*. 2007). Cetaceans, green and fresh sawfish are also likely to occur in the area, as well as possibly the Australian snubfin dolphin, a migratory species occurring mostly on the northern extent of the Sahul Shelf (DSEWPaC 2012).

According to DSEWPaC (2012) the carbonate banks and terrace system of the Sahul Shelf are regionally important because of their role in enhancing productivity relative to their surrounds. Little is known about the banks, terraces and associated channels but they are believed to be areas of enhanced productivity and biodiversity due to the upwellings of cold nutrient-rich water at the heads of the channels and the availability of hard substrate (Brewer *et al*. 2007).

10.1.22 Pinnacles of the Bonaparte Basin

The limestone Pinnacles of the Bonaparte Basin are located in the mid-outer shelf of the western Joseph Bonaparte Gulf and comprise of 61% of the limestone pinnacles in the Northwest Marine Region and 8% of the total limestone pinnacles found within the Australian Exclusive Economic Zone (Baker *et al.* 2008). The pinnacles range from water depths of 30 to 80 m providing hard substrate in a relatively sparse soft sediment habitat for sessile species. The pinnacles are thought to be remnants of the calcareous shelf and coastal features from previous low sea level stands, and have been recorded to be up to 50 m in height and range from 50 to 100 km long (Baker *et al.* 2008, Heyward *et al.* 1997).

Diverse communities of sessile benthic invertebrates including hard and soft corals, sponges, whips, fans, bryozoans and aggregations of demersal fish species such as snappers, emperors and groupers have been recorded (Brewer *et al.* 2007, Nichol *et al.* 2013). Foraging and general use has been recorded within the pinnacles by marine turtles and the area has also been suggested to be used by freshwater and green sawfish as well as humpback whales (Donovan *et al.* 2008). The pinnacles have been recognised as a sponge biodiversity hotspot which has recorded greater diversity and communities than that of the surrounding seafloor (NERP MBH 2014).

According to DSEWPaC (2012) the Pinnacles of the Bonaparte Basin are regionally important because of its biodiversity values (unique sea-floor feature with ecological properties of regional significance), which apply to both the benthic and pelagic habitats. The hard substrate of the pinnacles are likely to support a high number of species, although a better understanding of the species richness and diversity associated with these structures is required.

10.1.23 Diamantina Fracture Zone

The Diamantina Fracture Zone is located south of the Naturaliste Plateau covering a range of more than 100,000 km^2 in water depths greater than 3,000 m. The ridge, troughs and seamounts that form the fracture zone have been recorded to have a relief up to 4,000 m which has resulted in highly variable environmental conditions (Stow 2006, Richardson *et al.* 2005). The Diamantina Fracture Zone encompasses the deepest known points in Australia's exclusive economic zone, reaching depths of more than 6,000 metres.

Limited information is available for the Diamantina Fracture Zone, however it is likely that due to the highly variable environmental conditions within the distinctive community structures and unique habitats have the potential to form. The presence of seamounts and ridges has the potential to increase local primary and secondary productivity, which may in turn promote phytoplankton growth. Increased phytoplankton has been recorded to increase the diversity and abundance of marine life (e.g. whales, dolphins, fish and benthic species) (Rowden *et al.* 2010). The area is expected to sustain similar habitats to that of and around the Tasmanian Seamounts due to similar depths in the South-east Marine Region (Richardson et al. 2005).

According to DSEWPaC (2012) the Diamantina Fracture Zone is regionally important because of to enhance productivity and assist with dispersal and migration of species across the region and wider abyssal plain (Wilson & Kaufman 1987, in Richardson *et al.* 2005). While research on the Diamantina Fracture Zone is limited, its size, physical complexity and isolation indicate that it is likely to support deepwater communities characterised by high species diversity and endemism.

10.1.24 Albany Canyons Group and Adjacent Shelf Break

The Albany Canyons group and adjacent shelf break is located along a 700 km extent ranging from Cape Leeuwin to the east of Esperance and consists of 32 deep canyons which cut into the continental slope. Sonar surveys have indicated that individual canyons can extent up to 90 km long at water depths of 2,000 m. The canyons can start at the uppermost continental slope and reach the lowermost slope and extend onto the abyssal plain (Exon *et al.* 2005).

Due to close spacing of the numerous canyons, a wide range of depth dependent benthic habitats are connected increasing the habitat heterogeneity along the south western Australian continental margin. Offshore transport increases the sediment load and organic material is received from productive shelf waters. The closely spaced canyons have the potential to allow increased amounts of organic matter to reach the abyssal plain which may increase biodiversity in comparison to other areas within the south west Marine Region. (Richardson e*t al.* 2005).

According to DSEWPaC (2012), the Albany Canyons group and adjacent shelf break is regionally important and recognised as a key ecological feature for its high productivity, aggregations of marine life, and as a unique seafloor feature with ecological properties of regional significance (Pattiaratchi 2007). Both benthic and demersal habitats within the feature are of conservation value. The canyons are known to be a feeding area for the sperm whale (Bannister *et al.* 1996) and sites of orange roughy aggregations (Caton & McLoughlin 2004).

11. State Marine Conservation Reserves

11.1 Introduction

Marine parks and reserves have been progressively established in Western Australia since 1987. The Conservation and Parks Commission (CPC) is the vesting authority for marine parks and reserves under the provisions of the *Conservation and Land Management Act 1984*. Parks and Wildlife, within the Department of Biodiversity, Conservation and Attractions (DBCA), is responsible for day to day management of the parks.

There are three categories of state marine conservation reserves: marine parks; marine management areas; and marine nature reserves.

Marine parks are created to protect natural features and aesthetic values while allowing recreational and commercial uses that do not compromise conservation values. There are currently 18 marine parks within the EMBA (refer **Figure 9-1**, **Figure 9-2** and **Figure 9-3**).

Marine parks are multiple-use reserves that cater for a wide range of activities. Within marine parks there may be four types of management zones: recreation zones: general use zones; no-take areas known as sanctuary zones; and special purpose zones.

Each marine park has a 'management plan' that contains strategies to protect the high value assets in the park, as well as permitted activities tables. These tables provide explicit regulatory management.

Sanctuary zones are 'no-take' areas created primarily for conservation and scientific research and are designed to protect a particular significant ecosystem or habitat. Low-impact tourism may be permitted, but no recreational or commercial fishing, aquaculture, pearling, petroleum drilling or production is allowed.

Marine management areas provide an integrated management structure over areas that have high conservation value and intensive multiple-use. There are two marine management areas within the EMBA (described below).

There is currently only one state marine nature reserve: Hamelin Pool Nature Reserve part of the Shark Bay World Heritage Area (**Section 9.1.1**)

11.1.1 Ngari Capes Marine Park

The Ngari Capes Marine Park is gazetted as a Class A Marine Park. The park is located off the southwest coast of Western Australia, approximately 250 km south of Perth, covering approximately 123,790 ha. The seaward boundary of the marine park is congruent with the seaward limit of Western Australian waters (three nautical miles from the territorial baseline). The north-eastern boundary in Geographe Bay is located near the intersection of the Shire of Busselton boundary with the coastline. The Shire of Busselton–Shire of Capel boundary is approximately 30 m north-east of the marine park boundary, while the south-eastern boundary in Flinders Bay is located at 115˚17'00" E. The marine park consists of four areas that are representative of the Leeuwin–Naturaliste marine bioregion: Geographe Bay; Cape Naturaliste to Cape Mentelle coast; the Cape Mentelle to Cape Leeuwin coast; and Flinders Bay. These areas show distinct differences in geomorphology, oceanography, habitats and flora and fauna.

The Ngari Capes Marine Park was identified as one of the most diverse temperate marine environments in Australia. Warm, tropical waters of the Leeuwin Current mix with the cool waters of the Capes Current, resulting in high finfish diversity, including tropical and temperate species (see fish in **Section 5.1.1**) and internationally significant seagrass diversity with seagrasses occurring at depths greater than 40 m (see seagrasses in **Section 3.2**). The marine park also surrounds a number of islands that are important seabird nesting habitat and pinniped haul-outs (places where seals and sea lions leave the water and come onto land), including Hamelin Island, Sugarloaf Rock and the Saint Alouarn Islands which include Flinders Island, Seal Island and Square Rock (DEC 2013). These islands are vested with the Conservation Commission as nature reserve and are managed by DBCA for the purpose of conservation. The marine park is also adjacent to the Leeuwin Naturaliste National Park which extends to the high water mark (DEC 2013).

The Ngari Capes marine park was also created for its high social values. The unique geographical location of this region exposes it to large, uninterrupted ocean swells and results in the South West capes area being recognised as one of the world's premier surfing regions. Many activities occurring in the region are marine based, including commercial and recreational fishing, swimming, surfing, diving, snorkelling, boating, and marine nature-based tourism.

11.1.2 Jurien Bay Marine Park

The Jurien Bay Marine Park is a Class A marine park located on the central west coast of Western Australia about 200 km north of Perth and covers an area of 82,375 ha (CALM 2005b). Its western boundary is the seaward limit of Western Australian coastal waters. Its northern boundary is the northern point of Dynamite Bay at Green Head (30° 4' 7.9" South), and its southern boundary is located just south of Wedge (30° 50' 20" South) and is contiguous with the southern boundary of the Wanagarren Nature Reserve.

Jurien Bay Marine Park is considered to be broadly representative of the Central West Coast limestone reef system, which is a major marine ecosystem within this bioregion. The marine biota of the area consists of an unusual mix of tropical and temperate species as well as many endemic species (Larkum & Hartog, 1989). The Marine Park is dominated by five major marine habitat types: seagrass meadows; bare or sparsely vegetated mobile sand; shoreline and offshore intertidal reef platforms; subtidal limestone reefs; and reef pavement (CALM 2005b). Marine wildlife includes 14 species of cetaceans, a variety of sea and shorebirds which nest on the islands and the Australian sea lion (North Fisherman Island to the north of Jurien Bay is one of the main breeding sites for sea lions in the Central West Coast region and it is believed this breeding population is genetically distinct from the southern coast population – Gales et al. 1992). Commercial fishing for western rock lobster as well commercial wetlining, abalone, shark netting, beach seining for mullet and collecting of specimen shells and aquarium fish are carried out within the marine park.

11.1.3 Shark Bay Marine Park and Hamelin Pool Marine Nature Reserve

The Shark Bay Marine Reserves comprise the Shark Bay Marine Park and the Hamelin Pool Marine Nature Reserve. The Shark Bay Marine Park was gazetted on 30 November 1990 as A Class Marine Park Reserve No. 7 and vested in the National Park and Nature Conservation Authority (NPNCA) under the CALM Act. The marine park encompasses an area of 748,725 ha (CALM 1996).

The Bay is located near the northern limit of a transition region between temperate and tropical marine fauna. Of the 323 fish species recorded from Shark Bay, 83% are tropical species with 11% warm temperate and 6% cool temperate species. Similarly, of the 218 species of bivalves recorded in Shark Bay, 75% have a tropical range and 10% a southern Australian range, with 15% being endemic to the west coast (CALM 1996).

Key features of Shark Bay Marine Park include (CALM 1996, DSEWPaC 2013b):

+ 12 species of seagrass making it one of the most diverse seagrass assemblages in the world;
+ Seagrass that covers over 4,000 km^2 of the bay. The 1,030 km^2 Wooramel Seagrass Bank is the largest structure of its type in the world;
+ An estimated population of about 11,000 dugongs, one of the largest populations in the world;
+ Humpback and southern right whales use the bay as a migratory staging post;
+ Bottlenose dolphins occur in the bay, and green turtle and loggerhead turtle nest on the beaches;
+ Large numbers of sharks including whaler, tiger shark and hammerhead are present as well as an abundant population of rays, including the manta ray;
+ Hamelin Pool in Shark Bay contains the most diverse and abundant examples of stromatolite forms in the world, representative of life-forms which lived some 3,500 million years ago; and
+ Shark Bay Marine Park does not cover Bernier and Dorre Islands and only coastal waters inshore of Dirk Hartog Island (east of eastern shoreline).

Shark Bay was included on the World Heritage List in 1991 primarily on the basis of three natural features: vast seagrass beds; dugong population; and stromatolites (microbial colonies that form hard, dome-shaped deposits and are among the oldest forms of life on Earth) (DSEWPaC 2013b; see **Section 9.1**).

There is no zoning within the Hamelin Pool Marine Nature Reserve. This area is a 'look but don't take' area managed solely for the conservation of globally outstanding marine life. Hamelin Pool is one of only two known places in the world with living examples of marine stromatolites (DEC 2010). The shores of Hamelin Pool are also important for the formation of extensive marine algal mats formed by microbial algae. If damaged, the mats and stromatolites can take many hundreds of years to recover (DEC 2010).

11.1.4 Ningaloo Marine Park

The Ningaloo Marine Park was declared in May 1987 under the National Parks and Wildlife Conservation Act 1975 (Commonwealth). The Ningaloo Coast, incorporating both key marine and terrestrial values was later granted World Heritage Status in June 2011. In November 2012, the Ningaloo Marine Park (Commonwealth Waters) was renamed to be incorporated in the North-west Commonwealth Marine Reserves Network. The park covers an area of 263,343 km^2, including both State and Commonwealth waters, extending 25 km offshore.

The park protects a large portion of Ningaloo Reef, which stretches over 300 km from North West Cape south to Red Bluff. It is the largest fringing coral reef in Australia, forming a discontinuous barrier that encloses a lagoon that varies in width from 200 m to 7 km. Gaps that regularly intercept the main reef line provide channels for water exchange with deeper, cooler waters (CALM 2005). The Ningaloo Marine Park forms the backbone of the nature-based tourism industry, and recreational activities in the Exmouth region. Seasonal aggregations of whale sharks, manta rays, sea turtles and whales, as well as the annual mass spawning of coral attract large numbers of visitors to Ningaloo each year (CALM 2005).

The reef is composed of partially dissected basement platform of Pleistocene marine or Aeolian sediments or tertiary limestone, covered by a thin layer of living or dead coral or macroalgae. Key features that characterise the Ningaloo Reef include (CALM 2005):

+ Over 217 species of coral (representing 54 genera);
+ Over 600 species of mollusc (clams, oysters, octopus, cuttlefish, snails);
+ Over 460 species of fish;
+ Ninety-seven species of echinoderms (sea stars, sea urchins, sea cucumbers);
+ Habitat for numerous threatened species, including whales, dugong, whale sharks and turtles; and
+ Habitat for over 25 species of migratory wading birds listed in CAMBA and JAMBA.

11.1.5 Muiron Islands Marine Management Area

The Ningaloo Marine Park Management Plan (CALM 2005) created a MMA for the Muiron Islands, immediately adjacent to the northern end of the Park. This is managed as an integrated area together with the Ningaloo Marine Park, but its status as a MMA means that some activities, including oil and gas exploration, are still permitted under a strict environmental assessment process involving DMIRS.

The Muiron Islands, located 15 km northeast of the North West Cape, comprise the North and South Muiron Islands and cover an area of 1,400 ha (AHC 2006). They are low limestone islands (maximum height of 18 m above sea level (ASL)) with some areas of sandy beaches, macroalgae and seagrass beds in the shallow waters (particularly on the eastern sides) and coral reef up to depths of 5m, which surrounds both sides of South Muiron Island and the eastern side of North Muiron Island. The Muiron Islands MMA was WA's first MMA, gazetted in November 2004. It covers an area of 28,616 ha and occurs entirely within state waters (CALM 2005).

11.1.6 Barrow Island Marine Park

The Barrow Island Marine Park covers 4,169 ha, all of which is zoned as sanctuary zone (the Western Barrow Island Sanctuary Zone) (DEC 2007). It includes Biggada Reef, an ecologically significant fringing reef, and Turtle Bay, an important turtle aggregation and breeding area (DEC 2007). Representative areas of seagrass, macroalgal and deep water habitat are also represented within the marine park (DEC 2007). Passive recreational activities (such as snorkelling, diving and boating) are permitted but extractive activities such as fishing and hunting are not.

11.1.7 Barrow Island Marine Management Area

The Barrow Island Marine Management Area (MMA) is the largest reserve within the Montebello/ Barrow Islands marine conservation reserves, covering 114,693 ha (DEC 2007). The MMA includes most of the waters around Barrow Island, the Lowendal Islands and the Barrow Island Marine Park, with the exclusion of the port areas of Barrow Island and Varanus Island.

The MMA is not zoned apart from one specific management zone: the Bandicoot Bay Conservation Area. This conservation area is on the southern coast of Barrow Island and has been created to protect benthic fauna and seabirds. It includes the largest intertidal sand/mudflat community in the reserves, is known to be high in invertebrate diversity and is an important feeding area for migratory birds.

As for the other reserves in the Montebello/Barrow Islands marine conservation reserves, the Barrow Island MMA includes significant breeding and nesting areas for marine turtles and the waters support a diversity of tropical marine fauna, important coral reefs and unique mangrove communities (DEC 2007). Green, hawksbill and flatback turtles regularly use the island’s beaches for breeding, and loggerhead turtles are also occasionally sighted.

11.1.8 Montebello Islands Marine Park

Montebello/ Barrow/ Lowendal Islands are part of a shallow submarine ridge, which extends north from the mainland near Onslow. The ridge contains extensive areas of intertidal and shallow subtidal limestone pavement surrounding the numerous, mostly small islands which are found in the region. The seabed is generally less than 5 m deep and consists of sand veneered limestone pavement with patches of fringing coral reef (DEC 2007).

The island chain lies entirely within WA State waters, with the State-Commonwealth boundary extending out to encompass the islands and waters 3 nm west of Barrow Island and north of the Montebello Islands. These islands are protected within as marine conservation reserves: Montebello Islands Marine Park, Barrow Islands Marine Park and Barrow Island Marine Management Area.

The Montebello Islands Marine Park (58,331 ha) consists of two sanctuary zones, two recreation zones, one special purpose zone for benthic protection, eleven special purpose zones for pearling and general use zones.

The Montebello Islands comprise over 100 islands, the majority of which are rocky outcrops; rocky shore accounts for 81% of shoreline habitat (DEC 2007a).

The ecological and conservation values of the Montebello and Barrow Islands Marine Conservation Reserve (MCR) include important habitats including corals reefs and bommies, mangroves, seagrass and macroalgae meadows, rocky shorelines and hard substrate, intertidal sand and mudflat communities. These habitats provide protection, food and habitat for a large diversity of species, including dugongs, turtles, whales, other protected cetaceans and birds as well as sea snakes and fish. The area is considered to have a high biodiversity. The islands also provide feeding and resting areas for migrating shorebirds and seabird nesting areas.

Socio-economic values of the Montebello and Barrow Islands MCR include hydrocarbon exploration and production, pearling, nature-based tourism, commercial and recreational fishing, water sports, European history and maritime heritage and scientific research (DEC 2007)

Special purpose zones for pearling are established for the existing leaseholder to allow pearling to be the priority use of these areas (DEC 2007a). Commercial fishing includes a trap fishery for reef fishes, mainly in water depths of 30–100 m, and wet lining for reef fish and mackerel. Fish trawling also occurs in the waters near to the Montebello Islands. A tourist houseboat operates out of Claret Bay, at the southern end of Hermite Island, during the winter months. The Montebello Islands are becoming more frequently used by recreational boaters for camping, fishing and diving activities.

11.1.9 Rowley Shoals Marine Park

The Rowley Shoals (including the Commonwealth-managed Mermaid Reef Marine National Nature Reserve) are located approximately 300 km west-northwest of Broome, lying between 17°07'S, 119°36'E and 17°35'S, 118°56'E and encompassing approximately 87,674 ha (DEC 2007b).

The Rowley Shoals is ecologically significant in that the reefs form part of a series of important ecological "stepping stones" for a range of reef biota originating in Indonesian/west Pacific waters. Their position off the north-west Australian coast, an area of few offshore reef systems, provides an important upstream source for recruitment to reefs further south (DEC 2007b). Marine wildlife includes 184 species of corals, primarily Indo-West Pacific species, indicating the strong affinity of the Rowley Shoals communities with Indonesia. In terms of other species, at least 264 species of molluscs, 82 species of echinoderms and 389 species of finfish were also identified (DEC 2007b). The faunal assemblages of the Rowley Shoals Marine Park are regionally significant as they contain large numbers of species not found in the more turbid coastal environments of tropical Western Australia (DEC 2007b). There is a relatively low level of recreational and commercial activity, mostly atribuated to the remoteness of the Shoals with access difficult from both Indonesia and mainland Australia (DEC 2007b).

11.1.10 Lalang-garram/Camden Sound Marine Parks

The Lalang-garram/Camden Sound Marine Park was created on 19 June 2012 under Section 13 of the Conservation and Land Management Act 1984 (CALM Act). It is a multiple zone marine park that includes; Sanctuary, Special Purpose, and General Use zones (DPaW 2013). The marine park falls within the west Kimberley, which was recently added to the Australian National Heritage List because of its natural, indigenous and historic values to the nation.

The marine park is located about 150 km north of Derby (or 300 km north of Broome) and lies within the traditional country of three Aboriginal native title groups. The Dambimangari people's determination overlies the majority of the marine park. A section of the Wunambal Gaambera people's Uunguu determination includes a small portion of St George Basin, while a small section of the Mayala people's claim (native title not determined at the time of writing of Management Plan) overlies the southwest corner of the marine park (DPaW 2013).

The marine park covers an area of approximately 705,000 ha. It recognises and provides special management arrangements for this area of the Kimberley, which is a principal calving habitat of the humpback whale (*Megaptera novaeangliae*) population that migrates annually along Western Australia's coast. The marine park also conserves a range of species listed as having special conservation status including marine turtles, snubfin and Indo-Pacific humpback dolphins, dugong, saltwater crocodiles, and several species of sawfish. The park also includes a wide range of marine habitats and associated marine life, such as coral reef communities, rocky shoals, and the extensive mangrove forests and marine life of the St George Basin and Prince Regent River (DPaW 2013).

11.1.11 Marmion Marine Park

Marmion Marine Park was Western Australia's first marine park, declared in 1987 and is a multi-use reserve (CALM 2002). Marmion Marine Park is located offshore from Perth's northern suburbs, between Trigg Island and Burns Beach.

Habitats in the area include intertidal reef platforms, coastal sand beaches, a high limestone reef about 1 km from shore, Little Island and the Three Mile Reef system. Of note are complex assemblages of sea floor communities, including seagrass meadows, algal limestone pavement communities and crevice animal associations (CALM 2002).

The marine park provides an important habitat for marine mammals, such as sea lions, dolphins and whales. The island nature reserves within Marmion Marine Park provide an important habitat for several species of seabirds and haul-out areas for Australian sea lions, especially at Little Island and Burns Rocks (CALM 2002).

11.1.12 Swan Estuary Marine Park

The Swan Estuary Marine Park (A Class marine reserve number 4) was gazetted on 25 May 1990. The Swan Estuary Marine Park and Adjacent Nature Reserves Management Plan 1999-2009 was gazetted 7 April 2000 (CALM 1999).

The Swan Estuary Marine Park encompasses Alfred Cove, 200 ha adjacent to the suburbs of Attadale and Applecross; Pelican Point, a 45 ha area in Crawley; and Milyu, 95 ha adjacent to the Como foreshore (CALM 1999). All three localities are within 20 minutes of the Perth CBD.

These areas encompass mudflats, seagrass beds and intertidal vegetation such as sedges and saltmarsh, which provide many different habitats for a host of animals. The most important of these, due to their international significance, are the migratory wading birds. They come from as far afield as Asia, Mongolia and Siberia. About 33 of these species are protected, including the red-necked stint (CALM 1999).

11.1.13 Shoalwater Islands Marine Park

The Shoalwater Islands Marine Park is located within the Perth metropolitan area, adjacent to the city of Rockingham and was gazetted in 1990 (DEC 2007). There are three sanctuary zones, two special purpose zones and a large general use zone in the park.

The Shoalwater Island region is dominated by beach and rocky shore shoreline habitats. The many jagged edged islands and rocky islets of the marine park provide important roosting and nesting areas for numerous bird species. The marine park has some of the healthiest seagrass meadows in the Perth metropolitan area, consisting of long lived species such as *Posidonia* spp. and *Amphibolis* spp. Seagrass meadows provide an important habitat and nursery area for a large number of marine species such as fish, rock lobsters, worms, shellfish, crustaceans, fish sharks and rays (DEC 2007).

The habitats of the marine park are important for the feeding, resting and breeding of little penguins and other sea and shore birds. Penguin Island which is found within the marine park has the largest breeding colony of little penguin on the west coast of Australia (DEC 2007). The bottlenose dolphin is the most common marine mammal, and Australian sea lions are commonly seen throughout the park.

11.1.14 Eighty Mile Beach Marine Park

The Eighty Mile Beach Marine Park, located between Port Hedland and Broome, was gazetted on 29 January 2013. It covers an area of approximately 200,000 ha stretching for some 220 km from Cape Missiessy to Cape Keraudren, and includes sanctuary, recreation, general use and special purpose zones. The park is managed under the Eighty Mile Beach Marine Park Management Plan 2014-20124 (DPaW, 2014).

The listed ecological values of the Eighty Mile Beach Marine Park include the high sediment and water quality, the juxtaposition of the beach, coastal topography and seabed and the diverse and ecologically important habitats and marine/coastal flora and fauna. The listed habitat values of the marine park are as follows:

+ The intertidal sand and mudflat communities supporting a high abundance and diversity of invertebrate life and providing a valuable food source for shorebirds (including migratory species) and other fauna;
+ The diverse subtidal filter-feeding communities;
+ Macroalgal and seagrass communities providing habitat and feeding opportunities for fish, invertebrates and dugongs;
+ High diversity intertidal and subtidal coral reef communities; and
+ Mangrove communities and adjacent saltmarshes provide nutrients to the surrounding waters and habitat for fish and invertebrates.

The listed marine and coastal fauna values are as follows:

+ A high diversity and abundance of nationally and internationally important shorebirds and waders (including migratory species) are found in the marine park;
+ Flatback turtles are endemic to northern Australia and nest at Eighty Mile Beach;
+ Dugongs and several whale and dolphin species inhabit or migrate through the marine park;
+ A highly diverse marine invertebrate fauna provides an important food source for a variety of animals, including birds, fish and turtles, along with recreational and commercial fishing opportunities;
+ A diversity of fish species provides recreational and commercial fishing opportunities; and
+ A diversity of sharks and rays, including several protected species, are found in the park.

In addition to these natural values, the marine park contains land and sea important to traditional Indigenous owners through identity and place, family networks, spiritual practice and resource gathering. The marine park also has a history of European activity including exploration, pastoralism and commercial fishing (e.g. the pearl oyster fishery). The park contains a historical WWII plane wreck (*Dornier Do-24 X-36*) and shipwrecks (two pearl luggers). The marine park provides tourism opportunity and recreational value through its remoteness, diversity and abundance of habitats and marine fauna and the pristine nature of the marine and coastal environment.

The marine park contains vast intertidal sand and mudflats that extend up to 4 km wide at low tide and provide a rich source of food for many species. Eighty Mile Beach Marine Park is one of the world's most important feeding grounds for small wading birds that migrate to the area each summer, travelling from countries thousands of kilometres away (DPaW 2014) (see **Section 9.2.1**).

11.1.15 Lalang-garram/ Horizontal Falls and North Lalang-garram Marine Parks

The Lalang-garram/ Horizontal Falls and North Lalang-garram Marine Parks were established in 2016 under the State Government’s *Kimberley Science and Conservation Strategy* and are jointly managed by Dambimangari Traditional Owners and the Department of Parks and Wildlife (DPaW 2016). The marine parks fall within the west Kimberly region, included in the Australian National Heritage List for its nationally significant natural, indigenous and historic values (DoEE 2019c).

The Lalang-garram/ Horizontal Falls Marine Park extends from Talbot Bay (*Ganbadba*) in the west to Walcott Inlet (*Iledda*) and Glenelg River (*Molor Moloiyn*) in the east and covers approximately 353,000 ha (DPaW 2016). The marine park protects the internationally recognised Horizontal Falls and is important for the region’s tourism. The North Lalang-garram Marine Park lies between the Lalang-garram / Camden Sound and North Kimberley Marine Parks and covers approximately 110,000 ha (DPaW 2016).

The area’s large tidal range results in extensive intertidal areas with diverse ecosystems such as fringing coral reefs, mangroves and mudflat communities. Subtidal habitats and communities common to the marine parks include filter feeding communities of sponges and hard and soft corals. These intertidal and subtidal habitats provide critical foraging and nursery areas for dugong, marine turtles, estuarine crocodiles, snubfin and Indo-Pacific humpback dolphins, several species of sawfish and migratory seabirds. The marine parks are also a principal calving habitat for humpback whales (DPaW 2016).

11.1.16 North Kimberley Marine Park

The North Kimberley Marine Park was established in December 2016 as a Class A marine park under the CPC (DPaW 2016a). The marine park comprises four separate management areas including, Uunguu, Balanggarra, Miriuwung Gajerrong, and Wilinggin. It is a multiple zone marine park that includes: eight sanctuary zones, nine special purpose zones (recreation and conservation), two special use zone (cultural heritage), and general use areas (DPaW 2016a). The marine park is managed in accordance with the provisions of the CALM Act with joint management between the Department of Parks and Wildlife and Traditional Owners of the area.

The area within the marine park is recognised for its Aboriginal cultural and heritage values, natural values including coral reefs, marine turtle species, dugongs, seagrass and macroalgal communities, mangroves and saltmarshes, finfish, and water and sediment quality, as well as for its social values (i.e. recreation, tourism and community values) and commercial values and resource use (e.g. commercial fishing). The marine park lies within the Indian Ocean and Timor Sea of Western Australia's Kimberley region, covering an area of approximately 1,845,000 hectares (DPaW 2016a). The south-western boundary is approximately 270 km northeast of Derby.

11.1.17 Yawuru Nagulagun/ Roebuck Bay Marine Park

The Yawuru Nagulagun/Roebuck Bay Marine Park was approved by the State Minister for Environment in October 2016 and declared as a Class A reserve over the subtidal and intertidal areas of Roebuck Bay (excluding the Kimberley Ports Authority waters), (DBCA, 2017a). The Marine Park is managed with a joint management framework between Parks and Wildlife and Yawuru Registered Native Title Body Corporation (RNTBC). The intent is to manage the areas from the offshore waters around Roebuck and Broome, collectively referred to as the Yawuru conservation estate, as one ecological system (DPaW 2016b). The development of the joint management plan is in accordance with the Conservation and Land Management Act 1984 (Yawuru Organisation 2017) as well as contributes to the State Governments commitment under the Kimberly Science and Conservation Strategy, released in June 2011.

The Yawuru people have lived along the foreshores of Roebuck Bay for thousands of years, the Bay is part of the Yawuru traditional estate (DPaW 2016b). Roebuck Bay is an internationally significant Ramsar wetland, declared in 1990, and an important feeding ground for many species of migratory shorebirds. It hosts possibly the greatest diversity of shorebird species at any site across the globe (DBCA 2017b). The Bay has some of the most productive tropical intertidal flats in the world, and is consequently an important ground for Yawuru fishing, hunting and gathering of sea food. The Bay hosts communities of seagrass and macroalgae, providing food for protected species such as the dugong and flatback turtle. Marine mammals also pass through the waters of the Bay such as the Australian snubfin dolphin and the humpback dolphin, the humpback whale can also be found during annual migration (DPaW 2016b).

12. Australian Marine Parks

12.1 Introduction

In agreement with the States and NT governments, the Australian Commonwealth government was committed to establish Commonwealth marine parks as a component of the National Representative System of Marine Protected Areas (DoE 2014) (See **Figure 9-1, Figure** 9-2 and **Figure 9-3**). In November 2012, the Commonwealth Marine Reserves Network was proclaimed with the purpose of protecting the biological diversity and sustainable use of the marine environment (Director of National Parks 2012a). Commonwealth Marine Reserves were renamed as Australian Marine Parks in October 2017. Six marine regions are included in the Australian Marine Parks Network, including the Coral Sea, the South-west, the Temperate East, the South-east, the North and the North-west. The South-east network 10-year Management Plan came into effect on 1 July 2013. The remaining networks 10-year Management Plans were approved and came into effect on 1 July 2018.

The new management plans establish the management and zoning of the designated marine parks. The marine park networks pertinent to the EMBA include:

+ The South-West Marine Parks Network;
+ The North-West Marine Parks Network; and
+ The North Marine Parks Network.

The South-West Marine Parks Network comprises 14 marine parks. Seven of these occur in West Australian waters in the EMBA, including:

+ Abrolhos Commonwealth Marine Park;
+ Jurien Marine Park;
+ Two Rocks Marine Park;
+ Perth Canyon Marine Park;
+ Geographe Marine Park;
+ South-west Corner Marine Park; and
+ Bremer Marine Park

The North-West Marine Parks Network comprises 13 marine parks which all occur in West Australian waters pertinent to the EMBA:

+ Carnarvon Canyon Marine Park;
+ Shark Bay Marine Park;
+ Gascoyne Marine Park;
+ Ningaloo Marine Park;
+ Montebello Marine Park;
+ Dampier Marine Park;
+ Eighty Mile Beach Marine Park;
+ Argo-Rowley Terrace Marine Park;
+ Mermaid Reef Marine Park;
+ Roebuck Marine Park;

- Kimberley Marine Park;
- Ashmore Reef Marine Park; and
- Cartier Island Marine Park.

The Northern Marine Parks Network comprises eight marine parks. However, only the Oceanic Shoals Marine Park extends across the boundary with the North-West Marine Parks Network, into the EMBA.

The sizes of these marine parks range from 300—152,000 km^2, and the water depths within the marine parks vary from approximately 15—1,500 m deep. The EPBC Act requires that each management plan assign an International Union for the Conservation of Nature (IUCN) category to each marine park. Additionally, the Act also allows for the management plan to divide a marine park into zones and to assign a category to each zone, which may differ from the overall category of the marine park. Zoning considers the purposes for which the marine parks were declared, the objectives of the relevant management plans, the values of the marine park and requirements of the EPBC Act and EPBC Regulations.

Five types of zone are represented within the North Marine Parks Network. However, it is only the Multiple Use Zone (IUCN Category VI) of the Oceanic Shoals Marine Park which extends into the EMBA.

The North-West Marine Parks Network includes six different types of zoning:

- Sanctuary Zone (IUCN Category Ia);
- National Park Zone (IUCN Category II);
- Recreational Use Zone (IUCN Category IV);
- Habitat Protection Zone (IUCN Category IV);
- Multiple Use Zone (IUCN Category VI); and
- Special Purpose Zone (Trawl) (VI).

The South-west Marin Parks Network includes six different types of zoning:

- National Park Zone (IUCN Category II);
- Habitat Protection Zone (IUCN Category IV);
- Multiple Use Zone (IUCN Category VI);
- Special Purpose Zone (Mining Exclusion) (IUCN Category VI);
- Special Purpose Zone (IUCN Category VI); and
- Special Purpose Zone (Trawl) (IUCN Category VI).

A summary of the South-West and North-West Marine Parks Networks is provided in **Table 12-1**.

12.2 South-West Marine Parks Network

The South-West Commonwealth Marine Parks Network is aligned to the South-West Marine Region. The network covers 508,371 km^2 and includes 14 marine parks (Director of National Parks, 2018a). Broad values of the South-west Australian Marine Parks include:

- Natural values;
- Cultural values;
- Heritage values; and
- Socio-economic values.

Further detail on each of the relevant marine parks those that fall within the EMBA is provided below.

12.2.1 Abrolhos Marine Park

The Abrolhos Marine Park (including zones within the EMBA: Marine National Park Zone – IUCN Category II-2,548 km^2; Habitat Protection Zone – IUCN Category VI-23,239 km^2; Multiple Use Zone – IUCN Category VI-56,545 km^2; Special Purpose Zone – IUCN Category VI-5,729 km^2) covers an area of approximately 88,060 km^2 and protects the following conservation values (Director of National Parks, 2018a):

+ Important foraging areas for the:
  - Threatened Australian lesser noddy;
  - Northernmost breeding colony of the threatened Australian sea lion;
  - Great white sharks; and
  - Migratory common noddy, wedge-tailed shearwater, bridled tern, Caspian tern and roseate tern.
+ Important migration habitat for the protected humpback whale and pygmy blue whales;
+ The second largest canyon on the west coast, the Houtman Canyon;
+ Examples of the northernmost ecosystems of the Central Western Province and South-west Shelf Transition (including the Central West Coast meso-scale bioregion);
+ Examples of the deeper ecosystems of the Abrolhos Islands meso-scale bioregion;
+ Examples of the shallower, southernmost ecosystems of the Central Western Shelf Province provincial bioregion including the Zuytdorp meso-scale bioregion;
+ Examples of the deeper ecosystems of the Central Western Transition provincial bioregion;
+ Examples of diversity of seafloor features including: southern most banks and shoals of the North-west region; deep holes and valleys; slope habitats; terrace and shelf environments; and
+ Seven KEFs.

The Abrolhos Marine Park is adjacent to the Shark Bay World Heritage Property. The marine park does not contain any Commonwealth or National Heritage listings (Director of National Parks 2018a). The marine park contains 11 known shipwrecks listed under the *Underwater Culture Heritage Act 2018*. Commercial tourism, fishing, recreation and mining are important supported socio-economic activities in the park.

12.2.2 Jurien Marine Park

The Jurien Marine Park (including zones within the EMBA): Marine National Park Zone -IUCN Category II – 31 km^2 Special Purpose Zone -IUCN Category VI – 1,820 km^2) covers an area of approximately 1,851 km^2 and protects the following conservation values (Director of National Parks 2018a):

+ Important foraging areas for the:
  - Threatened soft-plumaged petrel;
  - Threatened Australian sea lion;
  - Threatened white shark; and
  - Migratory roseate tern, bridled tern, wedge-tailed shearwater, and common noddy.
+ Important migration habitat for the protected humpback whale;
+ Examples of the ecosystems of two provincial bioregions: the central part of the South-west Shelf Transition (which includes the Central West Coast meso-scale bioregion) and small parts of the Central Western Province;
+ Three KEFs; and
+ Heritage values represented by the SS Cambewarra and Oleander historic shipwreck.

The Jurien Marine Park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018a). Commercial tourism, fishing, recreation and mining are important supported socio-economic activities in the park.

12.2.3 Two Rocks Marine Park

The Two Rocks Marine Park (including zones within the EMBA): Multiple Use Zone - IUCN Category VI – 867 km^2; Marine National Park Zone - IUCN Category II – 15 km^2) covers an area of approximately 882 km^2 and protects the following conservation values (Director of National Parks 2018a):

+ Important foraging areas for the:
  - Threatened soft-plumaged petrel;
  - Threatened Australian sea lion; and
  - Migratory roseate tern, bridled tern, Caspian tern, wedge-tailed shearwater, and common noddy.
+ Important migratory areas for protected humpback whales and pygmy blue whales;
+ Seasonal calving habitat for the threatened southern right whale;
+ Examples of the ecosystem of the southernmost parts of the South-west Shelf Transition (including the Central West Coast meso-scale bioregion); and
+ Three KEFs.

The Two Rocks Marine Park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018a). Commercial tourism, fishing, recreation and scientific research are important supported socio-economic activities in the park.

12.2.4 Perth Canyon Marine Park

Perth Canyon Marine Park (including zones within the EMBA): Marine National Park Zone – IUCN Category II – 1,241 km^2; Habitat Protection Zone – IUCN Category IV –4,352 km^2; Multiple Use Zone – IUCN Category VI – 1,816 km^2) covers an area of approximately 7,409 km^2 and protects the following conservation values (Director of National Parks 2018a):

+ Globally important seasonal feeding aggregation for the threatened blue whale;
+ Important foraging areas for the:
  - Threatened soft-plumaged petrel;
  - Migratory sperm whale; and
  - Migratory wedge-tailed shearwater.
+ Important migratory areas for protected humpback whales and blue whales;
+ Seasonal calving habitat for the threatened southern right whale;
+ Examples of the ecosystems of the southernmost parts of the Central Western Province and South-west Shelf Transition (including the Central West Coast meso-scale bioregion), and the northernmost parts of the South-west Transition and Southwest Shelf Province (including the Leeuwin-Naturaliste meso-scale bioregion); and
+ Four KEFs.

The Perth Canyon Marine Park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018a). Commercial tourism, fishing, shipping, recreation and defence training are important supported socio-economic activities in the park.

12.2.5 Geographe Marine Park

Geographe Marine Park (including zones within the EMBA): Marine National Park Zone - IUCN Category II – 15 km^2; Special Purpose Zone - IUCN VI – 650 km^2; Multiple Use Zone - IUCN Category VI – 291 km^2; Habitat Protection Zone (IV) 21 km^2) covers an area of approximately 977 km^2 and protects the following conservation values (Director of National Parks 2018a):

+ Important foraging areas for the:
  - Threatened soft-plumaged petrel; and
  - Migratory wedge-tailed shearwater.
+ Important pre-migration aggregation area for the migratory flesh-footed shearwater;
+ Important migratory habitat for the protected humpback whale and blue whale;
+ Seasonal calving habitat for the threatened southern right whale.
+ Seasonal calving habitat for the threatened southern right whale.
+ Representation of the South-west Shelf Province on the continental shelf as well as the Leeuwin-Naturaliste meso-scale bioregion;
+ Two KEFs; and
+ Representation of the seagrass habitats of the Geographe Bay key ecological feature, which in this location extend the furthest into Commonwealth waters.

The Geographe Marine Park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018a). The marine park contains eight known shipwrecks listed under the *Underwater Culture Heritage Act 2018.* Commercial tourism, fishing and recreation are important supported socio-economic activities in the park.

12.2.6 South-west Corner Marine Park

The South-west Corner Marine Park (including zones within the EMBA: Marine National Park Zone - IUCN II – 54,841 km^2; Multiple Use Zone - IUCN VI –106,602 km^2; Special Purpose Zone (Mining exclusion) - IUCN VI – 9,550 km^2, Special Purpose Zone – IUCN VI – 5753 km^2; Habitat Protection Zone - IUCN IV – 95,088 km2) covers an area of approximately 271,833 km2 within the EMBA and protects the following conservation values (Director of National Parks 2018a):

+ Important migratory area for protected humpback whales and blue whales;
+ Important foraging areas for the:
  - Threatened white shark;
  - Threatened Australian sea lion;
  - Threatened Indian yellow-nosed albatross and soft-plumaged petrel;
  - Sperm whale;
  - Migratory flesh-footed shearwater, short-tailed shearwater and Caspian tern; and
  - Seasonal calving habitat for the threatened southern right whale.
+ Representation of three provincial bioregions (the South-west Transition and Southern Province in the off-shelf area, and the South-west Shelf Province on the continental shelf) and two meso-scale bioregions (southern end of the Leeuwin-Naturaliste meso-scale bioregion and western and central parts of the Western Australia South Coast meso-scale bioregion);
+ Representation of the Donnelly Banks, east of Augusta, characterised by higher productivity and including nursery habitats; and

- Six KEFs.

The South-west Corner Marine Park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018a). The marine park contains ten known shipwrecks listed under the *Underwater Culture Heritage Act 2018*. Commercial tourism, fishing, shipping and recreation are important supported socio-economic activities in the park.

12.2.7 Bremer Marine Park

The Bremer Marine Park: National Park Zone – IUCN II – 3,172 km^2; Special Purpose Zone (Mining exclusion) - IUCN VI – 1,300 km^2, which covers an area of approximately 4,472 km^2 and protects the following conservation values (Director of National Parks 2018a):

- Contains habitats, species and ecological communities associated with two bioregions: Southern Province and South-west Shelf Province;
- Two key ecological features (Albany Canyon group and adjacent shelf break and ancient coastline between 90 m and 120 m depth);
- Important foraging areas for:
- Threatened white shark;
- Threatened Australian sea lion;
- Threatened Indian yellow-nosed albatross, Australian fairy tern and soft-plumaged petrel; and
- Migratory flesh-footed shearwater, short-tailed shearwater, bridled tern and Caspian tern.
- Important migratory pathway for humpback whales;
- Significant calving habitat for the threatened southern right whale; and
- Important aggregation area for killer whales

The marine park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018a). Commercial tourism, fishing, shipping and recreation are important supported socio-economic activities in the park.

12.3 North-West Marine Park Network

The North-West Marine Parks Network is aligned to the North-west Marine Region. The network covers 335, 341 km^2 and includes 13 marine parks (Director of National Parks, 2018b). Broad values of the North-west Commonwealth Marine Reserves Network include:

- Natural values;
- Cultural values;
- Heritage values; and
- Socio-economic values.

Further detail on each of the relevant marine parks within the EMBA is provided below.

12.3.1 Carnarvon Canyon Marine Park

The Carnarvon Canyon Marine Park (Habitat Protection Zone – IUCN Category IV) covers an area of approximately 6,177 km^2 and protects the following conservation values (Director of National Parks 2018b):

- The Carnarvon Canyon a single channel canyon with seabed features that include slope, continental rise and deep holes and valleys;

- The Carnarvon Canyon ranges in depth from 1500 m to over 5,000 m, thereby providing habitat diversity for benthic and demersal species; and
- Central Western Transition provincial bioregion ecosystem examples are found here, which are characteristic of the biogeographic faunal transition between tropical and temperate species.

There is limited information about species' use of this Marine Park (Director of National Parks 2018b). The marine park does not contain any international, Commonwealth or National Heritage listings (Director of National Parks 2018b). Commercial fishing, tourism, shipping and mining are important supported socio-economic activities in the marine park.

12.3.2 Shark Bay Marine Park

The Shark Bay Marine Park (Multiple Use Zone – IUCN Category VI) covers an area of approximately 7,443 km^2 and protects the following conservation values (Director of National Parks 2018b):

- Foraging areas adjacent to important breeding areas for several species of migratory seabirds;
- Part of the migratory pathway of protected humpback whales;
- Internesting habitat for marine turtles;
- Waters that are adjacent to the largest nesting area for loggerhead turtles in Australia;
- Marine park and adjacent coastal areas important for shallow-water snapper;
- Protection to shelf and slope habitats as well as a terrace feature;
- Examples of the shallower ecosystems of the Central Western Shelf Province and Central Western Transition provincial bioregions including the Zuytdorp meso-scale bioregion; and
- Connectivity between the inshore waters of the Shark Bay World Heritage Area and the deeper waters of the area.

Whilst no listed international, Commonwealth or National Heritage places are within the marine park, the park is adjacent to Shark Bay World Heritage Area (Director of National Parks 2018b). Commercial tourism, fishing, mining and recreation are important socio-economic values of the park.

12.3.3 Gascoyne Marine Park

The Gascoyne Marine Park (Multiple Use Zone – IUCN Category VI-33,652 km^2; Habitat Protection Zone – IUCN Category IV-38,982 km^2; Marine National Park Zone – IUCN Category II-9,132 km^2) covers an area of approximately 81,766 km^2 and protects the following conservation values (Director of National Parks 2018a):

- Important foraging areas for: migratory seabirds threatened and migratory hawksbills and flatback turtles; and vulnerable and migratory whale shark;
- A continuous connectivity corridor from shallow depths around 15 m out to deep offshore waters on the abyssal plain at over 5,000 m in depth;
- Seafloor features including canyon, terrace, ridge, knolls, deep hole/valley and continental rise. It also provides protection for sponge gardens in the south of the reserve adjacent to Western Australian coastal waters;
- Ecosystems examples from the Central Western Shelf Transition, the Central Western Transition and the Northwest province provincial bioregions as well as the Ningaloo meso-scale bioregion;
- Four KEFs for the region:
  - Canyons on the slope between the Cuvier Abyssal Plain and the Cape Range Peninsula (enhanced productivity, aggregations of marine life and unique sea-floor feature);
  - Exmouth Plateau (unique sea-floor feature associated with internal wave generation);

  - Continental slope demersal fish communities (high species diversity and endemism – the most diverse slope bioregion in Australia with over 500 species found with over 64 of those species occurring nowhere else); and
  - Commonwealth waters adjacent to Ningaloo Reef.
+ The canyons in this reserve are believed to be associated with the movement of nutrients from deep water over the Cuvier Abyssal Plain onto the slope where mixing with overlying water layers occurs at the canyon heads. These canyon heads, including that of Cloates Canyon, are sites of species aggregation and are thought to play a significant role in maintaining the ecosystems and biodiversity associated with the adjacent Ningaloo Reef; and
+ The reserve therefore provides connectivity between the inshore waters of the existing Ningaloo Commonwealth marine park and the deeper waters of the area.

The park is also adjacent to World Heritage listings associated with the Ningaloo Coast. Commercial tourism, commercial fishing, mining and recreation are important socio-economic values of the park (Director of National Parks 2018b).

12.3.4 Ningaloo Marine Park

Ningaloo Marine Park stretches approximately 300 km along the west coast of the Cape Range Peninsula and is adjacent to the Western Australian Ningaloo Marine Park and Gascoyne Marine Park (Director of National Parks, 2018b). Ningaloo Reef is the longest fringing barrier reef in Australia forming a discontinuous barrier that encloses a lagoon that varies in width from 200 m to 7 km. Gaps that regularly intercept the main reef line provide channels for water exchange with deeper, cooler waters (CALM 2005). It is the only example in the world of extensive fringing coral reef on the west coast of a continent.

The Ningaloo Marine Park (Recreational Use Zone – IUCN Category II) covers an area of approximately 2,435 km^2 and protects the following conservation values (Director of National Parks 2018a):

+ Important habitat (foraging areas) for vulnerable and migratory whale sharks;
+ Areas used for foraging by marine turtles adjacent to important internesting sites;
+ Part of the migratory pathway of the protected humpback whale;
+ Foraging and migratory pathway for pygmy blue whales;
+ Breeding, calving, foraging and nursing habitat for dugong;
+ Shallow shelf environments which provides protection for shelf and slope habitats, as well as pinnacle and terrace seafloor features;
+ Seafloor habitats and communities of the Central Western Shelf Transition;
+ Three KEFs; and
+ The Ningaloo Coast World Heritage Property, the Ningaloo Coast National Heritage listing and Ningaloo Marine Area Commonwealth Heritage Listing.

Commercial tourism and recreation are important socio-economic values of the marine park (Director of National Parks 2018b).

12.3.5 Montebello Marine Park

The Montebello Marine Park is located offshore of Barrow Island and 80 km west of Dampier extending from the Western Australian state water boundary and is adjacent to the Western Australian Barrow Island and Montebello Islands Marine Parks. The Montebello Marine Park (Multiple Use Zone – IUCN Category VI) covers an area of approximately 3,413 km^2 and protects the following conservation values (Director of National Parks 2018b):

+ Foraging areas for migratory seabirds that are adjacent to important breeding areas;

- Areas used by vulnerable and migratory whale sharks for foraging;
- Foraging areas marine turtles which are adjacent to important nesting sites;
- Section of the north and south bound migratory pathway of the humpback whale;
- Shallow shelf environments with depths ranging from 15–150 m which provides protection for shelf and slope habitats, as well as pinnacle and terrace seafloor features;
- Seafloor habitats and communities of the Northwest Shelf Province provincial bioregions as well as the Pilbara (offshore) meso-scale bioregion; and
- One KEF for the region is the ancient Coastline (a unique seafloor feature that provides areas of enhanced biological productivity).

Commercial tourism, commercial fishing, mining and recreation are important socio-economic values for the park.

12.3.6 Dampier Marine Park

The Dampier Marine Park (Marine National Park Zone – IUCN Category I-73 km^2; Habitat Protection Zone – IUCN Category IV-104 km^2; Multiple Purpose Zone – IUCN Category VI-1,074 km^2) covers an area of approximately 1,252 km^2 and protects the following conservation values (Director of National Parks 2018b):

- Foraging areas for migratory seabirds that are adjacent to important breeding grounds;
- Important foraging areas for marine turtles adjacent to significant nesting sites;
- Part of the migratory pathway of the protected humpback whale;
- Protection for offshore shelf habitats and shallow shelf habitats adjacent to the Dampier Archipelago; and
- Communities and seafloor habitats of the Northwest Shelf Province provincial bioregion as well as the Pilbara (nearshore) and Pilbara (offshore) meso-scale bioregions are included.

Port activities, commercial fishing and recreation are important activities in the marine park (Director of National Parks 2018b). No heritage listings apply to the marine park.

12.3.7 Eighty Mile Beach Marine Park

The Eighty Mile Beach Marine Park (Multiple Use Zone – IUCN Category VI) is adjacent to the Western Australia Eighty Mile Beach Marine Park, 74 km north-east of Port Hedland and covers an area of approximately 10,785 km^2 and protects the following conservation values (Director of National Parks 2018b):

- Breeding, foraging and resting habitat for seabirds (one of the world's most important feeding grounds for migratory shorebirds and waders and is listed under the Ramsar Convention);
- Internesting and nesting habitat for marine turtles (it supports a significant nesting population of flatback turtles, which are endemic to northern Australia);
- Foraging, nursing and pupping habitat for sawfish;
- Migratory pathway for humpback whales;
- Coastal waters provide critical habitat for several shark and ray species at varying life stages;
- The Nyangumarta, Karajarri and Ngarla people's sea country extends into Eighty Mile Beach Marine Park. Access to sea country by families is important for cultural traditions, livelihoods and future socio-economic development opportunities; and
- Three known shipwrecks listed under the *Underwater Cultural Heritage Act 2018*: Lorna Doone (wrecked in 1923), Nellie (wrecked in 1908), and Tifera (wrecked in 1923).

Tourism, commercial fishing, pearling and recreation are important activities in the Marine Park (Director of National Parks 2018b).

12.3.8 Argo-Rowley Terrace Marine Park

The Argo-Rowley Marine Park is located approximately 270 km north-west of Broome, Western Australia, and extends to the limit of Australia's exclusive economic zone. The Marine Park (Multiple Use Zone – IUCN Category VI-108,812 km^2; Marine National Park Zone – IUCN Category II-36,050 km^2; Special Purpose Zone – IUCN Category VI-1,141 km^2) covers an area of approximately 146,003 km^2 and protects the following conservation values (Director of National Parks 2018b):

+ Foraging areas that are important for migratory seabirds as well as the endangered loggerhead turtle;
+ Important habitat and foraging for sharks;
+ Migratory pathway for pygmy blue whales (Director of National Parks 2018b);
+ Protection for communities and habitats of the deeper offshore waters (220 m to over 5,000 m) of the region;
+ Seafloor features including aprons and fans, canyons, continental rise, knolls/abyssal hills and the terrace and continental slope;
+ Communities and seafloor habitats of the Northwest Transition and Timor Province provincial bioregions;
+ Connectivity between the existing Mermaid Reef Marine National Nature Reserve and reefs of the Western Australian Rowley Shoals Marine Park and the deeper waters of the region;
+ Two KEFs in the reserve include:
  - The canyons linking the Argo Abyssal Plain with the Scott Plateau (unique seafloor feature with enhanced productivity and feeding aggregations of species); and
  - Mermaid Reef and the Commonwealth waters surrounding Rowley Shoals (an area of high biodiversity with enhanced productivity and feeding and breeding aggregations).

No heritage listings apply to this marine park (Director of National Parks 2018b). Commercial fishing, mining and recreation are important socio-economic values for the park.

12.3.9 Mermaid Reef Marine Park

The Mermaid Reef Marine Park (Multiple Use Zone – IUCN Category VI) lays approximately 280 km north-west of Broome, Western Australia, adjacent to the Argo–Rowley Terrace Marine Park and approximately 13 km from the Western Australian Rowley Shoals Marine Park. It covers an area of 540 km^2 and protects the following conservation values (Director of National Parks 2018b):

+ Mermaid Reef and Commonwealth waters surrounding Rowley Shoals are valued for its high productivity, aggregations of marine life and high species richness;
+ Mermaid Reef, Clerke Reef and Imperieuse Reef are biodiversity hotspot and key topographic feature of the Argo Abyssal Plain;
+ Rowley Shoals present some of the best geological examples of shelf atolls in Australian waters, and are ecologically significant in that they are considered ecological steppingstones for reef species originating in Indonesian/Western Pacific waters, are one of a few offshore reef systems on the north-west shelf, and may also provide an upstream source for recruitment to reefs further south;
+ Breeding habitat for seabirds;
+ Migratory pathway for the pygmy blue whale; and
+ One known shipwreck listed under the *Underwater Cultural Heritage Act 2018*: Lively (wrecked in 1810).

Tourism, recreation, and scientific research are important activities in the Marine Park (Director of National Parks 2018b).

12.3.10 Roebuck Marine Park

The Roebuck Marine Park (Multiple Use Zone – IUCN Category VI) covers an area of approximately 304 km^2 and protects the following conservation values (Director of National Parks 2018b):

+ Foraging habitat area for migratory seabirds adjacent to important breeding areas;
+ Foraging area adjacent to important nesting sites for flatback turtles;
+ Parts of the migratory pathway of the protected humpback whale;
+ Habitat adjacent to important foraging, nursing and pupping areas for freshwater, green and dwarf sawfish;
+ Foraging and calving areas for Australian snubfin, Indo-Pacific humpback and Indo-Pacific bottlenose dolphins;
+ Foraging habitat for dugong;
+ Protection for shallow shelf habitats ranging in depth from 15–70 m;
+ Ecosystems example of the Northwest Shelf Province provincial bioregion and the Canning meso-scale bioregion; and
+ Sea country valued for indigenous cultural identity, health and well-being for the Yawuru people (Director of National Parks 2018b).

No heritage listings apply to the marine park. Commercial tourism, fishing, pearling and recreation are important socio-economic values of the marine park (Director of National Parks 2018b).

12.3.11 Kimberley Marine Park

The Kimberley Marine Park (Multiple Use Zone – IUCN Category VI) is located approximately 100 km north of Broome, Western Australia, and extends from the Western Australian state water boundary north from the Lacepede Islands to the Holothuria Banks offshore from Cape Bougainville. It is adjacent to the Western Australian Lalanggarram / Camden Sound Marine Park and the North Kimberley Marine Park. It covers an area of 74,469 km^2, and protects the following conservation values (Director of National Parks 2018b):

+ Northwest Shelf Province;
  - Diverse benthic and pelagic fish communities
  - Ancient coastline thought to be an important seafloor feature
  - Migratory pathway for humpback whales
+ Northwest Shelf Transition;
  - High levels of species diversity
  - Endemism occur among demersal fish communities on the continental slope
+ Timor Province;
  - Reefs and islands of the bioregion are regarded as biodiversity hotspots
  - Endemism in demersal fish communities of the continental slope is high (two distinct communities have been identified on the upper and mid slopes)
  - Ancient coastline at the 125 m depth contour where rocky escarpments are thought to provide biologically important habitats in areas otherwise dominated by soft sediments;
  - Continental slope demersal fish communities characterised by high diversity of demersal fish assemblages;
  - breeding and foraging habitat for seabirds;

- Internesting and nesting habitat for marine turtles;
- Breeding, calving and foraging habitat for inshore dolphins;
- Calving, migratory pathway and nursing habitat for humpback whales;
- Migratory pathway for pygmy blue whales;
- Foraging habitat for dugong and whale sharks;
- The Wunambal Gaambera, Dambimangari, Mayala, Bardi Jawi and the Nyul Nyul people's sea country extends into the Kimberley Marine Park. Access to sea country by families is important for cultural traditions, livelihoods and future socio-economic development opportunities; and
- More than 40 known shipwrecks listed under the *Underwater Cultural Heritage Act 2018*.

Tourism, commercial fishing, mining, recreation, including fishing, and traditional use are important activities in the Marine Park (Director of National Parks 2018b).

12.3.12 Ashmore Reef Marine Park

The Ashmore Reef Marine Park (Sanctuary Zone – IUCN Category Ia; Recreational Use Zone – IUCN Category II) covers an area of approximately 583 km^2 (Director of National Parks 2018b). It forms part of the North-west Park Network. As the only oceanic reef in the north-east Indian Ocean with vegetated islands (East, Middle and West Islands), Ashmore is also the largest of three emergent, oceanic reefs in the region (DSEWPaC 2012). Both the Ashmore and Cartier Islands fall under the legal memorandum of understanding between Indonesia and Australia, as both areas are located within Australia's external territory (DSEWPaC 2012).

Ashmore Reef Marine Park is located on Australia's North West Shelf in the Indian Ocean, about 450 nautical miles (840 km) west of Darwin and 330 nautical miles (610 km) north of Broome. The reserve covers 583 km^2 and includes two extensive lagoons, shifting sand flats and cays, seagrass meadows, a large reef flat covering an area of 239 km^2. Within the reserve are three small islands known as East, Middle and West Islands (DoE, 2002).

Ashmore was designated a Ramsar Wetland of International Importance in 2003 due to the importance of its islands providing a resting place for migratory shorebirds and supporting large seabird breeding colonies.

The proclaimed marine park will protect the following conservation values (DoE 2014):

+ Ecosystems, habitats and communities associated with; the North West Shelf; Timor Province; and emergent oceanic reefs;
+ The island and reef habitats:
  - Contains critical nesting and internesting habitat for green turtles (including one of three genetically distinct breeding populations in the North-west Marine Region). Low level nesting activity by loggerhead turtles has also been recorded;
  - Large and significant feeding populations of green, hawksbill and loggerhead turtles occur around the reefs (it is estimated that approximately 11,000 marine turtles feed in the area throughout the year);
  - Supports a small dugong population of less than 50 individuals that breed and feed around the reef. This population is thought to be genetically distinct from other Australian populations;
  - Migratory pathway for pygmy blue whales (Director of National Parks 2018b);
  - Support some of the most important seabird rookeries on the North West Shelf including colonies of bridled terns, common noddies, brown boobies, eastern reef egrets, frigatebirds, tropicbirds, red-footed boobies, roseate terns, crested terns and lesser crested terns;
  - Is an important staging points/feeding areas for many migratory seabirds; and
  - Is internationally significant for its abundance and diversity of sea snakes.

- Two KEFs:
- Ashmore Reef and Cartier Island and surrounding Commonwealth waters; and
- Continental slope demersal fish communities (Director of National Parks 2018b);
- Cultural and heritage sites, including;
  - Ashmore lagoon as a rest/staging area for traditional Indonesian fishers
  - Indonesian artefacts; and
  - Grave sites.
  - Commonwealth heritage listing – Ashmore Reef

Ashmore Reef and nearby islands and reefs are associated with benthic communities consisting predominantly of sand and coral rubble, with noteworthy hard coral, soft coral, algae and seagrasses (Heyward *et al.* 2012; Skewes et al., 1999a, 1999b). The reefs host similar benthic communities, with areas of relatively high live coral cover, although episodes of coral bleaching have been recorded (Heyward *et al.* 2012). Benthic organisms that depend on photosynthesis such as seagrasses, macroalgae and zooxanthellate corals are typically restricted to shallower waters around the reefs, although in the clear tropical waters may be found at considerable depths. Given the shallowest sampling location is greater than 60 m, and that most sampling locations are greater than 100 m deep, diverse benthic communities driven by primary producers such as seagrasses, algae and zooxanthellate corals are not expected to occur at the sampling locations. Data collected in the vicinity of Ashmore Reef indicates that corals are likely to spawn during March and April (Heyward *et al.* 2010).

Soft sediments are widespread in the region, with sediment infauna communities in the region dominated by polychaetes and crustaceans. These taxa accounted for over 80% of benthic infauna sampled, both in terms of numbers of species and individual organisms (Smith *et al.* 1997).

Commercial tourism, recreation and scientific research are important socio-economic values of the marine park (Director of National Parks 2018b).

12.3.13 Cartier Island Marine Park

The Cartier Island Marine Park (Sanctuary Zone – IUCN Category Ia) is located approximately 45 km south-east of Ashmore Reef Marine Park and 610 km north of Broome, Western Australia. Both Marine Parks are in Australia's External Territory of Ashmore and Cartier Islands and are also within an area subject to a Memorandum of Understanding (MoU) between Indonesia and Australia, known as the MoU Box. The Marine Park covers an area of 172 km² and protects the following conservation values (Director of National Parks 2018b):

- Ashmore Reef and Cartier Island and surrounding Commonwealth waters;
- Areas of enhanced productivity in an otherwise low-nutrient environment;
- Regional importance for feeding and breeding aggregations of birds and marine life;
- Continental slope demersal fish communities;
- Area of high diversity in demersal fish assemblages;
- Area of high diversity and abundance of hard and soft corals, gorgonians (sea fans), sponges and a range of encrusting organisms;
- Breeding and foraging habitat for seabirds;
- Internesting, nesting and foraging habitat for marine turtles;
- Foraging habitat for whale sharks;
- Internationally significant for its abundance and diversity of sea snakes;

- One known shipwreck listed under the *Underwater Cultural Heritage Act 2018*: the Ann Millicent (wrecked in 1888).

Scientific research is an important activity in the Marine Park (Director of National Parks 2018b).

12.4 North Marine Park Network

The North Park Network is aligned to the North Marine Region. The network covers 157,480 km^2 (Director of National Parks 2018c). Broad values of the North Network include:

- Natural values;
- Cultural values;
- Heritage values; and
- Socio-economic values.

Further detail on the applicable Oceanic Shoals Marine Park is provided below.

12.4.1 Oceanic Shoals Marine Park

The Oceanic Shoals Marine Park (zones within EMBA: Multiple Use Zone - IUCN Category VI- 32,488 km^2; Special Purpose Zone – IUCN VI-24,443 km^2) covers an area of approximately 56,931 km^2 within the EMBA.

The marine park protects the following conservation values (DoE 2014):

- Important resting area for turtles between egg laying (internesting area) for the threatened flatback turtle and olive ridley turtle;
- Important foraging area for the threatened loggerhead turtle and olive ridley turtle;
- Examples of the ecosystems of two provincial bioregions: the Northwest Shelf Transition Province (which includes the Bonaparte, Oceanic Shoals, and Tiwi meso-scale bioregions) and the Timor Transition Province;
- KEFs represented in the park are (Director of National Parks 2018c):
  - Carbonate bank and terrace system of the Van Diemen Rise (unique sea-floor feature);
  - Carbonate banks and terrace system of the Sahul Shelf (unique sea-floor feature);
  - Pinnacles of the Bonaparte Basin (enhanced productivity, unique sea-floor feature); and
  - Shelf break and slope of the Arafura Shelf (unique sea-floor feature).

No heritage listings apply to the marine park. Commercial fishing and mining are important socio-economic values for the park (Director of National Parks 2018c).

A spatial predictive benthic habitat model of the Oceanic Shoals Marine Park has been developed by AIMS, as part of the Australian National Environmental Science Programme, to determine the spatial heterogeneity of the benthic environment and key classes of organisms within the reserve. The benthic habitat model maps the 10 broad classes of benthic organisms; alcyons, gorgonians, soft corals, hard corals, halimeda, macroalgae, seagrass, filterers (e.g. sponges), burrowers (e.g. sea urchins) and no biota detected (Radford and Puotinen 2016).

Table 12-1 Summary of marine network values, pressures, management programs and actions applicable to the EMBA

Marine network	Values	Pressures	Management programs and actions
SOUTH WEST	+ Nine bioregions + Key ecological features + EPBC listed species + Biologically important areas + Sea country indigenous values + Historic shipwrecks + Adjacent to Shark Bay World Heritage Area + Shipping and port activities + Commercial fishing + Marine tourism	+ Climate change + Hydrological changes from coastal development and agriculture (increase sediment loads and pollutants) + Illegal/unregulated/unreported fishing + Bycatch of non-target species + Habitat modification from mining + Human presence + Invasive species + Marine pollution	+ Communication, education and awareness programs + Promote suitable tourism experience + Facilitate partnerships between tourism operators and Indigenous operators + Indigenous engagement program + Marine monitoring programs + Park management via assessments / authorisation program for marine park activities + Marine park management and development of suitable infrastructure + Compliance planning and surveillance

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Marine network	Values	Pressures	Management programs and actions
NORTH WEST	+ Eight bioregions + Key ecological features + EPBC listed species + Biologically important areas + Sea country indigenous values + Native title determinations + Traditional Indonesian fishers + World Heritage Properties (Ningaloo Coast, Shark Bay) + Ashmore Reef Marine Park and Eighty-Mile Beach Ramsar sites + Shipping and port activities + Commercial fishing, pearling, aquaculture + Marine tourism + Scientific research	+ Climate change + Hydrological changes from coastal development and agriculture (increase sediment loads and pollutants) + Illegal/unregulated/unreported fishing + Bycatch of non-target species + Habitat modification from mining + Human presence + Invasive species + Marine pollution	+ Communication, education and awareness programs + Promote suitable tourism experience + Facilitate partnerships between tourism operators and Indigenous operators + Indigenous engagement program + Marine monitoring programs + Park management via assessments / authorisation program for marine park activities + Marine park management and development of suitable infrastructure + Compliance planning and surveillance
NORTH	+ One bioregion + Key ecological features + EPBC listed species + Biologically important areas + Historic shipwrecks	+ Climate change + Hydrological changes reliance upon the large number of estuaries and waterways that feed into the Gulf of Carpentaria and the waters adjacent to the Northern Territory coastline + Illegal/unregulated/unreported fishing + Bycatch of non-target species + Physical Habitat modification + Marine pollution	+ Communication, education and awareness programs + Promote suitable tourism experience + Facilitate partnerships between tourism operators and Indigenous operators + Indigenous engagement program + Marine monitoring programs + Park management via assessments / authorisation program for marine park activities + Marine park management and development of suitable infrastructure + Compliance planning and surveillance

13. Conservation Management Plans

In order to protect, maintain and enhance recovery of certain threatened species and ecological communities the DAWE may prepare conservation management plans in the form of Conservation Advice or Recovery Plans.

13.1 Conservation Advice

When a native species or ecological community is listed as threatened under the EPBC Act, conservation advice is developed to assist its recovery. Conservation advice provides guidance on immediate recovery and threat abatement activities that can be undertaken to ensure the conservation of a newly listed species or ecological community.

13.2 Recovery Plans

The Australian Government Minister for the Environment may make or adopt and implement recovery plans for threatened fauna, threatened flora (other than conservation dependent species) and threatened ecological communities listed under the Commonwealth EPBC Act. Recovery plans set out the research and management actions necessary to stop the decline of, and support the recovery of, listed threatened species or threatened ecological communities. The aim of a recovery plan is to maximise the long-term survival in the wild of a threatened species or ecological community.

Table 13-1: Summary of EPBC Act recovery plans applicable to the EMBA

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
Bird	Australian lesser noddy	Approved Conservation Advice for *Anous tenuirostris melanops* (Australian lesser noddy) (2015)	Habitat modification by pied cormorants (Houtman Abrolhos)
			Catastrophic destruction of habitat by cyclones
	Migratory species within the EMBA: + Asian dowitcher; + Bar-tailed godwit; + Black-tailed godwit; + Broad-billed sandpiper; + Common greenshank; + Common redshank; + Common sandpiper; + Double-banded plover; + Fork-tailed swift; + Grey plover; + Grey-tailed tattler; + Long-toed stint; + Little greenshank + Oriental plover; + Oriental pratincole; + Pacific golden plover; + Pectoral sandpiper; + Red-necked phalarope; + Red-necked stint; + Ruddy turnstone;	Wildlife Conservation Plan for Migratory Shorebirds (2015)	Habitat loss and degradation
			Pollution and Contaminants
			Invasive species
			Anthropogenic disturbance
			Climate change and variability
			Overharvesting of shorebird prey
			Fisheries bycatch
			Direct mortality (hunting)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
	+ Ruff (reeve); + Sanderling; + Sharp-tailed sandpiper; + Streaked shearwater; + Terek sandpiper; + Whimbrel; and + Wood sandpiper.		
	Christmas Island frigatebird	Conservation Advice for the Christmas Island frigatebird *Fregata andrewsi* (2020a) Recovery Plan for the Christmas Island Frigatebird (*Fregeta andrewsi*) (2004)	Introduction of a new disease
			Disturbance of habitat
			Fisheries – prey depletion
			Illegal killing and hunting in south-east Asia
			Invasive weeds
			Fisheries - bycatch
			Drowning in artificial water bodies
			Heavy metal contamination
			Marine debris - plastics
	Australasian bittern	Conservation Advice for *Botaurus poiciloptilus* (Australasian Bittern) (2019)	habitat loss through water reductions and transition from ponded rice to other farming systems
			habitat degradation through increased salinity, siltation and pollution; grazing by livestock and feral animalsan d changes in abundance of plant species
			Climate change through changes in water availability; changes in fire regimes and salinisation of coastal wetlands
			Infrastructure through urban development
			Predation by introduced vertebrate pests such as foxes and cats
	Red knot		Habitat loss and habitat degradation

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		Approved Conservation Advice for *Calidris canutus* (Red knot) (2016) Wildlife Conservation Plan for Migratory Shorebirds (2015)	Over-exploitation of shellfish
			Pollution/contamination impacts
			Disturbance
			Direct mortality (hunting)
			Diseases
			Extreme weather events
			Climate change impacts
	Curlew sandpiper	Approved Conservation Advice for *Calidris ferruginea* (Curlew Sandpiper) (2015)	Ongoing human disturbance
			Habitat loss and degradation from pollution
			Changes to the water regime
			Invasive plants
	Great knot	Approved Conservation Advice for *Calidris tenuirostriss* (Great knot) (2016) Wildlife Conservation Plan for Migratory Shorebirds (2015).	Habitat loss and habitat degradation
			Pollution/contaminants
			Disturbance
			Diseases
			Direct mortality (hunting)
			Climate change impacts
	Greater sand plover	Approved Conservation Advice for *Charadrius leschenaultii* (Greater sand plover) (2016) Wildlife Conservation Plan for Migratory Shorebirds (2015)	Habitat loss and habitat degradation
			Pollution/contamination impacts
			Disturbance
			Direct mortality (hunting)
			Diseases
			Climate change impacts

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
	Lesser sand plover	Approved Conservation Advice for *Charadrius mongolus* (Lesser sand plover) (2016) Wildlife Conservation Plan for Migratory Shorebirds (2015)	Habitat loss and habitat degradation
			Pollution/contamination impacts
			Disturbance
			Direct mortality (hunting)
			Diseases
			Climate change impacts
	Antipodean albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Amsterdam albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Tristan albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Southern royal albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Wandering albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Northern royal albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Blue petrel	Approved Conservation Advice for *Halobaena caerulea* (blue petrel) (2015)	Habitat loss, disturbance and modification
			Predation
	Western Alaskan bar-tailed godwit	Wildlife Conservation Plan for Migratory Shorebirds (2015) Approved Conservation Advice for *Limosa lapponica baueri* (Bar-tailed godwit (western Alaskan)) (2016)	Habitat loss and habitat degradation
			Over-exploitation of shellfish
			Pollution/contamination impacts
			Disturbance
			Direct mortality (hunting)
			Diseases
			Extreme weather events
			Climate change impacts
	Northern Siberian bar-tailed godwit	Approved Conservation Advice for *Limosa lapponica menzbieri* (Bar-tailed godwit (northern Siberian)) (2016)	Habitat loss and habitat degradation
			Over-exploitation of shellfish
			Pollution/contamination impacts
			Disturbance
			Direct mortality (hunting)
			Diseases
			Extreme weather events
			Climate change impacts
	Southern giant petrel		Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Northern giant petrel	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Eastern curlew	Approved Conservation Advice *for Numenius madagascariensis* (eastern curlew) (2015)	Ongoing human disturbance
			Habitat loss and degradation from pollution
			Changes to the water regime

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Invasive plants
	Fairy prion (southern)	Approved Conservation Advice for *Pachyptila turtur subantarctica* (fairy prion (southern)) (2015)	Competition with blue petrels
			Soil erosion
			Fire
	Abbott's booby	Conservation Advice for the Abbott's booby *Papasula abbotti* (2020b)	Vegetation clearing – edge effects from previous clearing and new vegetation clearing
			Climate change – severe storm events and prey depletion
			Introduction of a new disease
			Invasive weeds
			Yellow crazy ants – habitat modification
			Fisheries – prey depletion
			Marine debris - plastics
	Christmas Island white-tailed tropicbird	Conservation Advice for *Phaethon lepturus fulvus* white-tailed tropicbird (Christmas Island) (2014)	Introduced predators on Christmas Island
			Crazy ants
	Sooty albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Competition for nest space
	Soft-plumaged petrel	Approved Conservation Advice for *Pterodroma mollis* (soft-plumaged petrel) (2015)	Accidental introduction of predators (relevant only to Maatsuyker Island, located offshore of Tasmania)
	Australian painted snipe	Commonwealth Conservation Advice on *Rostratula australis* (Australian painted snipe) (2013)	Loss and degradation of wetlands, through drainage and the diversion of water for agriculture and reservoirs
			Grazing and associated trampling of wetland vegetation/nests, nutrient enrichment and disturbance to substrate by livestock
			Climate change
			Predation by feral animals
			Introduction of weeds
	Australian fairy tern	Commonwealth Conservation Advice on *Sternula nereis nereis* (fairy tern) (2011)	Predation by introduced mammals and native birds
			Disturbance by humans, dogs and vehicles
			Increasing salinity in waters adjacent to Fairy Tern colonies
			Irregular water management
			Weed encroachment
			Oil spills, particularly in Victoria (potential threat)
	Indian yellow-nosed albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Shy albatross	Conservation Advice *Thalassarche cauta* Shy Albatross (2020c) National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Fisheries bycatch
			Disease
			Competition for nesting habitat
			Marine plastics
			Human disturbance
			Previous harvesting for feathers and eggs
			Climate change
	White-capped albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Campbell albatross		Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
	Black-browed albatross	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (2011)	Incidental catch resulting from fishing operations
			Competition with fisheries for marine resources
			Dependence on discards
			Marine pollution
			Climate change
			Intentional shooting/killing
			Feral pest species
			Human disturbance at the nest
			Parasites and diseases
			Loss of nesting habitat
			Competition for nest space
Mammals	Sei whale	Approved Conservation Advice for *Balaenoptera borealis* (sei whale) (2015)	Climate and oceanographic variability and change
			Anthropogenic noise and acoustic disturbance
			Habitat degradation including pollution (increasing port expansion and coastal development)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Pollution (persistent toxic pollutants)
			Vessel strike
			Prey depletion due to fisheries (potential threat)
			Resumption of commercial whaling (potential threat)
	Blue whale	Blue Whale Conservation Management Plan 2015 - 2025 (2015)	Whaling
			Climate Variability and Change
			Noise Interference
			Habitat Modification
			Vessel Disturbance
			Overharvesting of prey
	Fin whale	Approved Conservation Advice for *Balaenoptera physalus* (fin whale) (2015)	Climate and oceanographic variability and change
			Anthropogenic noise and acoustic disturbance
			Habitat degradation including coastal development, port expansion and aquaculture
			Pollution (persistent toxic pollutants)
			Fisheries catch, entanglement and bycatch
			Vessel strike
			Resource depletion due to fisheries (potential threat)
			Resumption of commercial whaling (potential threat)
	Southern right whale	Conservation Management Plan for the Southern Right Whale 2011 – 2021 (2012)	Entanglement
			Vessel disturbance
			Whaling
			Climate variability and change
			Noise interference

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Habitat modification
			Overharvesting of prey
	Humpback whale	Approved Conservation Advice for *Megaptera novaeangliae* (humpback whale) (2015)	Whaling
			Climate and Oceanographic Variability and Change
			Overharvesting of Prey
			Noise Interference
			Habitat degradation including coastal development and port expansion
			Entanglement
			Vessel disturbance and strike
	Australian sea-lion	Recovery Plan for the Australian Sea Lion (*Neophoca cinerea*) (2013)	Fishery bycatch (primary threat)
			Entanglement in marine debris (primary threat)
			Marine aquaculture
			Habitat degradation
			Human disturbance
			Direct killing (primary threat)
			Disease
			Pollution and oil spills
			Noise
			Competition and prey depletion
			Climate change
Reptiles	Short-nosed seasnake		Degradation of reef habitat, primarily as a result of coral bleaching (primary threat)
			Oil and gas exploration

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
		Approved Conservation Advice on *Aipysurus apraefrontalis* (Short-nosed seasnake) (2011)	Incidental catch and death in commercial prawn trawling fisheries
	Leaf-scaled seasnake	Approved Conservation Advice on *Aipysurus foliosquama* (Leaf-scaled seasnake) (2011)	Degradation of reef habitat, primarily as a result of coral bleaching (primary threat)
			Oil and gas exploration
			Incidental catch and death in commercial prawn trawling fisheries (north-west marine area)
			Unsustainable and illegal fishing practices (currently the most significant threat in the Ashmore region)
	Loggerhead turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (2017) Loggerhead turtle – WA genetic stock	Fisheries bycatch – international (moderate), domestic (high)
			Indigenous take (moderate)
			Terrestrial predation (moderate)
			Habitat modification – infrastructure/coastal development (moderate), dredging/trawling (moderate)
			Chemical and terrestrial discharge – acute (high), chronic (low)
			Marine debris – entanglement and ingestion (moderate; unknown)
			Climate change and variability (high)
			International take – outside Australia's jurisdiction (moderate), within Australia's jurisdiction (low)
			Light pollution (moderate)
			Vessel disturbance (moderate)
			Noise interference – acute (moderate), chronic (moderate; unknown)
			Recreational activities (low)
			Diseases and pathogens (low; unknown)
			Fisheries bycatch – international (moderate), domestic (high)
			Cumulative impacts of threats

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
	Green turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (2017) Green turtle – NWS genetic stock (NWS), Scott-Browse genetic stock (ScBr), Ashmore genetic stock (AR)	Fisheries bycatch – international (moderate), domestic (moderate)
			Indigenous take (moderate)
			Terrestrial predation NWS – moderate, AR –high; unknown, ScBr – moderate; unknown)
			Habitat modification – infrastructure/coastal development (NWS – moderate, AR – low, ScBr – high), dredging/trawling (NWS – moderate, AR – low, ScBr – low)
			Chemical and terrestrial discharge – acute (NWS, AR, ScBr –high), chronic (NWS – moderate, AR – high, ScBr – high)
			Marine debris – entanglement (NWS – moderate, AR – very high, ScBr – moderate; unknown) and ingestion (NWS – low; unknown, AR – moderate, ScBr – moderate)
			Climate change and variability (NWS – moderate, AR – very high, ScBr – high)
			International take – outside Australia's jurisdiction (moderate; unknown for NWS and ScBr), within Australia's jurisdiction (moderate; unknown for NWS and ScBr)
			Light pollution (NWS – high, AR – moderate, ScBr – moderate)
			Vessel disturbance (moderate)
			Noise interference – acute (NWS – moderate; unknown, AR – low, ScBr – moderate), chronic (NWS – moderate; unknown, AR – low, ScBr – moderate; unknown)
			Recreational activities
			Diseases and pathogens (low; unknown for AR and ScBr)
			Cumulative impacts of threats
	Leatherback turtle	Approved Conservation Advice on *Dermochelys coriacea* (2008)	Incidental capture in commercial fisheries
			Harvest of eggs and meat
			Ingestion of marine debris
			Boat strike
			Predation on eggs by wild dogs, pigs and monitor lizards
			Degradation of foraging areas

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Changes to breeding sites
		Recovery plan for marine turtles in Australia 2017 – 2027 (2017)	Fisheries bycatch – international (high), domestic (high)
			Indigenous take (low)
			Terrestrial predation (moderate; unknown)
			Habitat modification – infrastructure/coastal development (moderate), dredging/trawling (low)
			Chemical and terrestrial discharge – acute (low), chronic (low; unknown)
			Marine debris – entanglement (moderate) and ingestion (high)
			Climate change and variability (high)
			International take – outside Australia's jurisdiction (high), within Australia's jurisdiction (low)
			Light pollution (low)
			Vessel disturbance (moderate)
			Noise interference – acute (low; unknown), chronic (low; unknown)
			Recreational activities (low)
			Diseases and pathogens (low; unknown)
			Fisheries bycatch – international (high), domestic (high)
			Cumulative impacts of threats
	Hawksbill turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (2017) Hawksbill turtle – WA genetic stock	Fisheries bycatch – international (moderate), domestic (moderate)
			Indigenous take (moderate)
			Terrestrial predation (moderate)
			Habitat modification – infrastructure/coastal development (moderate), dredging/trawling (moderate)
			Chemical and terrestrial discharge – acute (moderate), chronic (moderate)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Marine debris – entanglement (moderate) and ingestion (low; unknown)
			Climate change and variability (high)
			International take – outside Australia's jurisdiction (very high), within Australia's jurisdiction (moderate)
			Light pollution (high)
			Vessel disturbance (moderate)
			Noise interference – acute (moderate), chronic (moderate; unknown)
			Recreational activities (low)
			Diseases and pathogens (low; unknown)
			Cumulative impacts of threats
	Olive ridley turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (2017) Olive ridley turtle – Northern Territory genetic stock	Fisheries bycatch – international (moderate), domestic (high)
			Indigenous take (moderate)
			Terrestrial predation (moderate; unknown)
			Habitat modification – infrastructure/coastal development (low), dredging/trawling (low)
			Chemical and terrestrial discharge – acute (high), chronic (moderate)
			Marine debris – entanglement (very high) and ingestion (moderate; unknown)
			Climate change and variability (very high)
			International take – outside Australia's jurisdiction (moderate), within Australia's jurisdiction (moderate)
			Light pollution (moderate)
			Vessel disturbance (moderate)
			Noise interference – acute (low), chronic (low; unknown)
			Recreational activities (low)
			Diseases and pathogens (low; unknown)

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Cumulative impacts of threats
	Flatback turtle	Recovery plan for marine turtles in Australia 2017 – 2027 (2017) Flatback turtle – Pilbara coast genetic stock (Pil), South-west Kimberley coast genetic stock (swKim) and Cape Domett (CD)	Fisheries bycatch – international (low), domestic (moderate)
			Indigenous take (moderate)
			Terrestrial predation (moderate)
			Habitat modification – infrastructure/coastal development (Pil – high, swKim – moderate), dredging/trawling (moderate)
			Chemical and terrestrial discharge – acute (high), chronic (moderate)
			Marine debris – entanglement (moderate) and ingestion (low)
			Climate change and variability (Pil – high, swKim – moderate)
			International take – outside Australia's jurisdiction (low), within Australia's jurisdiction (low)
			Light pollution (Pil – high, swKim – moderate)
			Vessel disturbance (moderate)
			Noise interference – acute (moderate), chronic (moderate; unknown)
			Recreational activities (Pil – low, swKim – moderate)
			Diseases and pathogens (low; unknown)
			Cumulative impacts of threats
Sharks and fish	Grey nurse shark	Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) (2014)	Mortality due to incidental capture by commercial and recreational fisheries
			Mortality die to shark control programs
			Ecotourism
			Public aquarium trade
			Pollution and disease
			Ecosystem effects - habitat modification and climate change

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
	Great white shark	Recovery plan for the White Shark (*Carcharodon carcharias*) (2013)	Mortality related to being caught accidentally (bycatch) or illegally (targeted) by commercial and recreational fisheries, including issues of post release mortality
			Mortality related to shark control activities such as beach meshing or drumlining (east coast population)
			Illegal trade in white shark products
			Ecosystem effects as a result of habitat modification and climate change
			Ecotourism
	Northern river shark	Approved Conservation Advice for *Glyphis garricki* (northern river shark) (2014)	Commercial fishing activities
			Recreational fishing
			Indigenous fishing
			Illegal, unreported and unregulated fishing
			Habitat degradation and modification
			Marine debris
			Collection of animals for display in public aquaria (no known occurrences to date)
		Sawfish and River Sharks Multispecies Recovery Plan (2015)	Fishing activities including: being caught as by-catch in the commercial and recreational sectors; through indigenous fishing; and illegal, unreported and unregulated fishing
			Habitat degradation and modification
	Dwarf sawfish	Approved Conservation Advice on *Pristis clavata* (dwarf sawfish) (2009)	Being caught as bycatch in commercial and recreational net fishing
			Illegal, unreported and unregulated fishing
			Habitat degradation due to increasing human development
		Sawfish and River Sharks Multispecies Recovery Plan (2015)	Fishing activities including: being caught as by-catch in the commercial and recreational sectors; through indigenous fishing; and illegal, unreported and unregulated fishing
			Habitat degradation and modification
	Freshwater sawfish	Approved Conservation Advice for *Pristis pristis* (largetooth sawfish) (2014)	Commercial fishing activities
			Recreational fishing

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
			Indigenous fishing
			Illegal, unreported and unregulated fishing
			Habitat degradation and modification
			Marine debris
			Collection of animals for display in public aquaria
		Sawfish and River Sharks Multispecies Recovery Plan (2015)	Fishing activities including: being caught as by-catch in the commercial and recreational sectors; through indigenous fishing; and illegal, unreported and unregulated fishing
			Habitat degradation and modification
	Green sawfish	Approved Conservation Advice for *Pristis zijsron* (green sawfish) (2008)	Capture as bycatch and byproduct in gillnet and trawl fisheries
			Illegal capture for fins and rostra
			Habitat degradation through coastal development
		Sawfish and River Sharks Multispecies Recovery Plan (2015)	Fishing activities including: being caught as by-catch in the commercial and recreational sectors; through indigenous fishing; and illegal, unreported and unregulated fishing
			Habitat degradation and modification
	Whale shark	Approved Conservation Advice for *Rhincodon typus* (whale shark) (2015)	Intentional and unintentional mortality from fishing outside of Australian waters
			Boat strike from large vessels
			Habitat disruption from mineral exploration, production and transportation
			Disturbance from domestic tourism operations
			Marine debris
			Climate change
	Blind gudgeon	Approved Conservation Advice for *Milyeringa veritas* (blind gudgeon) (2008)	Habitat degradation and modification associated with sedimentation from mining/construction, canal development, water abstraction, point source pollution from sewage, landfill, dumping and mining; and diffuse pollution from urban development/ petroleum infrastructure

Taxa	Common name	Recovery Plan / Conservation Advice	Threats
	Blind cave eel	Approved Conservation Advice for *Ophisternon candidum* (blind cave eel) (2008)	Habitat degradation and modification associated with sedimentation from mining/construction, canal development, water abstraction, point source pollution from sewage, landfill, dumping and mining; and diffuse pollution from urban development
	Balston's pygmy perch	Approved Conservation Advice for *Nannatherina balstoni* (Balston's pygmy perch) (2008)	Habitat degradation and modification associated with flow and increased salinisation, siltation and eutrophication that occur through changes to flow regimes (regulation and abstraction), road maintenance, mineral sand exploration and mining, ground water extraction and agricultural and forestry practices in the uppermost catchment
	Black-stripe minnow	Approved Conservation Advice for *Galaxiella nigrostriatal* (Black-striped minnow) (2018)	Climate change – increased air and water temperatures, decreased rainfall, increased evaporation, lowering groundwater table.
			Invasive species (*Gambusia holbrooki*), aggressive interactions and competition

14. Social, Economic and Cultural Features

14.1 Industry

In 2018/19, Western Australia's petroleum industry was worth $38.4 billion per annum. The petroleum sector accounted for 26% of the total value of WA's mineral and petroleum sales in 2018/19, with 20 per cent of all mineral and petroleum sales coming from Liquefied Natural Gas (LNG). Currently Western Australia has four operating LNG projects; the North West Shelf, Gorgon, Pluto and Wheatstone. There are also a number of Floating Production and Storage Offtake (FPSO) facilities in the Timor Sea and North West Shelf, as denoted on **Figure 14-1** to **Figure 14-3**. Offshore development is focussed in the Carnarvon Basin, Browse Basin and on the North West Shelf (DMP 2014). There are also domestic gas plants on Varanus Island in the North West Shelf, Devil Creek Onshore Gas Plant and Macedon Gas Plant in the Pilbara region and an oil facility near Dongara called Cliff Head. There are several exploration and production permits and leases throughout WA and Commonwealth waters in the EMBA. Existing petroleum infrastructure, permits and licences are shown in **Figure 14-1** to **Figure 14-3**.

14.2 Other Infrastructure

The Jasuraus submarine communication cable links Australia with Indonesia. The cable was installed as a link from Australia to provide telephone services connection to the world in 1995-1996. Travelling north out of Port Hedland for approximately 210 km the cable then heads north-west toward Jakarta, Indonesia. The cable runs up through Permit Areas WA-435-P and WA437-P. Its capacity and major role was overtaken in 2000 by other subsea cables out of Australia. However, Telstra continues to manage the cable as it remains an emergency backup link out of Australia. The cable includes two submerged repeaters in the wider region.

Santos

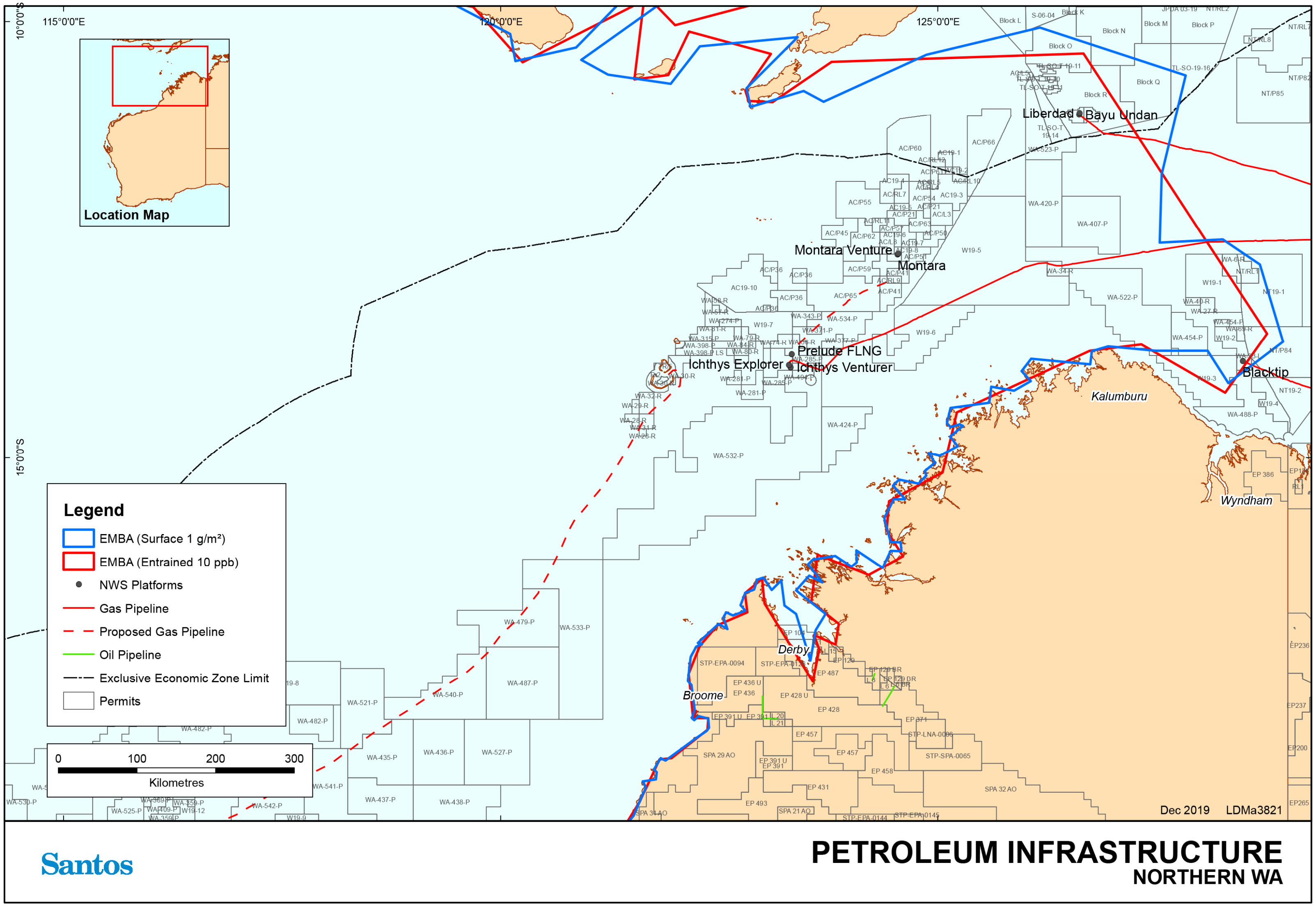


Figure 14-1: Existing petroleum infrastructure, permits and licences – Northern WA

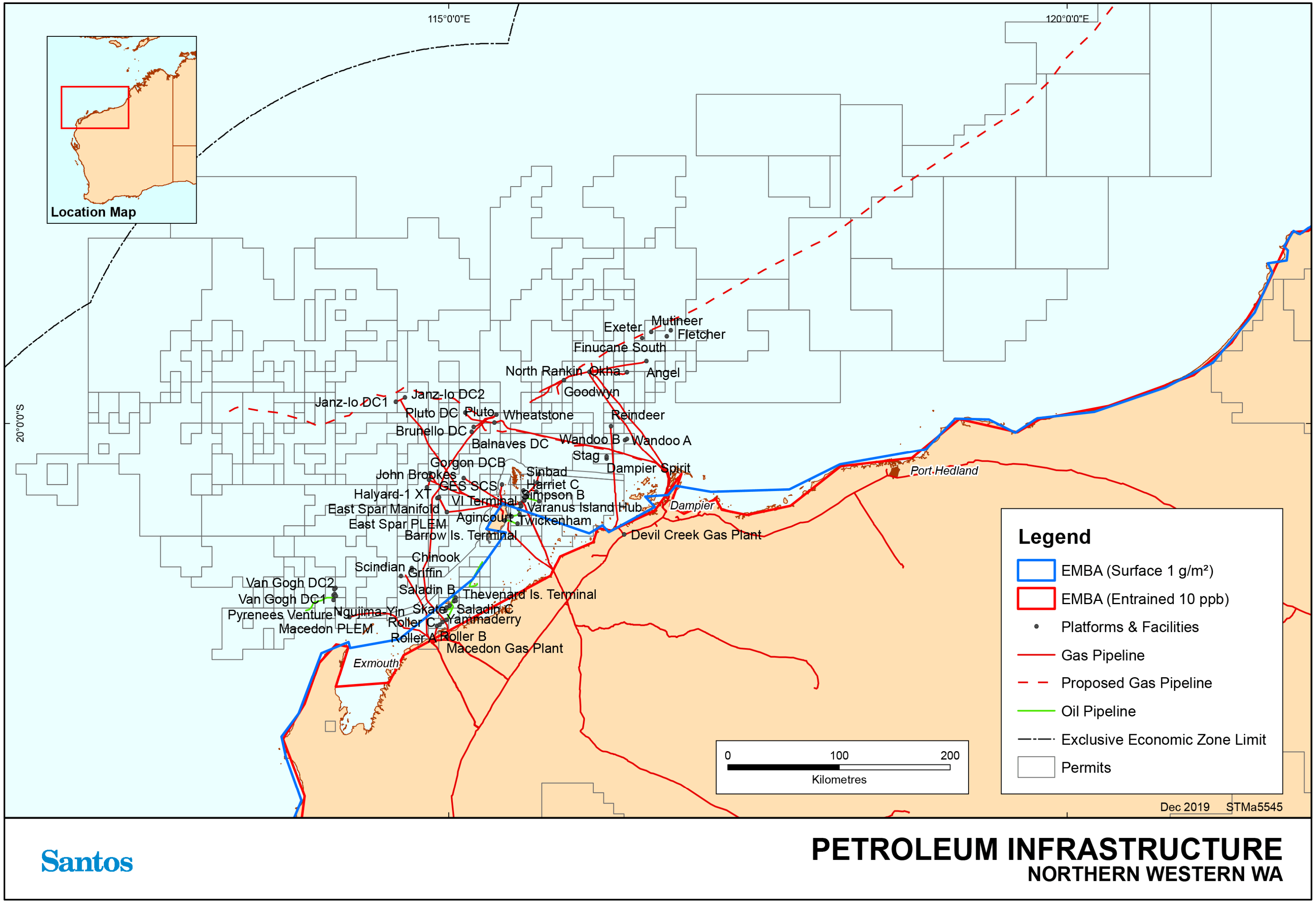


Figure 14-2: Existing petroleum infrastructure, permits and licences – Northern Western Australia

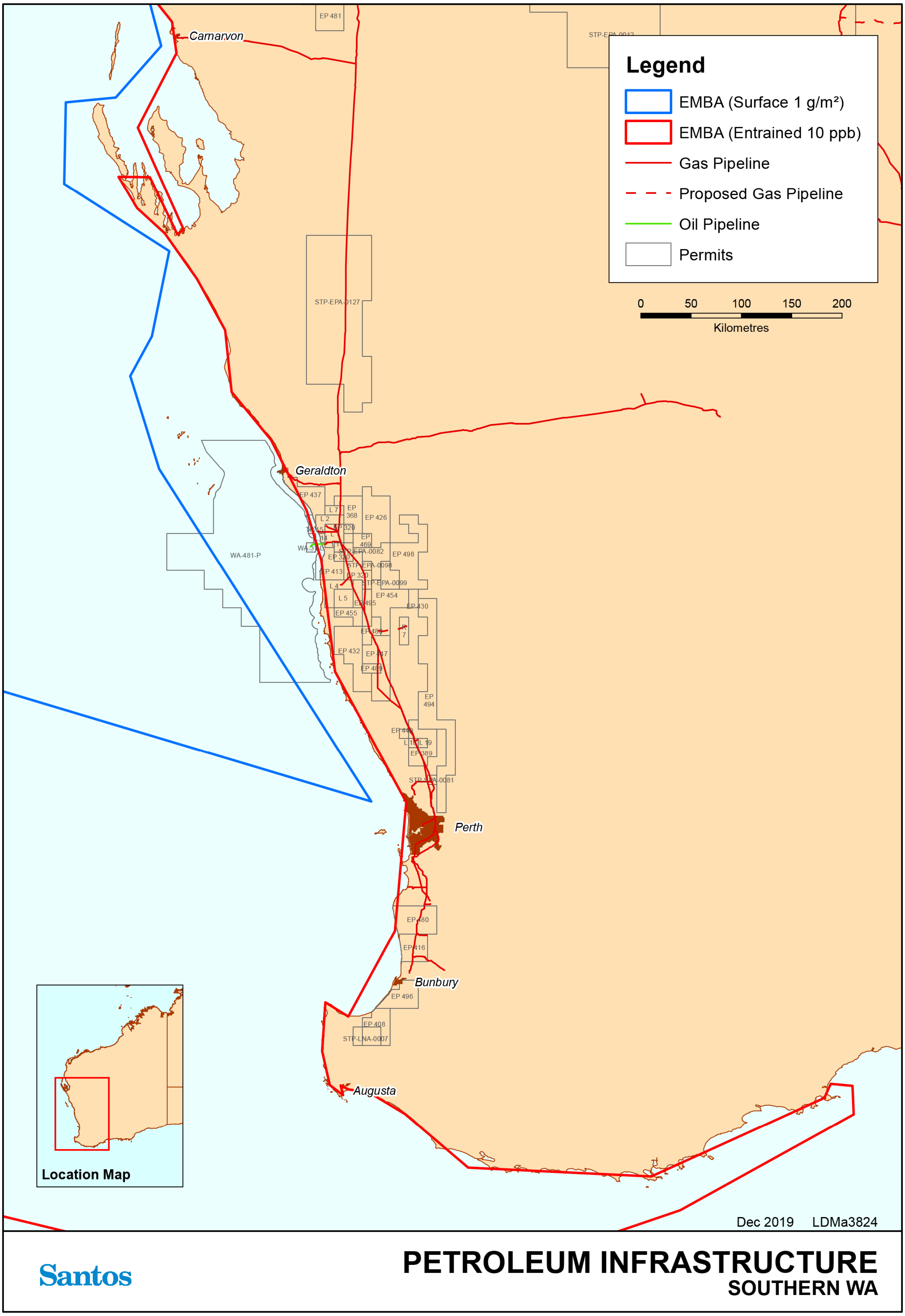


Figure 14-3: Existing petroleum infrastructure, permits and licences –Southern WA

14.3 Shipping

The Western Australian coastline supports twelve ports including the major ports of Dampier, Port Hedland and Broome which are operated by their respective port authorities. Large cargo vessels move through the region to and from Fremantle, transiting along coastline. Commercial shipping also moves to and from marine terminals associated with the oil and gas industry (see **Section 14.1**). Other large ports include Geraldton, Busselton, Albany and Esperance. Closer proximity shipping also includes construction vessels/barges/dredges, domestic support vessels, and offshore survey vessels.

The Australian Maritime Safety Authority (AMSA) has established a network of shipping fairways off the north-west coast of Australia to manage traffic patterns (AMSA 2013). The Shipping Fairways are designed to keep shipping traffic away from offshore infrastructure and aims to reduce the risk of collision (AMSA 2013).

Use of the fairways is strongly recommended but not mandatory. The International Regulations for *Preventing Collisions at Sea 1972* apply to all vessels navigating within or outside the shipping fairways. The use of these fairways does not give vessels any special right of way (AMSA 2012).

Under the *Commonwealth Navigation Act 2012*, certain vessels operating in Australian waters are required to report their location on a daily basis to the Rescue Coordination Centre (RCC) in Canberra. This Australian Ship Reporting System (AUSREP) is an integral part of the Australian Maritime Search and Rescue system and is operated by AMSA through the RCC. Vessels recorded in waters in the EMBA through the AUSREP system in 2019 are shown in **Figure 14-4**.

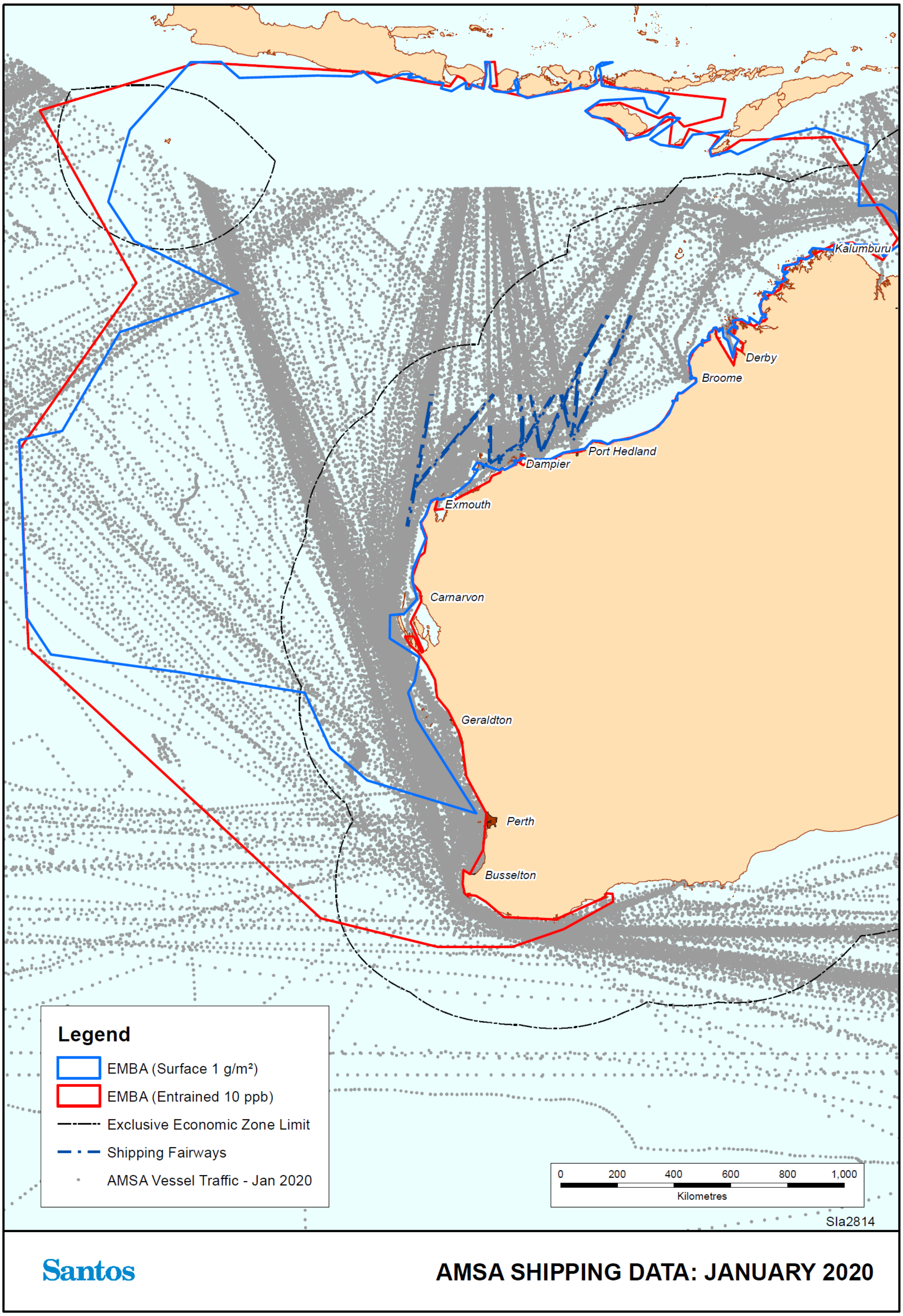


Figure 14-4: AMSA ship locations and shipping routes

14.4 Defence Activities

Key defence bases and facilities are illustrated in **Figure** 14-5.

The Naval Communication Station Harold E. Holt is located on the northwest coast of Australia, 6 km north of Exmouth. The town of Exmouth was built at the same time as the communications station to provide support to the base and to house dependent families of US Navy personnel (Shire of Exmouth 2018, DoE 2014).

The station provides very low frequency radio transmission to US Navy and Royal Australian Navy ships and submarines in the western Pacific Ocean and eastern Indian Ocean. With a transmission power of 1 megawatt, it is the most powerful transmission station in the southern hemisphere (Shire of Exmouth 2018, DoE 2014).

Two Royal Australian Airforce (RAAF) bases are located in the northwest of WA; Learmonth RAAF Base, near Exmouth and Curtin RAAF Base near Derby (RAAF 2014).

Designated military exercise areas occur over waters and airspace of the north west of WA and may be activated following the required notifications.

Additional defence activities that occur within the EMBA include:

+ Broome training depot;
+ Exmouth admin and high frequency transmitting;
+ Exmouth Very Low Frequency transmitting station;
+ Geraldton training depot “A” Company 16th Battalion;
+ HMAS Stirling-Rockingham;
+ HMAS Stirling-Garden Island;
+ Karratha training depot;
+ Learmonth – air weapons range;
+ Learmonth radar site – Vlaming Head Exmouth; and
+ Yampi Sound training area.

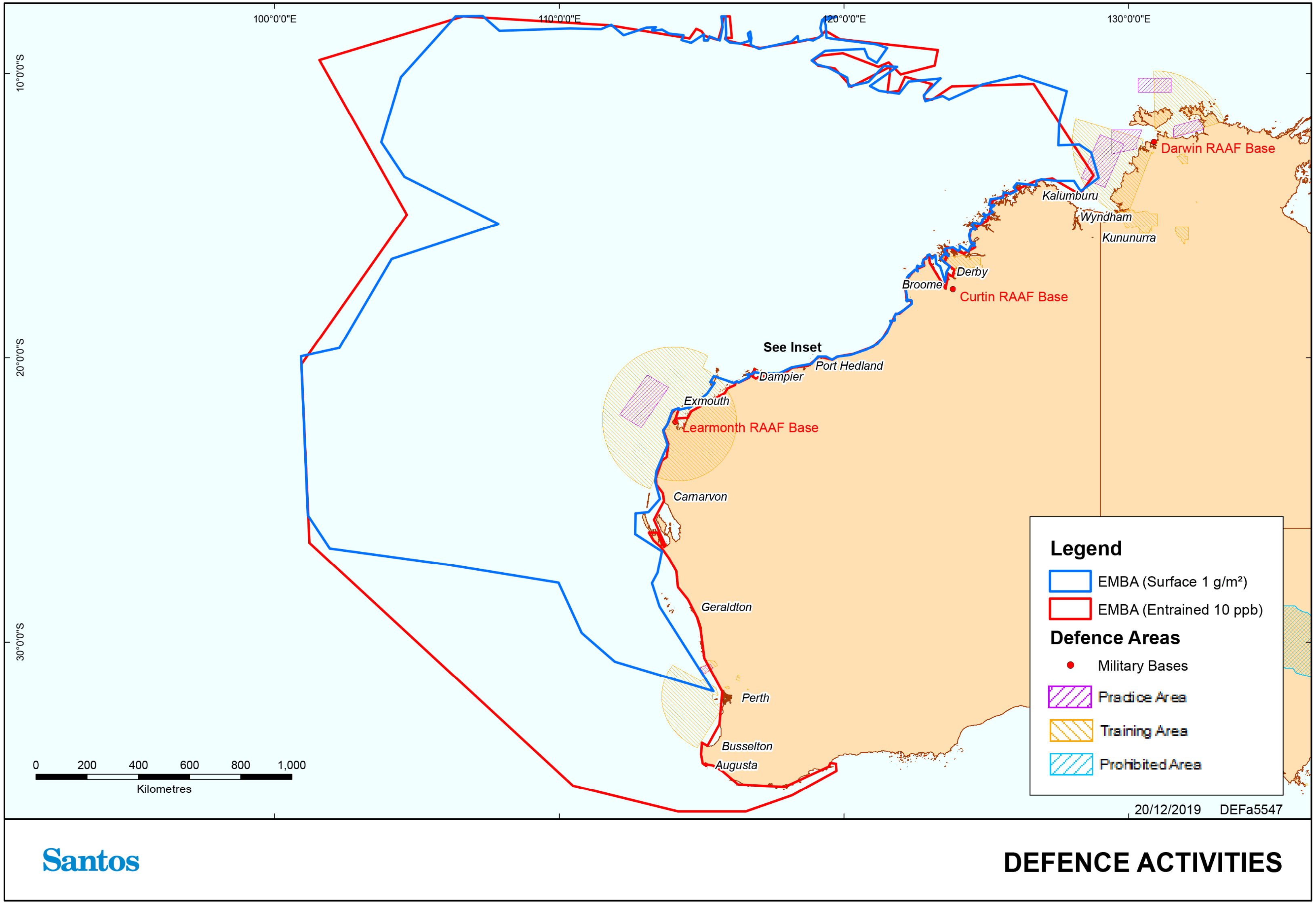


Figure 14-5: Defence activities in WA

14.5 Tourism

The Kimberley, Pilbara and Gascoyne regions are popular visitor destination for Australian and international tourists. Tourism is concentrated in the vicinity of population centres including Broome, Dampier, Exmouth, Coral Bay and Shark Bay.

Marine and coastal use is also clustered around major population centres along the WA coastline including Perth, Bunbury, Geraldton, Margaret River, Jurien Bay, August and Albany.

Tourism contributes to local economies in terms of both income and employment and tourists include local, interstate and international visitors. Popular water-based activities include fishing, swimming, snorkelling/ diving, surfing/windsurfing/kiting and boating, while popular land based activities include bushwalking, camping, bird watching and four-wheel driving.

Seasonal nature-based tourism such as humpback whale watching, whale shark encounters and tours of turtle hatching mainly occurring around Ningaloo Reef, Cape Range National Park, Broome and Perth (Tourism Western Australia 2014). Seasonal aggregations of whale sharks, manta rays, sea turtles and whales, as well as the annual mass spawning of coral attract large numbers of visitors to Ningaloo each year (CALM 2005).

14.6 Cultural Heritage

Four places of cultural significance are protected as National Heritage Places in the waters from Busselton to the NT border. The Dampier Archipelago (including Burrup Peninsula), Batavia Shipwreck Site and Survivor Camps Area 1629 – Houtman Abrolhos, Dirk Hartog Landing Site 1616 – Cape Inscription area and the HMAS Sydney II and HSK Kormoran Shipwreck Site are discussed in **Section 9**. Additional Commonwealth Heritage Places denoted for their historic value in the EMBA are listed in **Appendix A**.

14.6.1 Indigenous Heritage

Indigenous people have a strong ongoing association with the area that extends from the beginning of human settlement in Australia some 50,000 years ago. The close, long standing relationship between Aboriginal peoples and the coastal and marine environments of the area is evident in indigenous culture today, in addition to archaeological sites such as the Burrup Peninsula. The Indigenous peoples of the northwest continue to rely on coastal and marine environments and resources for their cultural identity, health and wellbeing, as well as their domestic and commercial economies (DEWHA 2008a). With the EMBA, Barrow Island, Montebello Islands, Exmouth, Ningaloo Reef, Kimberly Coast, Eighty Mile Beach, Roebuck Bay, Dampier Peninsula and the South West and the adjacent foreshores have a long history of occupancy by Indigenous communities. Areas that are covered by registered native title claims are likely to practice indigenous fishing techniques at various sections of the WA coastline, most notably in the Kimberley coastal region and islands.

Marine resource use by Indigenous people is generally restricted to coastal waters. Fishing, hunting and the maintenance of maritime cultures and heritage through ritual, stories and traditional knowledge continue as important uses of the nearshore region and adjacent areas. However, while direct use by Aboriginal people deeper offshore waters is limited, many groups continue to have a direct cultural interest in decisions affecting the management of these waters. The cultural connections Aboriginal people maintain with the sea may be affected, for example, by offshore fisheries and industries. In addition, some Indigenous people are involved in commercial activities such as fishing and marine tourism, so have an interest in how these industries are managed in offshore waters with respect to their cultural heritage and commercial interests (DEWHA 2008a).

14.6.2 Maritime Heritage

Details of recorded shipwreck sites are available on the Australian National Shipwreck Database are managed by the DAWE although precise locations of the wrecks are sometimes unknown. A search of the Australian National Shipwreck Database in the EMBA identified 942 shipwrecks. Key shipwrecks in the North West Marine Region are listed in **Table 14-1** and shown in **Figure 14-6** to **Figure 14-9**, in addition to the Ann Millicent (DEWHA 2008a). Under the Commonwealth *Underwater Culture Heritage Act 2018* all shipwrecks older than 75 years are protected, while those dated pre-1900 are protected by WA law under the *Maritime Archaeology Act 1973*. Within the EMBA, there are 697 shipwrecks in excess of 75 years old.

Table 14-1: Shipwrecks

Name	Description	Location
Ann Millicent	Iron hulled barque, wrecked c. 1888	Cartier Island
Batavia	Wood sailing vessel, wrecked 1629	Morning Reef, Houtman Abrolhos Islands
Crown of England	1,847 t sailing ship, wrecked c. 1912	Wreck Point, Depuch Island
Eddystone	2,040 t brigantine rigged iron steamship	Cossack Roads, Depuch Island Passage
Perentie	Barge	Barrow Island
Fin	Early iron whaler	Frazer Island, Point Cloates
Karrakatta	1,271 t, schooner rigged, coastal steamship	King Sound, 140 km north-northwest of Derby
Manfred	587 t barque	3 km north west of West Island in the Lacepede Islands
Perth	499 t, iron coastal steamship	Ningaloo Reef
Rowley Shoals unconfirmed wreck	Armed whaler of 200–250 t, possibly the Lively, wrecked c 1800	Mermaid Reef
Zvir	Iron steamer	Frazer Island, Point Cloates
Browse Island (East) unconfirmed wreck	Late nineteenth century iron sailing vessel of approximately 1,000 t	Browse Island
Fairy Queen	115 t Singapore built brigantine	Point Murat, North West Cape
Gudrun	Iron frames and fastenings	Cape Peron Flats in Shark Bay
SS Sunbeam	Iron hulled, single screw steamer	Middle Osborne Island, Admiralty Gulf
Trial	English East Indiaman of about 500 t, wrecked c 1622	Trial (or Tryal) Rocks, 20 km northwest of the Montebello Islands
Zuytdorp	Seventeenth century Dutch East Indiaman	Zuytdorp Cliffs, 75 km north of Kalbarri

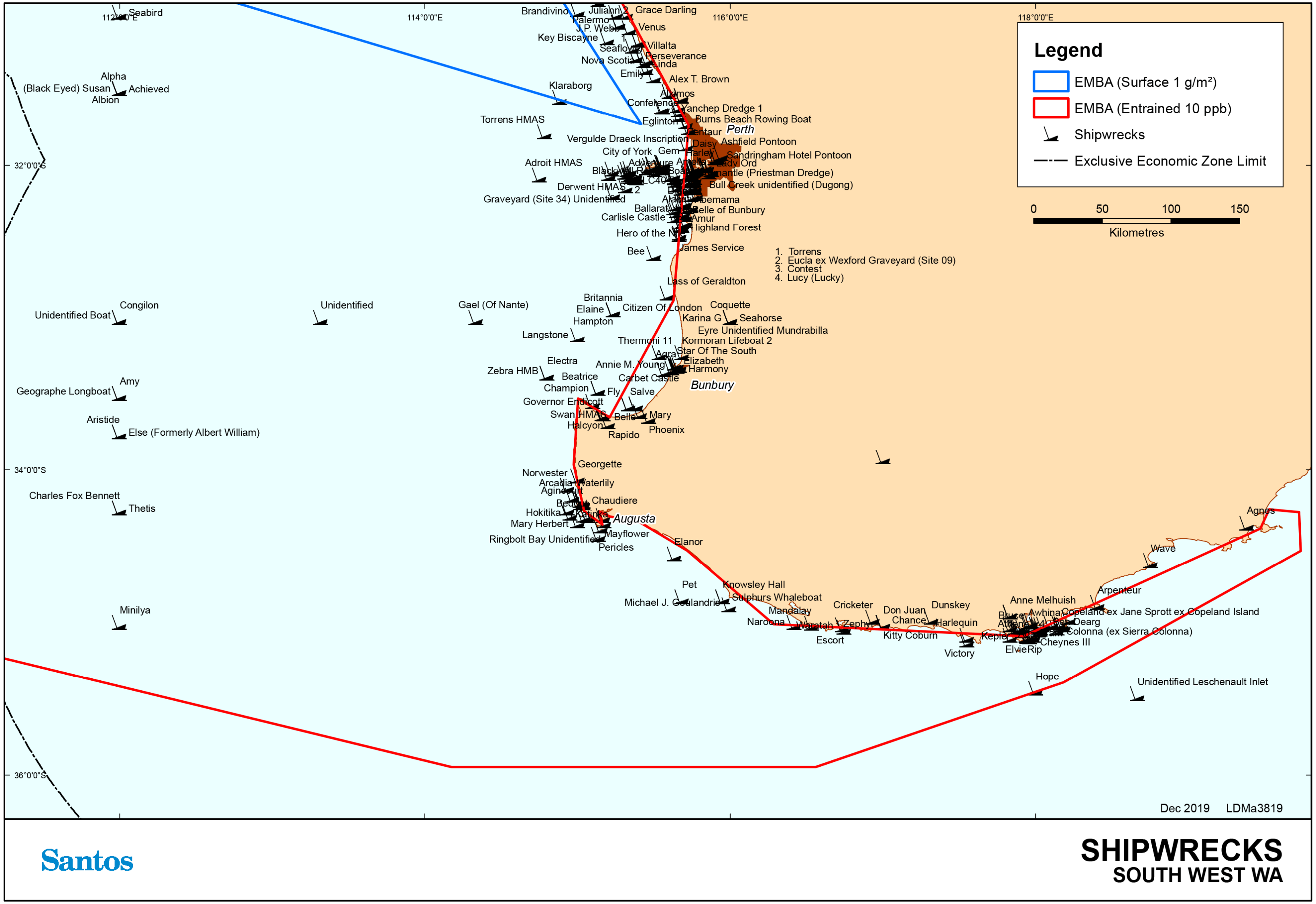


Figure 14-6: Shipwrecks – South West WA

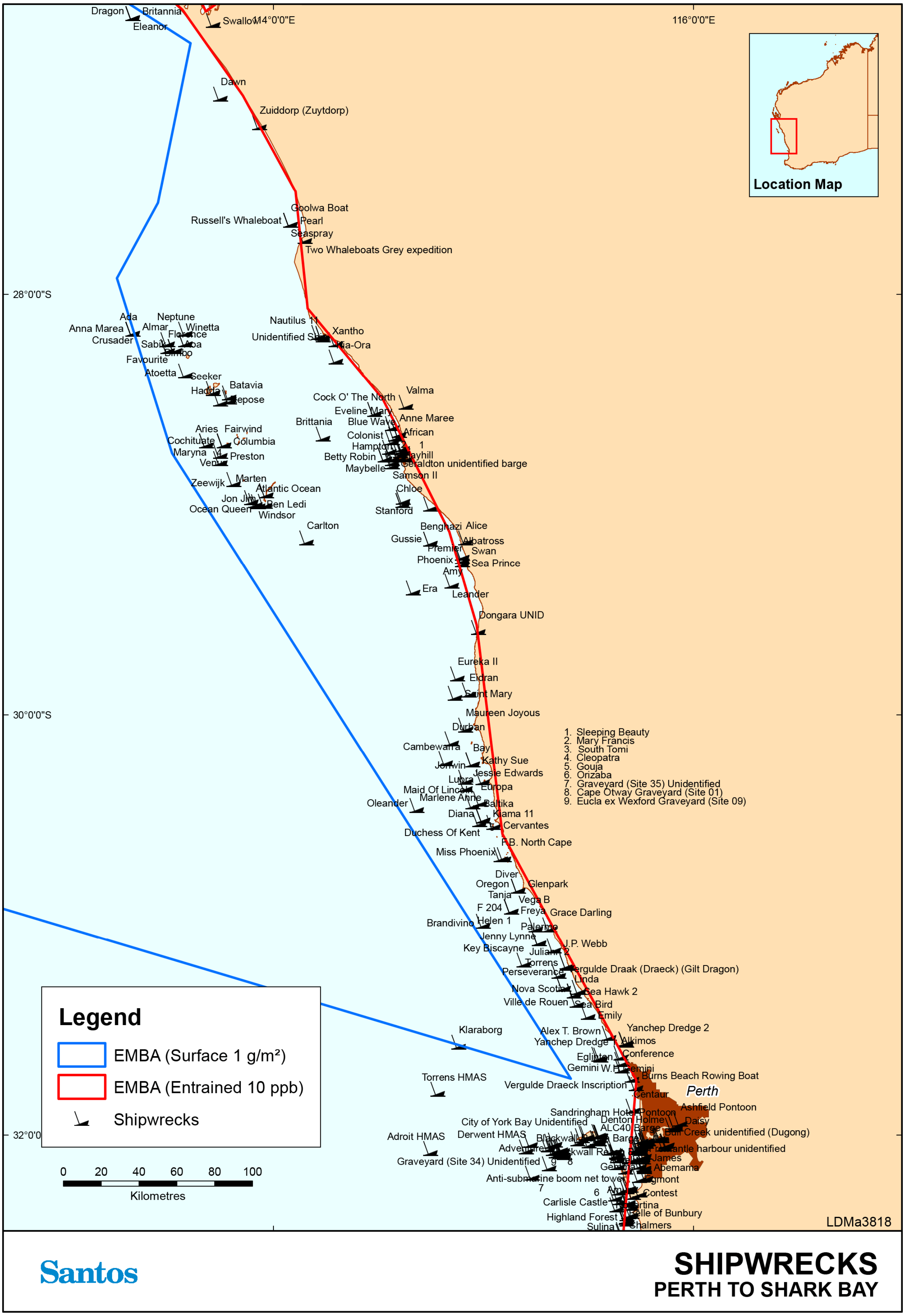


Figure 14-7: Shipwrecks – Perth – Shark Bay

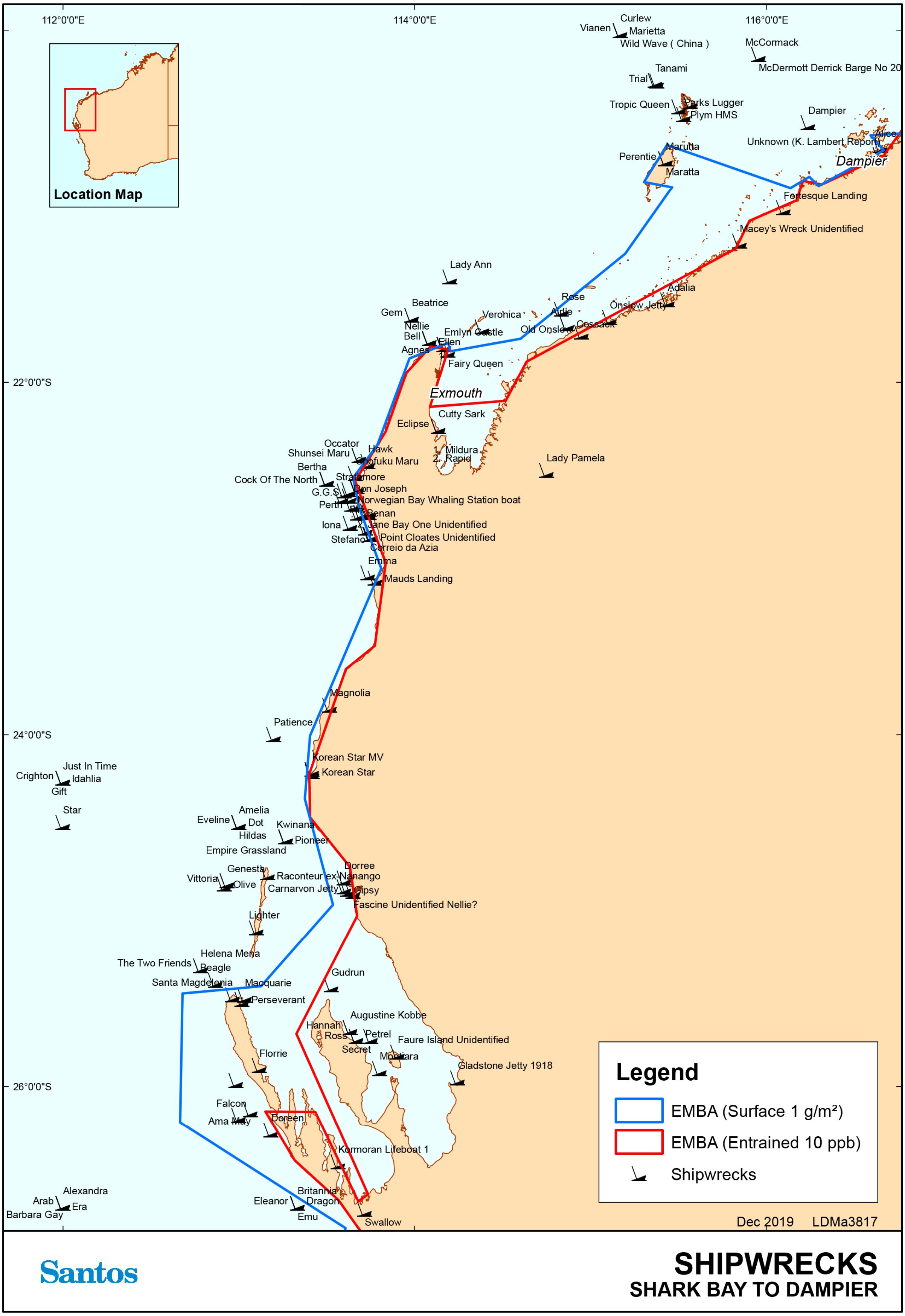


Figure 14-8: Shipwrecks – Shark Bay – Dampier

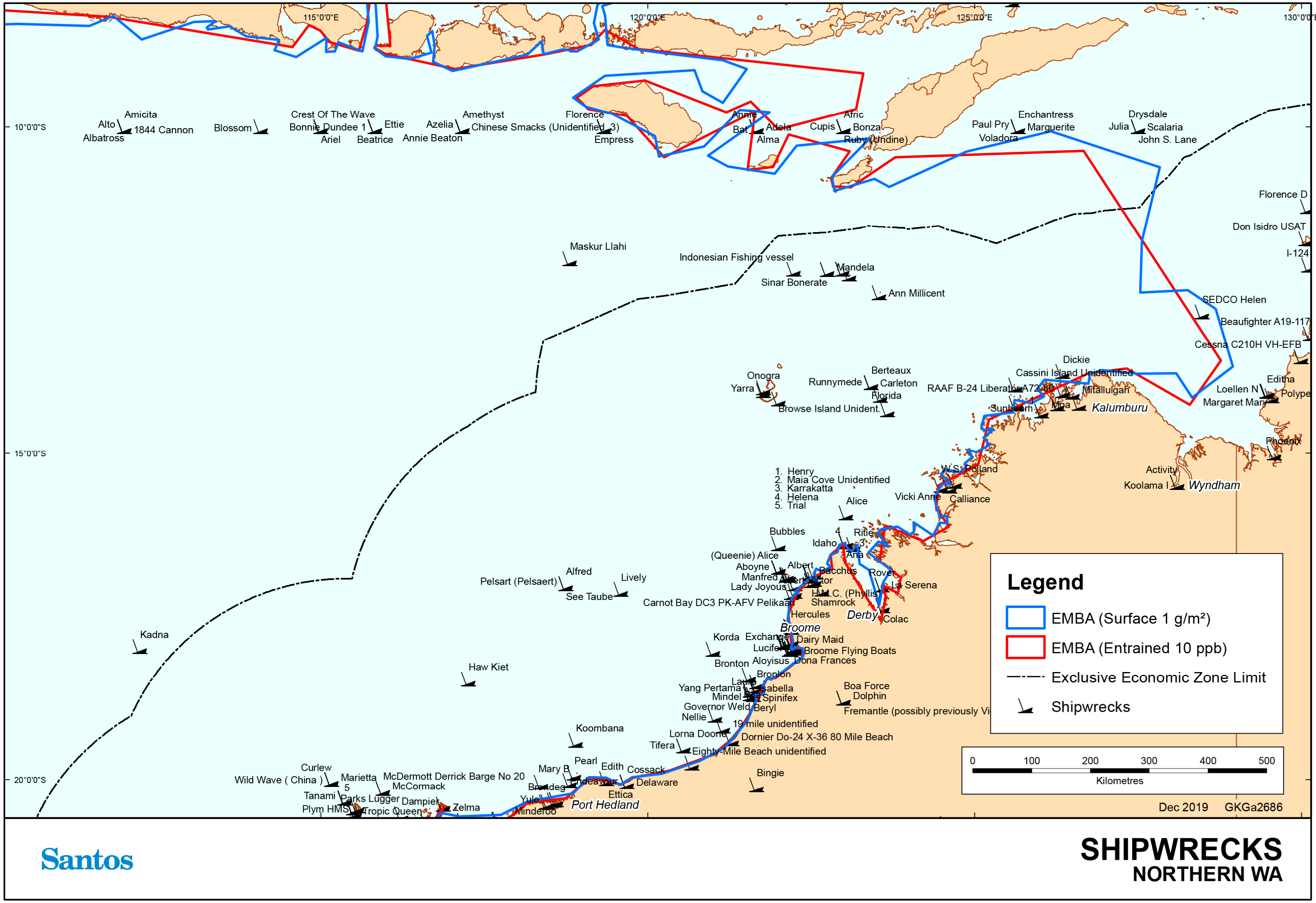


Figure 14-9: Shipwrecks – Northern WA

14.7 Commercial Fisheries

A valuable and diverse commercial fishing industry is supported by both the offshore and coastal waters in the North Coast, Gascoyne, West Coast and South Coast Bioregions between the WA and NT and South Australian borders. The major fisheries in this area target tropical finfish, large pelagic fish species, crustaceans (prawns and scampi), Western Rock Lobster and pearl oysters (Fletcher and Santoro 2013). A number of smaller fisheries also exist in this area including the octopus and beche-de-mer fisheries.

14.7.1 State Fisheries

State fisheries are managed by the WA Department of Primary Industries and Regional Development (DPIRD) (formerly Department of Fisheries (DoF)) with specific management plans, regulations and a variety of subsidiary regulatory instruments under the *Fish Resources Management Act 1994* (WA). The information on State managed fisheries has been derived from '*The State of the Fisheries'* Report 2018/2019 (Gaughan *et al.* 2020) and direct consultation with DPIRD. Santos consults regularly with State fisheries relevant to activity operational areas, mainly by distribution of an Annual Consultation Update by post.

State commercial fisheries that exist between Kalbarri (WA) and the NT border are shown in **Figure** 14-10. A summary of all commercial fisheries in the area is also summarised **Table 14-2**. These are:

North Coast Bioregion

+ Onslow Prawn Managed Fishery (OPMF);
+ Nickol Bay Prawn Managed Fishery (NBPMF) – referred to as Nickol Bay Prawn Limited Entry Fishery in **Figure** 14-10;
+ Broome Prawn Managed Fishery (BPMF);
+ Kimberley Prawn Managed Fishery (KPMF);
+ Kimberley Gillnet & Barramundi Managed Fishery (KGBF);
+ Kimberley Developing Mud Crab Fishery – not shown in **Figure** 14-10;
+ Northern Demersal Scalefish Managed Fishery (NDSF);
+ North Coast Traditional Trochus Fishery – not shown in **Figure** 14-10;
+ Pilbara Demersal Scalefish Fisheries – not shown in **Figure** 14-10;
+ Pilbara Developing Crab Fishery – not shown in **Figure** 14-10;
+ Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF);
+ Pilbara Trap Managed Fishery (PTMF);
+ Pilbara Line Fishery;
+ Western Australian Sea Cucumber Fishery (referred to as Beche-de-mer Fishery in **Figure** 14-10);
+ Mackerel Managed Fishery (Area 1 – Kimberley and Area 2 – Pilbara);
+ Western Australian Pearl Oyster Fishery – referred to as Pearl Oyster Managed Fishery in **Figure** 14-10;
+ Northern Shark Fisheries (closed, not shown in **Figure** 14-10) including:
    - Western Australian North Coast Shark Fishery - not shown in **Figure** 14-10; and
    - Joint Authority Northern Shark Fishery - not shown in **Figure** 14-10;
    - North Coast Trochus Fishery – not shown in **Figure** 14-10; and
    - Pilbara Developing Crab Fishery – not shown in **Figure** 14-10.

Gascoyne Bioregion

+ Exmouth Gulf Prawn Managed Fishery;
+ Gascoyne Demersal Scalefish Managed Fishery;
+ Shark Bay Scallop Managed Fishery – referred to as Shark Bay Scallop Limited Entry Fishery on **Figure** 14-10;
+ Shark Bay Prawn Managed Fishery – referred to as Shark Bay Prawn Limited Entry Fishery on **Figure** 14-10;
+ Shark Bay Beach Seine and Mesh Net Managed Fishery – not shown in **Figure** 14-10**;**
+ Shark Bay Crab Interim Managed Fishery; and
+ Mackerel Fishery (Area 3 – Gascoyne/West Coast).

West Coast Bioregion

+ Roe's Abalone – not shown in **Figure** 14-10;
+ Abrolhos Islands and Mid-West Trawl Managed Fishery (AIMWRMF) (Closed) – referred to as Abrolhos Islands and Mid-West Trawl Limited Entry Fishery in **Figure** 14-10;
+ West Coast Demersal Scalefish Interim Managed Fishery (WCDSIMF);
+ South West Trawl Managed Fishery – referred to as South West Trawl Limited Entry Fishery in **Figure** 14-10;
+ Mandurah to Bunbury Developing Crab Fishery – not shown in **Figure** 14-10;
+ Cockburn Sound Crab Managed Fishery – not shown in **Figure** 14-10**;**
+ Cockburn Sound Line and Pot Managed Fishery – not shown in **Figure** 14-10;
+ Cockburn Sound Mussel Managed Fishery – not shown in **Figure** 14-10;
+ Warnbro Sound Crab Managed Fishery (closed) – not shown in **Figure** 14-10;
+ West Coast Nearshore and Estuarine Finfish Fisheries, including:
+ Cockburn Sound Fish Net Managed Fishery – not shown in **Figure** 14-10;
+ West Coast Beach Baited Managed Fishery – not shown in **Figure** 14-10;
+ South West Beach Seine Fishery – not shown in **Figure** 14-10; and
+ West Coast Estuarine Managed Fishery – not shown in **Figure** 14-10;
+ Temperate Demersal Gillnet and Demersal Longline Fisheries, including:
    - West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (West Coast Bioregion) – not shown in **Figure** 14-10;
+ West Coast Deep Sea Crab (Interim) Managed Fishery – referred to as West Coast Deep Sea Crustacean Managed Fishery in **Figure** 14-10;
+ West Coast Nearshore Net Managed Fishery – not shown in **Figure** 14-10;
+ Octopus Interim Managed Fishery – not shown in **Figure** 14-10;
+ West Coast Rock Lobster Managed Fishery; and
+ West Coast Purse Seine Fishery – not shown in **Figure** 14-10.

South Coast Bioregion

+ Greenlip/Brownlip Abalone Fishery – not shown in **Figure** 14-10;

- South Coast Crustacean Managed Fishery – not shown in **Figure** 14-10**;**
- South Coast Deep-Sea Crab Fishery – not shown in **Figure** 14-10;
- South Coast Estuarine Managed Fishery – not shown in **Figure** 14-10**;**
- South Coast Open Access Netting Fishery – not shown in **Figure** 14-10; and
- South West Coast Beach Net – not shown in **Figure** 14-10.
- South Coast Salmon Managed Fishery;
- South West Coast Salmon Managed Fishery – not shown in **Figure** 14-10;
- Temperate Demersal Gillnet and Demersal Longline Fisheries including:
    - Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (South Coast Bioregion)
    - South West Trawl Managed Fishery (SWTMF) – referred to as South West Trawl Limited Entry Fishery in **Figure** 14-10; and
    - Windy Harbour/Augusta Rock Lobster Managed Fishery – not shown in **Figure** 14-10.

Whole of State Fisheries

- Marine Aquarium Fish Managed Fishery (MAFMF);
- Specimen Shell Managed Fishery; and
- Hermit Crab Fishery (HCF) – not shown in **Figure** 14-10.

Some of the fisheries listed above will be more susceptible to impacts than others, particularly fisheries without the ability to escape impacts. For example, above average water temperatures over the last three years will have had an impact on prawn fisheries in Exmouth and scallops and blue swimmer crabs in Shark Bay which have been significantly affected by the initial heat wave event of 2010/11 (Caputi *et al*. 2014).

14.7.2 Commonwealth Fisheries

Commonwealth fisheries are those within the 200 nautical mile Australian Fishing Zone (AFZ) managed by Australian Fisheries Management Authority (AFMA) and are, on the high seas, and, in some cases, by agreement with the States and Territory, to the low water mark. Information on Commonwealth managed fisheries has been derived from '*Fishery Status'* Report 2019 (Department of Agriculture 2019)

Commonwealth fisheries who have permits to operate in the EMBA include:

- North West Slope Trawl (NWST);
- Northern Prawn Fishery (NPF);
- Southern Bluefin Tuna Fishery (SBFTF);
- Western Tuna and Billfish Fishery (WTBF) (including Southern Tuna and Billfish Fishery shown in **Figure** 14-11);
- Small Pelagic Fishery (SPF);
- Southern and Eastern Scalefish and Shark Fishery (SESSF) – not shown in **Figure** 14-11;
- Skipjack Tuna Fishery (STF) (referred to as Western Skipjack Tuna Fishery in **Figure** 14-11); and
- Western Deepwater Trawl (WDTF) (referred to as Western Deepwater Trawl Fishery in **Figure** 14-11).

Commonwealth commercial fisheries between Kalbarri (WA) and the NT Border are shown in **Figure** 14-11 and summarised in **Table 14-2**.

14.7.3 Indonesian Commercial and Subsistence Fishing

Within the northern and north-western extent of the EMBA is a defined area where a Memorandum of Understanding (MoU) exists between the Australian and Indonesian Governments. The Agreement between the Government of Australia and the Government of the Republic of Indonesia Relating to Cooperation in Fisheries (1992 Fisheries Cooperation Agreement) provides the framework for fisheries and marine cooperation between Australia and Indonesia, and facilitates information exchange on research, management and technological developments, complementary management of shared stocks, training and technical exchanges, aquaculture development, trade promotion and cooperation to deter illegal fishing.

Cooperation under the Agreement today takes place under the auspices of the Working Group on Marine Affairs and Fisheries. Established in 2001, the Working Group on Marine Affairs and Fisheries is the primary bilateral forum to enhance collaboration across the spectrum of marine and fisheries issues relevant to the areas of the Arafura and Timor seas. The Working Group brings together the fisheries, environment and scientific research portfolios and agencies from both countries.

The MoU Box (shown on **Figure** 14-10 and **Figure** 14-11) is an area of Australian water in the Timor Sea where Indonesian traditional fishers, using traditional fishing methods only, are permitted to operate. Officially it is known as the Australia-Indonesia Memorandum of Understanding regarding the Operations of Indonesian Traditional Fishermen in Areas of the Australian Fishing Zone and Continental Shelf – 1974.

As part of negotiations to delineate seabed boundaries, Australia and Indonesia entered into the MoU which recognises the rights of access for traditional Indonesian fishers in shared waters to the north of Australia. This access was granted in recognition of the long history of traditional Indonesian fishing in the area. The MoU provides Australia with a tool to manage access to its waters while for Indonesia, it enables Indonesian traditional fishers to continue their customary practices and target species such as trepang, trochus, abalone and sponges. Guidelines under the MoU were agreed in 1989 in order to clarify access boundaries for traditional fishers and take into account the declaration of the 200 nautical mile fishing zones. Because of its approximate shape the MoU area became known as the MoU Box.

Between 2006 and 2008, a series of surveys were undertaken to understand the traditional practice of Indonesian fishers that journey to Scott Reef within the MoU boundary (ERM 2008, 2009). The majority of perahu (vessels) that travel to Scott Reef originate from the islands of Rote (near West Timor) and Tonduk and Raas (in East Java). Some crew from the Rote perahus are recruited from the region of Alor (one of the Lesser Sundas chain, located north of East Timor and east of Bali). In 2007, an estimated 800 fishers (approximately 80 vessels) travelled from these home islands to Scott Reef, mainly to collect trepang. Similar vessel numbers sailed to Scott Reef in 2008.

Journeys to Scott Reef are generally restricted to drier months when wind speeds and directions are more desirable. Most Indonesian fishers travel to Scott Reef during July to October, although a few Rotenese make the journey to Scott Reef in the early season between April and June. Other fishers plan to go after Aidil Fitri, a religious holiday widely celebrated on Tonduk Island that celebrates the end of Ramadan.

The fishers focus their activities in and around the shallow water lagoons of Scott Reef primarily targeting trepang; and opportunistically gather trochus shells. They also catch fish largely for subsistence purposes although the average fish catch per lete-lete (traditional Indonesian fishing vessel) in 2008 increased to commercial volumes. Although deeper waters are more plentiful in trepang, deep diving is generally not undertaken by the fishers due to the MoU stipulation on the exclusive use of traditional equipment only (Woodside Energy Limited 2011).

14.8 Aquaculture

14.8.1 North Coast Bioregion

Aquaculture development in this region is dominated by the production of pearls from the species *Pinctada maxima.* A large number of pearl oysters for seeding is obtained from wild stocks and supplemented by hatchery-produced oysters with major hatcheries operating at Broome and the Dampier Peninsular. Pearl farm sites are located mainly along the Kimberley coast, particularly in the Buccaneer Archipelago, in Roebuck Bay and at the Montebello Islands. Developing marine aquaculture initiatives in this region include growing trochus and barramundi.

The Pearl Oyster Fishery of Western Australia operates in shallow coastal waters (DoF 2006). All the leases are within the 35m diving depth. Through consultation the Pearl Producer's Association (PPA) have raised concern that spawning stock is found to the 100 m depth contour. However, this is not supported in the study by Condie *et al* (2006) who modelled oyster larva transport in the Eighty Mile Beach region and found that while some larvae travelled more than 60 km, most were transported less than 30 km. The model results suggest that spawning in the Eighty Mile Beach region is concentrated around the 8 to 15m depth range, with potential smaller contributions from the northeast. These spawning events are likely to lead to successful recruitment locally and alongshore to the southwest.

They also feed larvae into neighbouring shallow coastal environments (through tidal oscillations) and deeper waters to the west (>20 m). However, spat abundances seem to be low in these areas, suggesting that recruitment is strongly limited by habitat availability and possibly high mortality rates in shallow water. High local abundances of broodstock and spat observed occasionally in deeper water (<30 m) seem to be supported by intermittent larval transport from inshore populations. Spawning in this area seems to contribute little to recruitment in the inshore populations.

Further aquaculture in this region mainly focuses on barramundi farming within Cone Bay, with two aquaculture licences granted in this area located about 200 km north-east of Broome (Gaughan and Santoro 2020).

Further aquaculture operations have expanded in the region with the establishment of the Kimberley Aquaculture Development zone, which encompasses almost 2,000 ha of coastal waters within Cone Bay supporting the production of up to 20,000 t of finfish annually (Gaughan and Santoro 2020).

14.8.2 Gascoyne Coast Bioregion

Hatchery production of oysters is the core of the pearling industry in the Gascoyne region. Hatcheries in Carnarvon and Exmouth supply spat to pearl farms in the north-west and several hatcheries supply juveniles to the black-lip pearl oyster to developing black pearl farms in the region. Pearl production is carried out on a small scale in Shark Bay and Exmouth Gulf. The local aquiculture sector is also focussing on the production of aquarium species.

14.8.3 West Coast Bioregion

The principal aquaculture development activities in this region are the production of blue mussels (*Mytilus galloprovincialis*) and marine algae (*Dunaliella salina*) and the emerging black pearl industry based on the production of *Pinctada margaritifera* at the Abrolhos Islands. The main mussel farming area is in southern Cockburn Sound, where conditions are sheltered and the nutrient and planktonic food levels are sufficient to promote good growth rates fishing (Fletcher and Santoro 2015).

Further aquaculture operations are expected following the establishment of the Mid-West Aquaculture Development Zone by DPIRD, which aims to provide a platform to stimulate aquaculture investment and development in the bioregion (Gaughan and Santoro 2020).

14.8.4 South West Bioregion

The predominant aquaculture activity undertaken in this region is the production of mussels and oysters from Oyster Harbour at Albany. This activity is restricted to this area where there are sufficient nutrient levels related to terrestrial run-off to provide the planktonic food necessary to promote growth of filter-feeding bivalves fishing (Fletcher and Santoro 2015). The high-energy environment and limited protected deep waters limits other forms of aquaculture such as sea cage farming.

Further invertebrate aquaculture operations are expected after recent funding to establish a South Coast Aquaculture Development Zone by DPIRD. An initial south coast aquaculture project aims to identify suitable areas for artificial farm structures to be constructed supporting shellfish production including abalone and edible oysters (Gaughan and Santoro 2020).

14.8.5 Indonesian Aquaculture

An analysis by WorldFish has indicated that aquaculture will overtake capture fisheries as the major source of fish in Indonesia before 2030 (Phillips *et al.* 2015). By volume, Indonesian aquatic production is dominated by seaweeds, but by value, domestically consumed species such tilapia and milkfish, together with export-orientated commodities such as shrimp and tuna, are of greater importance (Phillips *et al*. 2015).

Carrageenan seaweed farming based primarily on the cultivation of *Kappaphycus* and *Eucheuma* species has grown significantly in Indonesia. Due to the simple farming techniques required, low requirements of capital and material inputs, and short production cycles it has become a favourable livelihood for smallholder farmers and fishers (Valderrama *et al*. 2013). Indonesia's coastline provides ideal conditions for fish farming in "brackish waters". Aquaculture in Indonesia is predominantly used for seaweed production, whilst offshore fish cultivation remains relatively undeveloped (Global Business Guide 2014).

14.9 Recreational Fisheries

14.9.1 North Coast Bioregion

The North Coast Bioregion (Pilbara/Kimberley) runs from the Ashburton River to the Western Australia/Northern Territory border (WAFIC 2016). The oceanography of this region includes waters of Pacific Ocean origin that enter through the Indonesian archipelago bringing warm, low salinity waters polewards via the Indonesian throughflow and Holloway currents which flow seasonally and interact with Indian ocean waters. Recreational fishing is experiencing a significant growth in this region, with a distinct seasonal peak in winter when the local population increases by significant numbers of metropolitan and inter-state tourists. This has been added to by the increased recreational fishing by those involved in the construction or operation of major developments in this region. Owing to the high tidal range, much of the angling activity is boat-based with beach fishing limited to periods of flood tides and high water. Numerous creek systems, mangroves, rivers and ocean beaches provide shore and small boat fishing for a variety of species including barramundi, tropical emperors, mangrove jack, trevallies, sooty grunter, threadfin, mud crabs and cods. Offshore islands, coral reef systems and continental shelf waters provide species of major recreational interest including saddletail snapper and red emperor, cods, coral and coronation trout, sharks, trevally, tuskfish, mackerels and billfish (WAFIC 2016).

14.9.2 Gascoyne Coast Bioregion

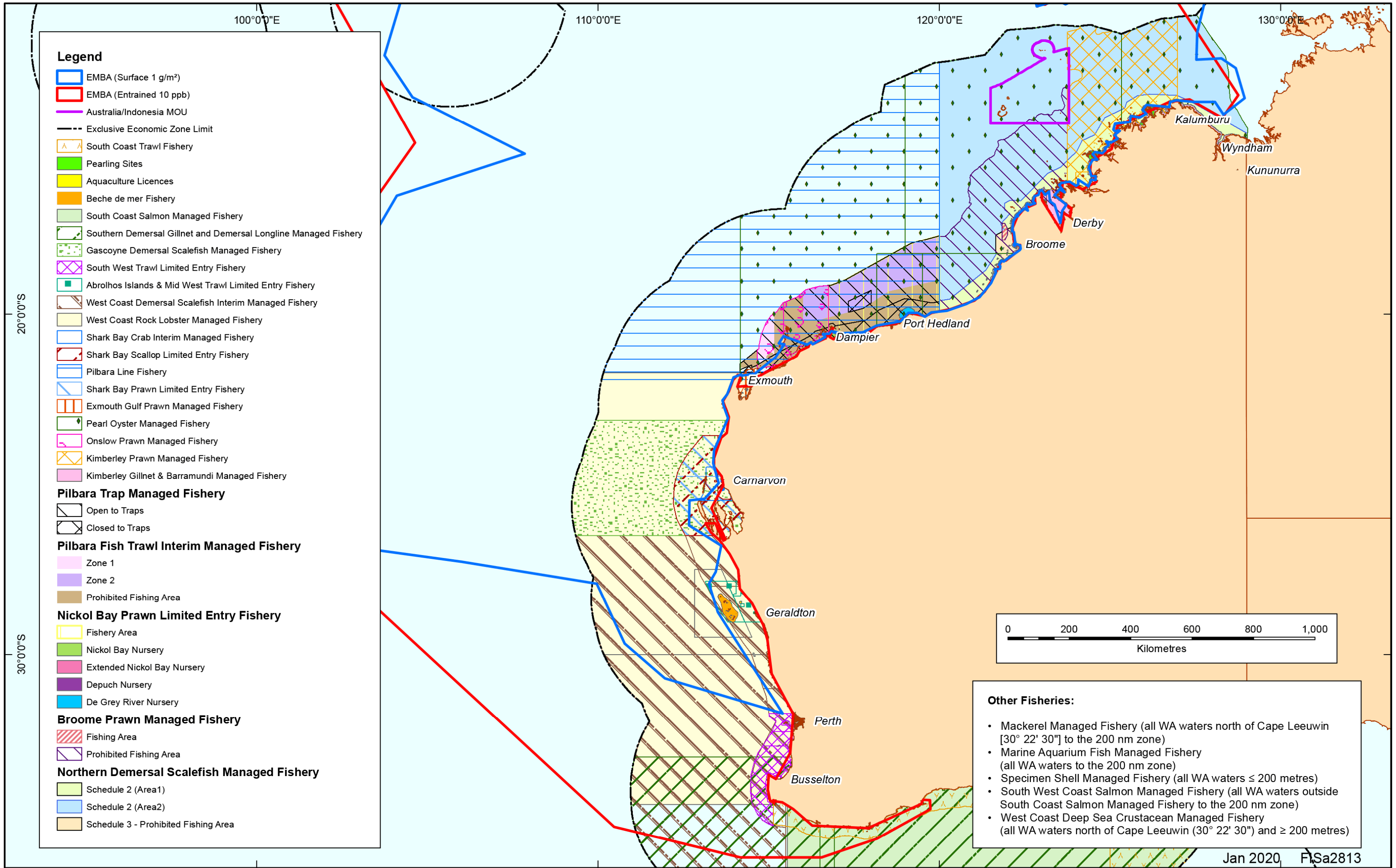
The Gascoyne Coast Bioregion extends from just north of Kalbarri to the Ashburton River, south of Onslow. The marine environment of this region represents a transition between the fully tropical waters of the north-west shelf of the north coast region and the temperate waters of the west coast region. This region has been identified as one of the 18 world 'hotspots' in terms of tropical reef endemism and the second most divers marine environment in the world in terms of tropical reef species. This region is a focal point for winter recreational fishing and is a key component of many tourist visits. Angling activities include beach and cliff fishing (e.g. Steep Point and Quobba), embayment and shallow-water boat angling (e.g. Shark Bay, Exmouth Gulf and Ningaloo lagoons), and offshore boat angling for demersal and larger pelagic species (e.g. off Ningaloo). The predominant target species include the tropical species such as emperors, tropical snappers, groupers, mackerels, trevallies and other game fish. Temperate species at the northern end of their ranges such as pink snapper, tailor and whiting also provide significant catches, particularly in Shark Bay (WAFIC 2016).

14.9.3 West Coast Bioregion

The marine environment of the West Coast Bioregion which lies between Kalbarri and Augusta is predominantly a temperate oceanic zone, but it is heavily influenced by the Leeuwin current, which transports warm tropical water southward along the edge of the continental shelf. This region contains the state's major population centres and is the most heavily used bioregion for recreational fishing (Fletcher and Santoro 2015). The range of recreational fishing opportunities includes estuarine fishing, beach fishing and boat fishing either in embayments or offshore for demersal and pelagic game species often around the islands and out to the continental shelf (WAFIC 2016).

14.9.4 South West Bioregion

The South West Bioregion includes the water from Augusta to Eucla on the Western Australia/South Australia border. The continental shelf waters of this region are generally temperate but low in nutrients due to the seasonal presence of the tail of the tropical Leeuwin current and limited terrestrial run-off. As much of the south coast is remote or difficult to access, recreational beach and boat fishing tends to be concentrated around the main population and holiday centres. The major target species for beach and rock anglers are salmon, herring, whiting and trevally, while boat anglers target pink snapper, queen snapper, Bight redfish, a number of shark species, salmon fish and King George whiting. Another component of the recreational fishery is dinghy and shoreline fishing off estuaries and rivers where the main angling targets are black bream and whiting. Recreational netting primarily targeting mullet also occurs in these estuaries (WAFIC 2016).



STATE COMMERCIAL FISHING ZONES

Figure 14-10: State commercial fishing zones

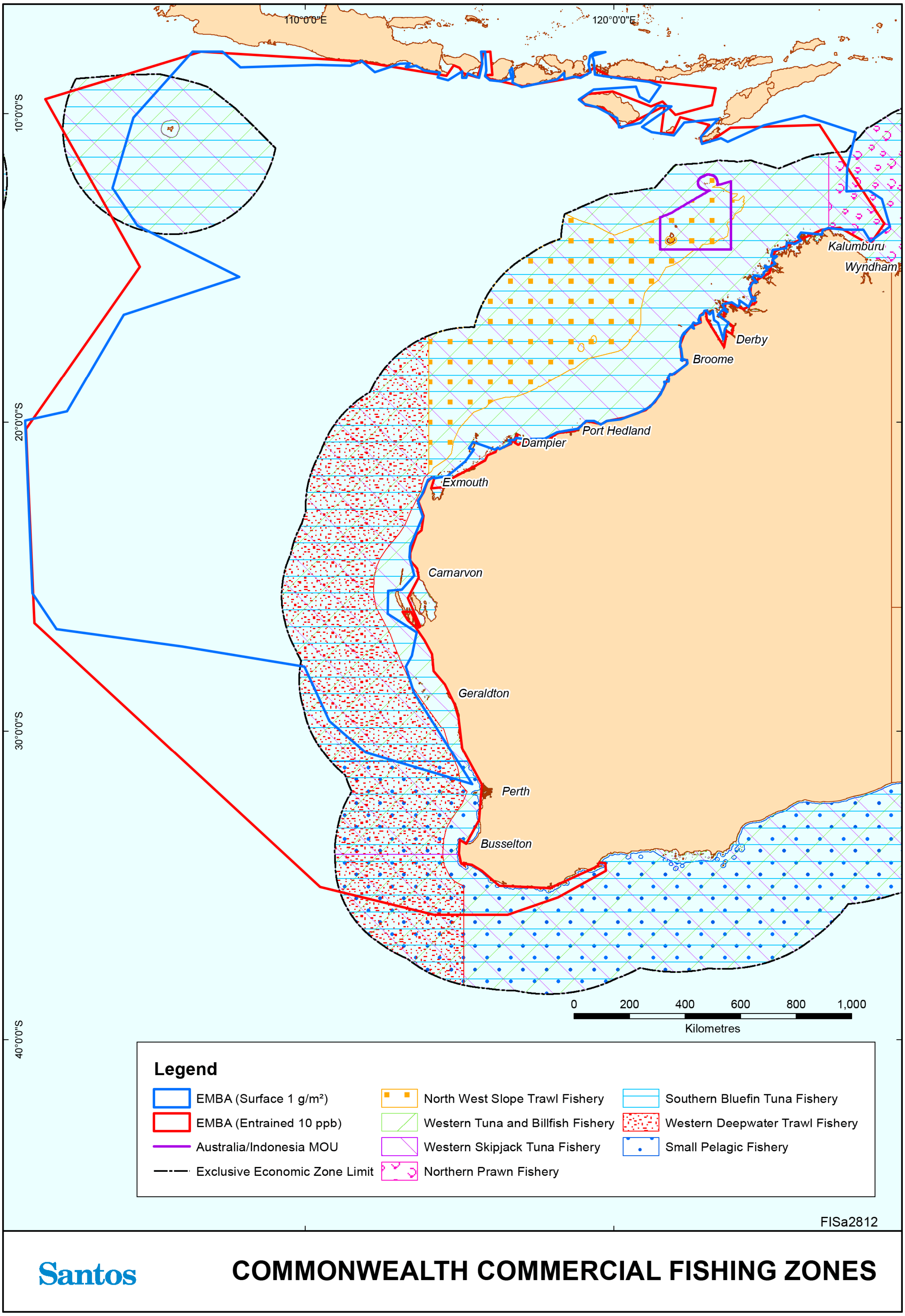


Figure 14-11: Commonwealth commercial fishing zones

Table 14-2: Commercial fisheries with permits to operate within the EMBA

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
State Managed Fisheries				
Abrolhos Islands and Mid-West Trawl Managed Fishery (AIMWTMF)	Saucer scallops (*Ylistrum balloti*), with a small component targeting the western king prawn (*Penaeus latisulcatus*)	2017/2018: 651 tonnes	Operates using low opening otter trawl systems.	All the waters of the Indian Ocean adjacent to Western Australia between 27°51´ south latitude and 29°03´ south latitude on the landward side of the 200 m isobath'.
Broome Prawn Managed Fishery (BPMF)	Western king prawns (*Penaeus latisulcatus*) and coral prawns (a combined category of small penaeid species).	Extremely low fishing effort occurred as only a single boat undertook trial fishing to investigate whether catch rates were sufficient for commercial fishing. This resulted in negligible landings of western king prawns with no byproduct recorded.	Otter trawl	The BPMF operates in a designated trawl zone off Broome. The boundaries of the BPMF are 'all Western Australian waters of the Indian Ocean lying east of 120° east longitude and west of 123°45' east longitude on the landward side of the 200 m isobath'. The actual trawl area is contained within a delineated small area north west of Broome.
Cockburn Sound Mussel Managed Fishery	Blue mussels (*Mytilus edulis*)	2015: Unspecified	Agriculture	Main mussel farming occurs in southern Cockburn Sound.
Cockburn Sound Crab Managed Fishery	Blue Swimmer (*Portunus armatus)* Blue swimmer crab (*Portunus armartus)*	2017/2018: 5: closed to commercial and recreational fishing since April 2014	Drop nets, scoop nets, diving	Encompasses the inner waters of Cockburn Sound, from South Mole at Fremantle to Stragglers Rocks, through Mewstone to Carnac Island and Garden Island, along the eastern shore of Garden Island and back to John Point on the mainland.
Cockburn Sound Line and Pot Managed Fishery	Southern garfish (*Hyporhamphus melanochir*), Australian herring (*Arripis geogianus*)	2017/2018: 257 tonnes	Line (fish) Shelter and trigger pots (octopus)	Encompasses the inner waters of Cockburn Sound, from South Mole at Fremantle to Stragglers Rocks, through Mewstone to Carnac Island and Garden Island, along the eastern shore of Garden Island and back to John Point on the mainland.

Santos

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Exmouth Gulf Prawn Managed Fishery	Western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus* spp.) and banana prawns (*Penaeus merguiensis*).	2017/2018: 713 tonnes	Low opening otter trawls.	Sheltered waters of Exmouth Gulf Essentially the western half of the Exmouth Gulf (eastern part is a nursery ground). The Muiron Islands and Point Murat provide the western boundary; Serrurier Island provides the northern limit
Gascoyne Demersal Scalefish Managed Fishery (GDSMF)	Targets pink snapper (*Pagrus auratus*) and goldband snapper (*Pristipomoides multidens*). Other demersal species caught include the rosy snapper (*P. filamentosus*), ruby snapper (*Etelis carbunculus*), red emperor (*Lutjanus sebae*), emperors (Lethrinidae, including spangled emperor*, Lethrinus nebulosus*, and redthroat emperor, *L. miniatus*), cods (Epinephelidae, including Rankin cod, *Epinephelus multinotatus* and goldspotted rockcod, *E. coioides*), pearl perch (*Glaucosoma burgeri*), mulloway (*Argyrosomus japonicas*), amberjack (*Seriola dumerili*) and trevallies (Carangidae).	2017/2018: Snapper: 133 tonnes Other demersals: 144 tonnes	Mechanised handlines	The GDSF operates in the waters of the Indian Ocean and Shark Bay between latitudes 23°07'30"S and 26°30'S. Vessels are not permitted to fish in inner Shark Bay.
Abalone Managed Fishery	Greenlip abalone (*Haliotis laevigata*) Brownlip abalone (*H. conicopora)*	2017/2018: 98 tonnes	Dive fishery The principal harvest method is a diver working off 'hookah' (surface supplied breathing apparatus) or SCUBA using an abalone 'iron' to prise the shellfish off rocks – both commercial and recreational divers employ this method.	Shallow coastal waters off the south-west and south coasts of Western Australia Covers all Western Australian coastal waters, which are divided into eight management areas. Commercial fishing for greenlip/brownlip abalone is managed in three separate areas.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Hermit Crab Fishery (HCF)	Australian land hermit crab (*Coenobita variabilis*)	2017/2018: 58,643 (lowest reported in the last 10 years (2008-2017; catch range 58,643-118,203).	Land based hand collection typically using four-wheel drives to access remote beaches	Operates in Western Australian waters north of the Exmouth Gulf (22°30'S)
Kimberley Developing Mud Crab Managed Fishery	Mud crab (*Scylla serrata*)	2017/2018: 60 tonnes (also includes catch data from Pilbara Developmental crab fishery)	Mud Crab traps	This fishery operates between Broome and Cambridge Gulf. Three commercial operators are permitted to fish from King Sound to the Northern Territory border, with closed areas around communities and fishing camps. One Aboriginal Corporation is permitted to fish in King Sound, with the other Aboriginal Corporation permitted to fish in a small area on the western side of the Dampier peninsula, north of Broome. Notices issued under the *Fish Resources Management Act 1994* prohibit all commercial fishing for mud crabs in Roebuck Bay and an area of King Sound near Derby.
Kimberley Gillnet and Barramundi Managed Fishery (KGBF)	Barramundi *(Lates calcarifer),* King threadfin *(Polydactylus macrochir),* Blue threadfin *(Eleutheronema tetradactylum)*	2017/2018: 79.9 tonnes	Gill net in inshore waters	Nearshore and estuarine zones of the North Coast Bioregion from the WA/NT border (129ºE) to the top end of Eighty Mile Beach, south of Broome (19ºS). The waters of the KGBF are defined as 'all Western Australian waters north of 19° south latitude and west of 129° east longitude and within three nautical miles of the high water mark of the mainland of Western Australia and the waters of King Sound south of 16°21.47´ south latitude.
Kimberley Prawn Managed Fishery (KPMF)	Banana prawns (*Penaeus merguiensis*) Tiger prawns (*Penaeus esculentus*)	2017/2018: 269 tonnes	Otter trawl	The KPMF operates off the north of the state between Koolan Island and Cape Londonderry.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	Endeavour prawns (*Metapenaeus endeavouri*) Western king prawns (*Penaeus latisulcatus*)			The boundaries of the KPMF are 'all Western Australian waters of the Indian Ocean lying east of 123°45´ east longitude and west of 126°58´ east longitude'. It abuts the western boundary of the Commonwealth Northern Prawn Fishery (NPF).
Mandurah to Bunbury Developing Crab Fishery	Blue swimmer crab (*Portunus armartus)*	2017/2018: 5.2 tonnes	Drop nets, scoop nets, diving	Fishery extends from south of the Shoalwater Islands Marine Park (32°22'40''S) to Point McKenna near Bunbury (33°16'S) and offshore to 115°30'E. The fishery is divided into two zones with crab fishing historically being permitted within Area 1, Comet Bay between 32°22''40''S and 32°30'S, and Area 2, Cape Bouvard to the southern boundary of the fishery. In 2015 crab fishing within Area 2 ceased.
Marine Aquarium Fish Managed Fishery (MAFMF)	Over 250 target species of finfish. (228 species caught in 2012). Fishermen can also take coral, live rock, algae, seagrass and invertebrates. The main fish species landed in 2012 were scribbled angelfish (*Chaetodontoplus duboulayi*) and green chromis (*Chromis cinerascens*) The main coral species landed in 2012 were the coral like anemones of the Corallimorpharia.	2017/2018: Total catch of 150,544 fishes, 21.9 t of coral, live rock & living sand and 322 L of marine plants.	Hand harvest while diving or wading. Hand held nets	Dive based fishery operating all year throughout WA waters, but restricted by diving depths. The MAFMF is able to operate in all State waters (between the Northern Territory border and South Australian border). The fishery is typically more active in waters south of Broome with higher levels of effort around the Capes region, Perth, Geraldton, Exmouth and Dampier. Operators in the MAFMF are also permitted to take coral, live rock, algae, seagrass and invertebrates under the Prohibition on Fishing (Coral, 'Live Rock' and Algae) Order 2007 and by way of Ministerial Exemption (Gaughan & Santoro, 2018).
Nickol Bay Prawn Managed Fishery (NBPMF)	Primarily targets banana prawns (*Penaeus merguiensis*)	2017/2018: 227 tonnes	Otter trawl	Operates along the western part of the North-West Shelf in coastal shallow waters

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
				The boundaries of the NBPMF are 'all the waters of the Indian Ocean and Nickol Bay between 116°45' east longitude and 120° east longitude on the landward side of the 200 m isobath'. The NBPMF incorporates the Nickol Bay, Extended Nickol Bay, Depuch and De Grey size managed fish grounds (State of the Fisheries 2014-15).
North Coast Trochus Fishery	Trochus (*Tectus niloticus*)	2017/2018: Unspecified	Harvested by with handheld levers or chisels	Indigenous fishery operating within King Sound
Northern Demersal Scalefish Managed Fishery (NDSF)	Red emperor (*Lutjanus sebae*) Goldband snapper (*Pristipomoides multidens*)	2017/2018:1317 tonnes (total) Goldband snapper (not including other jobfish): 473 tonnes Red emperor: 34 – 47 tonnes	The permitted means of operation within the fishery include handline, dropline and fish traps, but since 2002 it has essentially been a trap-based fishery which uses gear time access and spatial zones as the primary management measures (State of the Fisheries 2014-15).	The Northern Demersal Scalefish Managed Fishery (NDSF) operates off the northwest coast of Western Australia in the waters east of 120° E longitude. These waters extend out to the edge of the Australian Fishing Zone (200 nautical miles). The Fishery consists of three zones; Zone A is an inshore area, Zone B comprises the area with most historical fishing activity and Zone C is an offshore deep slope developmental area. The fishery is further divided into two fishing areas; an inshore sector and an offshore sector. The inshore waters in the vicinity of Broome are closed to commercial fishing.
WA North Coast Shark Fisheries	Sandbar (*Carcharhinus plumbeus*), hammer head (*Sphyrnidae*), blacktip (*Carcharhinus melanopterus*) and lemmon sharks (*Negaprion brevirostris*).	2017/2018: closed since 2008/2009	Gill net, longline	Comprised of the State-managed WA North Coast Shark Fishery in the Pilbara and western Kimberley, and the Joint Authority Northern Shark Fishery in the eastern Kimberley.
Octopus Interim Managed Fishery	*Octopus cf. tetricus*, with occasional bycatch of *O. ornatus* and *O. cyanea* in the northern parts of the fishery,	2017/2018: Commercial: 257 tonnes Recreational: 1 tonne	Line and pots Trawl and trap (land Octopus as byproduct)	Fishery in development phase. Four main categories in WA waters. Octopus are primarily caught in the Developing Octopus Interim Managed Fishery (largest fishery) are

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	and *O.maorum* in the southern and deeper sectors.			limited to the boundaries of the developmental fishery, which is an area bounded by the Kalbarri Cliffs (26°30'S) in the north and Esperance in the south. Passive and by-product harvests of octopus occur in both the Cockburn Sound (Line and Pot) Managed Fishery and the West Coast Rock Lobster Managed Fishery.
Onslow Prawn Managed Fishery (OPMF)	Western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), endeavour prawns (*Metapenaeus* spp.)	2017/2018: Negligible (Minimal fishing occurred in 2017)	Otter trawl	Operates along the western part of the North-West Shelf with most prawning activities concentrated in the shallower water off the mainland. The boundaries of the OPMF are 'all the Western Australian waters between the Exmouth Prawn Fishery and the Nickol Bay prawn fishery east of 114º39.9' on the landward side of the 200 m depth isobath'.
Pilbara Developmental Crab Fishery	Blue Swimmer (*Portunus armatus)* Mud Crab (*Scylla* spp)	2017/2018: 60 tonnes (total number includes Kimberley Developing Mud Crab Fishery)	Variety of gear but mostly commercial crab pots (Hourglass traps used in inshore waters from Onslow through to Port Hedland with most commercial and activity occurring in and around Nickol Bay) Recreational fishers use drop nets or scoop nets, with diving for crabs becoming increasingly popular	The majority of the commercially and recreationally-fished stocks are concentrated in the coastal embayments and estuaries between Geographe Bay in the south west and Nickol Bay in the north. Crabbing activity along the Pilbara coast is centred largely on the inshore waters from Onslow through to Port Hedland, with most commercial and recreational activity occurring in and around Nickol Bay.
Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF)	Variety of demersal scalefish including goldband snapper (*Pristipomoides multidens*), red emperor (*Lutjanus sebae*), bluespotted emperor	2017/2018: 1,780 tonnes	Demersal trawl	The Pilbara Fish Trawl (Interim) Managed Fishery is situated in the Pilbara region in the north west of Australia. It occupies the waters north of latitude 21°35'S and between

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	(*Lethrinus punctulatus*), crimson snapper (*Lutjanus erythropterus*), saddletail snapper (*Lutjanus malabaricus*), Rankin cod (*Epinephelus multinotatus*), brownstripe snapper (*Lutjanus vitta*), rosy threadfin bream (*Nemipterus furcosus*), spangled emperor (*Lethrinus nebulosus*) and frypan Moses' snapper (*Argyrops Lutjanusspinifer russelli*).			longitudes 114°9'36"E and 120°E. The Fishery is seaward of the 50 m isobath and landward of the 200 m isobath. The Fishery consists of two zones; Zone 1 in the south west of the Fishery (which is closed to trawling) and Zone 2 in the North, which consists of six management areas.
Pilbara Trap Managed Fishery (PTMF)	Blue-spot emperor (*Lethrinus hutchinsi*), Red snapper (*Lutjanus erythropterus*), Goldband snapper (*Pristipomoides multidens*), Scarlet perch (*Lutjanus malabaricus*), Red emperor (*Lutjanus sebae*), Spangled emperor (*Lethrinus nebulosus*), Rankin cod (*Epinephelus multinotatus*)	2017/2018: 400–600 tonnes	Use of rectangular traps with single opening and 50 mm x 70 mm rectangular mesh panels. Trap fishing normally targets areas around rocky outcrops and reefs	Permitted to operate within waters bounded by a line commencing at the intersection of 21°56´ S latitude and the high water mark on the western side of the North West Cape.
Pilbara Line Managed Fishery	Variety of demersal scalefish including goldband snapper (*Pristipomoides multidens*), red emperor (*Lutjanus sebae*), bluespotted emperor (*Lethrinus punctulatus*), crimson snapper (*Lutjanus erythropterus*), saddletail snapper (*Lutjanus malabaricus*), Rankin cod (*Epinephelus multinotatus*), brownstripe snapper (*Lutjanus vitta*), rosy threadfin bream (*Nemipterus furcosus*), spangled emperor (*Lethrinus nebulosus*) and frypan snapper (*Argyrops spinifer*), Ruby	2017/2018: 50–115 tonnes	Line	The Pilbara Trap Managed Fishery lies north of latitude 21°44´ S and between longitudes 114°9´36´´ E and 120° E on the landward side of a boundary approximating the 200 m isobath and seaward of a line generally following the 30 m isobath.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	snapper (*Etelis carbunculus*) and eightbar grouper (*Hyporthodus octofasciatus)*			
Roe's Abalone	Western Australian Roe's abalone (*Haliotis roei*)	2017/2018: Commercial: 49 tonnes Recreational: 23 tonnes	Dive and wade fishery. The commercial fishery harvest method is a single diver working off a 'hookah' (surface-supplied breathing apparatus) using an abalone 'iron' to prise the shellfish off rocks. Abalone divers operate from small fishery vessels (generally less than 9 metres in length).	Operating in shallow coastal waters along WA's western and southern coasts from Shark Bay to the SA border. Divided into 8 management areas. Commercial fishing for Roe's abalone is managed in 6 separate regions from the South Australian border to Busselton Jetty – Areas 1, 2, 5, 6, 7 and 8. Area 8 of the fishery was not fished in 2013.
Shark Bay Crab Interim Managed Fishery	Blue swimmer crab (*Portunus armatus*)	2017/2018: 443 tonnes total Crab: 153 tonnes	Trawl and trap	Waters of Shark Bay north of Cape Inscription, to Bernier and Dorre Islands and Quobba Point. In addition, two fishers with long-standing histories of trapping crabs in Shark Bay are permitted to fish in the waters of Shark Bay south of Cape Inscription.
Shark Bay Prawn Managed Fishery	Western king prawn (*Penaeus latisulcatus*), brown tiger prawn (*Penaeus esculentus*), Variety of smaller prawn species including endeavour prawns (*Metapenaeus* spp.) and coral prawns (various species).	2017/2018: 1,608 tonnes	Low opening otter trawls	The boundaries of the Shark Bay Prawn Managed Fishery are located in and near the waters of Shark Bay
Shark Bay Scallop Managed Fishery	Saucer Scallop (*Ylistrum balloti*)	2017/2018: 1,632 tonnes	Low opening otter trawls	The boundaries of the Shark Bay Scallop Managed Fishery are located in and near the waters of Shark Bay

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
South Coast Open Access Netting Fishery	Insufficient information	Insufficient information	Insufficient information	Bunbury to the South Australian Border
Specimen Shell Managed Fishery (SSF)	Shells (cowries, cones) The Specimen Shell Managed Fishery (SSF) is based on the collection of individual shells for the purposes of display, collection, cataloguing, classification and sale. Just under 200 (196) different Specimen Shell species were collected in 2012, using a variety of methods.	2017/2018: 7,806 shells	Hand harvest while diving or wading along coastal beaches below the high water mark An exemption method being employed by the fishery is using a remote controlled underwater vehicle at depths between 60 and 300 m.	Dive based fishery operating all year throughout WA waters, but restricted by diving depths. The fishing area includes all Western Australian waters between the high water mark and the 200 m isobath. While the fishery covers the entire WA coastline, there is some concentration of effort in areas adjacent to population centres such as Broome, Karratha, Exmouth, Shark Bay, metropolitan Perth, Mandurah, the Capes area and Albany.
South Coast Salmon Managed Fishery	WA salmon (*Arripis truttaceus*)	2017: 50 tonnes	Beach seine net, rod and line	Licensees operate from 18 designated beaches within the South Coast Bioregion, many of which have huts that are referred to as salmon camps.
South West Coast Salmon Managed Fishery	WA salmon (*Arripis truttaceus*)	Insufficient information	Insufficient information	Insufficient information
South West Coast Beach Net	Insufficient information	Insufficient information	Insufficient information	Insufficient information
South West Trawl Managed Fishery (SWTMF)	Saucer scallops (*Ylistrum balloti*)	2017/2018: 460 t meat weight (2,301 t whole weight)	Otter trawls	Waters between 31°34’27’’S and 115°8’8’’E where it intersects with the high water mark at Cape Leeuwin and on the landward side of the 200 m isobath.
Temperate Demersal Gillnet and Demersal	Gummy shark (*Mustelus antarcticus*), dusky shark (*Carcharhinus obscurus*), whiskery shark (*Furgaleus macki*) and	2017/2018: 2016-17Sharks and rays: 936 tonnes Scalefish: 133 tonnes	Demersal gillnets and power-hauled reels (to target sharks) Demersal longline	The Temperate Demersal Gillnet and Demersal Longline fisheries consists of Zone 1 of the Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery and the West Coast Demersal Gillnet

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
Longline Fisheries (TDGDLF)	sandbar shark (*Carcharhinus plumbeus*).			and Demersal Longline (Interim) Managed Fishery. The Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (JASDGDLF) spans the waters from 33° S latitude to the WA/SA border and comprises three management zones Zone 1 extends southwards from 33° S to 116° 30' E longitude off the south coast. Zone 2 extends from 116°30' E to the WA/SA border (129° E). A small number of Zone 3 units permit fishing throughout Zone 1 and eastwards to 116° 55'40" E. The West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (WCDGDLF) technically extends northwards from 33° S latitude to 26° S longitude. However, the use of shark fishing gear has been prohibited north of 26° 30' S (Steep Point) since 1993. Demersal gillnet and longline fishing inside the 250 metre depth contour has been prohibited off the Metropolitan coast (between latitudes 31° S and 33° S) since November 2007.
Warnbro Sound Crab Managed Fishery	Blue Swimmer (*Portunus armatus)* Blue swimmer crab (*Portunus armartus)*	2017/2018: closed to commercial and recreational fishing	Drop nets, scoop nets, diving	Includes Warnbro sound and adjacent water, extending from Becher Point to John Point.
West Coast Deep Sea Crustacean (Interim) Managed Fishery	Crystal (Snow) crabs (*Chaceon albus*), Giant (King) crabs (*Pseudocarcinus gigas*) and Champagne (Spiny) crabs (*Hypothalassia acerba*).	2017/2018: 164.4 tonnes	Baited pots operated in a longline formation in the shelf edge waters (>150 m)	North of latitude 34° 24' S (Cape Leeuwin) and west of the Northern Territory border on the seaward side of the 150 m isobath out to the extent of the AFZ, mostly in 500 to 800 m of water.
West Coast Demersal Scalefish	West Coast Inshore Demersals:	2017/2018: 248 tonnes	Handline and drop line	The WCDSIMF encompasses the waters of the Indian Ocean just south of Shark Bay (at

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
(Interim) Managed Fishery	West Australian Dhufish (*Glaucosoma hebraicum*), Pink snapper (*Pagrus auratus*) with other species captured including Redthroat Emperor (*Lethrinus miniatus*), Bight Redfish (*Centroberyx gerrardi*) and Baldchin Groper (*Choerodon rubescens*). West Coast Offshore Demersals: Eightbar Grouper *Hyporthodus octofasciatus*, Hapuku *Polyprion oxygeneios*, Blue-eye Trevalla *Hyperoglyphe antarctica* and Ruby Snapper *Etelis carbunculus*.			26°30'S) to just east of Augusta (at 115°30'E) and extends seaward to the 200 nm boundary of the Australian Fishing Zone (AFZ). The commercial fishery is divided into five management areas comprising four inshore areas and one offshore area. The inshore areas, i.e. Kalbarri, Mid-West, Metropolitan and South-West, extend outwards to the 250 m depth contour, while the Offshore Area extends the entire length of the fishery from the 250 m depth contour to the boundary of the AFZ.
West Coast Estuarine Managed Fishery	Blue swimmer crab (*Portunus armartus)*	2017/2018: 353 tonnes (blue swimmer crab) commercial and 58-77 tonnes recreational	Drop nets, scoop nets, diving (crabs)	Includes the waters of the Swan and Canning Rivers (Area 1), the waters of the Peel Inlet and Harvey Estuary, together with the Murray Serpentine, Harvey and Dandalup Rivers (Area 2) and waters of the Hardy Inlet (Area 3). Of these areas only Areas 1-2 are permitted for crab fishing.
West Coast Nearshore and Estuarine Finfish Fisheries	Nearshore: whitebait (*Hyperlophus vittatus*), western Australian salmon (*Arripis truttaceus*), Australian herring (*Arripis georgianus*), sourthern school whiting (*Sillago bassensis*), yellowfin whiting (*Sillago schomburgkii*), yelloweye mullet (*Aldrichetta forsteri*), tailor (*Pomatomus saltarix*), southern garfish (*Hyporhamphus melanochir*), silver trevally (*Pseudocaranx georgianus*) and King George whtiting (*Sillaginodes punctate*). Estuarine*:* sea mullet (*Mugil cephalus*), estuary cobbler	2017/2018: 353 tonnes	Haul, beach seine and gill netting (commercial). Line fishing (recreational)	Five commercial fisheries target nearshore and/or estuarine finfish in the West Coast Bioregion. Nearshore: Cockburn Sound Fish Net Managed Fishery operating within in Cockburn sound, South West Coast Salmon Managed Fishery operating on various beaches south of the Perth Metropolitan area, West Coast Beach Bait Managed Fishery operating on beaches spanning from Moore River to Tim's Thicket and the South West Beach Seine Fishery operating on

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	(*Cnidoglanis macrocephalus*) and black bream (*Acanthopagrus butcheri*).			various beaches from Tim's Thicket southwards to Port Geographe Bay Marina. Estuarine: West Coast Estuarine Managed Fishery operating in the Swan/Canning and Peel Harvey estuaries, and in the Hardy Inlet
West Coast Nearshore Net Managed Fishery	Southern garfish (Hyporhamphus melanochir), Australian herring (Arripis georgianus),	Insufficient information	Insufficient information	Insufficient information
West Coast Purse Seine Fishery	Scaly mackerel (*Sardinella lemuru*), pilchard (*S. sagax*), Australian anchovy (*Engraulis australis*), yellowtail scad (*Trachurus novaezelandiae*) and maray (*Etrumeus teres*).	2017/2018: 1,095 tonnes	Purse seine gear	Waters between Ningaloo and Cape Leeuwin including three separate zones: Northern Development (22°00'S to 31°00'S), Perth Metropolitan (31°00'S to 33°00'S) and Southern Development Zone (33°00'S to Cape Leeuwin).
West Coast Rock Lobster Managed Fishery (WCRLMF)	Western rock lobster (*Panulirus cygnus*)	2016: 272 – 400 tonnes (346-481 tonnes based on updated average weight)	Baited traps (pots). Pots and diving (recreational catch)	The fishery is situated along the west coast of Australia between Latitudes 21°44´ to 34°24´ S. The fishery is managed in three zones: Zone A – Abrolhos Islands, north of latitude 30° S excluding the Abrolhos Islands (Zone B) and south of latitude 30° S (Zone C).
West Coast Demersal Gillnet and Demersal Longline (WCDGDLF)*	Gummy shark (*Mustelus antarcticus*), dusky shark (*Carcharhinus obscurus*), whiskery shark (*Furgaleus macki*) and sandbar shark (*C. plumbeus*)	2016/2018: 936 tonnes of sharks and rays	Demersal gillnets and demersal longline (not widely used)	Operates between 26° and 33° S.
Mackerel Fishery	Spanish mackerel *(Scomberomorus commerson)*, grey mackerel *(S.semifasciatus)*, with other species from the genera *Scomberomorus*, *Grammatorcynus* and *Acanthocybium* also contributing to commercial catches.	2016: Commercial: The commercial catch of spanish mackerel was 276 tonnes in 2016 (Gaughan & Santoro, 2018)	Trolling or handline Near-surface trolling gear from vessels in coastal areas around reefs, shoals and headlands. Jig fishing is also used to capture grey mackerel *(S.semifasciatus)*	The Fishery extends from the West Coast Bioregion to the WA/NT border, to the 200 nautical mile AFZ with most effort and catches recorded north of Geraldton, especially from the Kimberley and Pilbara coasts of the Northern Bioregion. Restricted to coastal and shallower waters.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
				Catches are reported separately for three Areas: Area 1 - Kimberley (121º E to WA/NT border); Area 2 -Pilbara (114º E to 121º E); Area 3 - Gascoyne (27º S to 114º E) and West Coast (Cape Leeuwin to 27º S).
Western Australian Pearl Oyster Managed Fishery	Indo- Pacific silver-lipped pearl oyster (*Pinctada maxima*).	2018: 468,573 shells	Drift diving restricted to shallow diveable depths. The collection of pearl oysters for the Pearl Oyster Managed Fishery is restricted to shallow diving depths below 35 m. Divers are attached to large outrigger booms on a vessel and towed slowly over the pearl oyster beds, harvesting legalised oysters by hand as they are seen.	The fishery is separated into four zones: Pearl Oyster Zone 1: NW Cape (including Exmouth Gulf) to longitude 119°30'E. There are five licensees in this zone. No fishing in this zone since 2008 Pearl Oyster Zone 2: East of Cape Thouin (118°20´ E) and south of latitude 18°14´ S. The 9 licensees in this zone also have full access to Zone 3. This zone is the mainstay of the fishery. Pearl Oyster Zone 3: West of longitude 125°20´ E and north of latitude 18°14´ S. The 2 licensees in this zone also have partial access to Zone 2. Pearl Oyster Zone 4: East of longitude 125°20´ E to the Western Australia/Northern Territory border. Although all licensees have access to this zone, exploratory fishing has shown that stocks in this area are not economically viable. However, pearl farming does occur.
Western Australian Sea Cucumber Fishery (formerly known as Beche-de-mer)	Sandfish (*Holothuria scabra*) and deepwater redfish (*Actinopyga echinites*).	2016: 93 tonnes	Hand-harvest fishery, with animals caught principally by diving, and a smaller amount by wading.	The Western Australian Sea Cucumber Fishery is permitted to operate throughout WA waters with the exception of a number of specific closures around the Dampier Archipelago, Cape Keraudren, Cape Preston

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
				and Cape Lambert, the Rowley Shoals and the Abrolhos Islands. The fishery is primarily based in the northern half of the State, from Exmouth Gulf to the Northern Territory border.
Commonwealth Managed Fisheries				
North West Slope Trawl	Scampi (crayfish): velvet scampi (*Metanephrops velutinus*) and boschmai scampi (*Metanephrops boschmai*). Deepwater prawns (penaeid and carid): pink prawn (*Parapenaeus longirostris*), red prawn (*Aristaeomorpha foliacea*), striped prawn (*Aristeus virilis*), giant scarlet prawn (*Aristaeopsis edwardsiana*), red carid prawn (*Heterocarpus woodmasoni*) and white carid prawn (*Heterocarpus sibogae*). Snapper.	2017-18: 79.7 total tonnes.	Demersal crustacean trawl seaward of the 200 m isobath.	Extends from 114° E to approximately 125° E off the WA coast between the 200 m isobath and the outer limit of the Australian Fishing Zone (AFZ).
Western Skipjack Tuna Fishery	Skipjack tuna (*Katsuwonus pelamis*)	2017-18: None in either zones	Purse seine	The Skipjack Tuna Fishery is split into two sectors; east and west. The Western Skipjack Tuna Fishery is located in all Australia waters west of 142° 30’ 00°E, out to 200 nm from the coast. There has been no fishing effort in the Skipjack Tuna Fishery since the 2008-09 season, and in that season activity concentrated off South Australia (Department of Agriculture 2019).
Small Pelagic Fishery	Australian sardine (*Sardinops sagax*), blue mackerel (*Scomber australasicus*), jack mackerel	2018-19: 9,424 tonnes	Purse-seine and midwater trawling	Extends from Queensland to southern Western Australia.

Fishery	Target Species	Catch[1]	Fishing Method	Area Description
	(*Trachurus declivis*) and redbait (*Emmelichthys nitidus*).			
Southern Bluefin Tuna Fishery	Southern bluefin tuna (*Thunnus maccoyii*).	2017-18: 6,159 tonnes	Purse seine vessels primarily in Great Australian Bight all year round and longline off southern NSW in winter. Around 98% of Australia's SBT quota is taken by 5–10 purse seine vessels fishing for 13–25 kg southern bluefin tuna.	Fishery includes all waters of Australia, out to 200 nm from the coast. No current effort on the North West Shelf, fishing activity is concentrated in the Great Australian Bight and off South-east Australia (Department of Agriculture 2019).
Western Deepwater Trawl Fishery	A diverse range of species are caught, ranging from tropical and ruby snappers on the shelf edge to orange roughy (*Hoplostethus atlanticus*), oreo dories and bugs (*Ibacus* spp.) in the deeper temperate waters.	2017-18: 101.9 tonnes	Demersal fish trawl seaward of the 200 m isobath.	Its northernmost point is from the boundary of the AFZ to longitude 114° E, and its southernmost point is from the boundary of the AFZ to longitude 115°08' E. Deep water off WA, from the 200 m isobath to the edge of the AFZ.
Western Tuna and Billfish Fishery	Broadbill swordfish (*Xiphias gladius*), albacore tuna (*Thunnus alalunga*), striped marlin (*Kajikia audax*), bigeye tuna (*T. obesus*) and yellowfin tuna (*T. albacares*).	2018: 278 tonnes	Pelagic, longline, minor line and purse seine.	Extends westward from Cape York Peninsula (142°30' E) off Queensland to 34° S off the WA west coast. It also extends eastward from 34° S off the west coast of WA across the Great Australian Bight to 141° E at the South Australian–Victorian border. In recent years, fishing effort has concentrated off south-west Western Australia and South Australia with no current effort on the North West Shelf (Department of Agriculture 2019).

Source: Apache (2008); Australian Fisheries Management Authority (2011); Department of Fisheries (2013), Stakeholder consultation.

[1]Sources for catch data: Department of Agriculture 2019; Gaughan *et al*, 2019; DPIRD 2018.

15. Document review

This document is to be reviewed annually at a minimum. The review and revision will consider any changes to the spatial scope of the document, i.e. the Environment that May be Affected (EMBA), as well as any changes to EPBC Act Matters of National Environmental Significance (MNES) from one review year to the next, regardless of any changes to the spatial extent of the EMBA. A review of changes to MNES shall consider at a minimum any changes to EPBC Act species lists, species management/recovery plans and MNES spatial layers. Changes are to be recorded within the MNES review register (**Appendix B**).

16. References

16.1 Physical Environment

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Appendix A: EPBC Act Protected Matters Report

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.

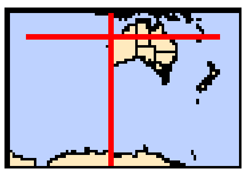
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

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

Report created: 10/11/20 15:56:19

Coordinates

Buffer: 1.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	2
National Heritage Places:	9
Wetlands of International Importance:	7
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	6
Listed Threatened Species:	196
Listed Migratory Species:	109

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:	9
Commonwealth Heritage Places:	24
Listed Marine Species:	216
Whales and Other Cetaceans:	44
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	1
Australian Marine Parks:	45

Extra Information

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

State and Territory Reserves:	140
Regional Forest Agreements:	1
Invasive Species:	64
Nationally Important Wetlands:	19
Key Ecological Features (Marine)	24

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Status
Shark Bay, Western Australia	WA	Declared property
The Ningaloo Coast	WA	Declared property

National Heritage Properties [Resource Information]

Name	State	Status
Natural		
Fitzgerald River National Park	WA	Listed place
Lesueur National Park	WA	Listed place
Shark Bay, Western Australia	WA	Listed place
The Ningaloo Coast	WA	Listed place
The West Kimberley	WA	Listed place
Indigenous		
Dampier Archipelago (including Burrup Peninsula)	WA	Listed place
Historic		
Batavia Shipwreck Site and Survivor Camps Area 1629 - Houtman Abrolhos	WA	Listed place
Dirk Hartog Landing Site 1616 - Cape Inscription Area	WA	Listed place
HMAS Sydney II and HSK Kormoran Shipwreck Sites	EXT	Listed place

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Ashmore reef national nature reserve	Within Ramsar site
Becher point wetlands	Within 10km of Ramsar
Eighty-mile beach	Within Ramsar site
Hosnies spring	Within Ramsar site
Peel-yalgorup system	Within Ramsar site
Roebuck bay	Within Ramsar site
The dales	Within Ramsar site

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea
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
North
North-west
South-west

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
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community likely to occur within area
Monsoon vine thickets on the coastal sand dunes	Endangered	Community likely to

Name	Status	Type of Presence
of Dampier Peninsula		occur within area
Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of Western Australia	Endangered	Community likely to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area
Thrombolite (microbialite) Community of a Coastal Brackish Lake (Lake Clifton)	Critically Endangered	Community known to occur within area
Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain ecological community	Critically Endangered	Community likely to occur within area

Listed Threatened Species

[Resource Information]

Name	Status	Type of Presence
Birds		
Accipiter hiogaster natalis Christmas Island Goshawk [82408]	Endangered	Species or species habitat known to occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Breeding known to occur within area
Atrichornis clamosus Noisy Scrub-bird, Tjimiluk [654]	Endangered	Species or species habitat known to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat known to occur within area
Calyptorhynchus baudinii Baudin's Cockatoo, Long-billed Black-Cockatoo [769]	Endangered	Breeding known to occur within area
Calyptorhynchus latirostris Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area
Cereopsis novaehollandiae grisea Cape Barren Goose (south-western), Recherche Cape Barren Goose [25978]	Vulnerable	Species or species habitat known to occur within area
Chalcophaps indica natalis Christmas Island Emerald Dove, Emerald Dove (Christmas Island) [67030]	Endangered	Species or species habitat 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
Dasyornis longirostris Western Bristlebird [515]	Endangered	Species or species habitat known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat 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 likely to occur within area
Erythrura gouldiae Gouldian Finch [413]	Endangered	Species or species habitat known to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat known to occur within area
Falcunculus frontatus whitei Crested Shrike-tit (northern), Northern Shrike-tit [26013]	Vulnerable	Species or species habitat likely to occur within area
Fregata andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Breeding known to occur within area
Geophaps smithii blaauwi Partridge Pigeon (western) [66501]	Vulnerable	Species or species habitat likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Malurus leucopterus edouardi White-winged Fairy-wren (Barrow Island), Barrow Island Black-and-white Fairy-wren [26194]	Vulnerable	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Malurus leucopterus leucopterus White-winged Fairy-wren (Dirk Hartog Island), Dirk Hartog Black-and-White Fairy-wren [26004]	Vulnerable	Species or species habitat likely to occur within area
Ninox natalis Christmas Island Hawk-Owl, Christmas Boobook [66671]	Vulnerable	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat known to occur within area
Pezoporus flaviventris Western Ground Parrot, Kyloring [84650]	Critically Endangered	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Breeding likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Polytelis alexandrae Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat known to occur within area
Psophodes nigrogularis nigrogularis Western Heath Whipbird [64449]	Endangered	Species or species habitat known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour 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	Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely

Name	Status	Type of Presence
		to occur within area
Turdus poliocephalus erythropleurus Christmas Island Thrush [67122]	Endangered	Species or species habitat likely to occur within area
Turnix varius scintillans Painted Button-quail (Houtman Abrolhos) [82451]	Vulnerable	Species or species habitat likely to occur within area
Tyto novaehollandiae kimberli Masked Owl (northern) [26048]	Vulnerable	Species or species habitat likely to occur within area
Fish		
Galaxiella nigrostriata Blackstriped Dwarf Galaxias, Black-stripe Minnow [88677]	Endangered	Species or species habitat known to occur within area
Milyeringa veritas Blind Gudgeon [66676]	Vulnerable	Species or species habitat known to occur within area
Nannatherina balstoni Balston's Pygmy Perch [66698]	Vulnerable	Species or species habitat known to occur within area
Ophisternon candidum Blind Cave Eel [66678]	Vulnerable	Species or species habitat known to occur within area
Insects		
Hesperocolletes douglasi Douglas' Broad-headed Bee, Rottnest Bee [66734]	Critically Endangered	Species or species habitat may occur within area
Trioza barrettae Banksia brownii plant louse [87805]	Endangered	Species or species habitat known to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Bettongia lesueur Barrow and Boodie Islands subspecies Boodie, Burrowing Bettong (Barrow and Boodie Islands) [88021]	Vulnerable	Species or species habitat known to occur within area
Bettongia lesueur lesueur Burrowing Bettong (Shark Bay), Boodie [66659]	Vulnerable	Species or species habitat known to occur within area
Bettongia penicillata ogilbyi Woylie [66844]	Endangered	Species or species habitat known to occur within area
Conilurus penicillatus Brush-tailed Rabbit-rat, Brush-tailed Tree-rat, Pakooma [132]	Vulnerable	Species or species habitat likely to occur within area
Crocidura trichura Christmas Island Shrew [86568]	Critically Endangered	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat known to occur within area
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Isoodon auratus auratus Golden Bandicoot (mainland) [66665]	Vulnerable	Species or species habitat likely to occur within area
Isoodon auratus barrowensis Golden Bandicoot (Barrow Island) [66666]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes conspicillatus conspicillatus Spectacled Hare-wallaby (Barrow Island) [66661]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes hirsutus Central Australian subspecies Mala, Rufous Hare-Wallaby (Central Australia) [88019]	Endangered	Translocated population known to occur within area
Lagorchestes hirsutus bernieri Rufous Hare-wallaby (Bernier Island) [66662]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes hirsutus dorreae Rufous Hare-wallaby (Dorre Island) [66663]	Vulnerable	Species or species habitat known to occur within area
Lagostrophus fasciatus fasciatus Banded Hare-wallaby, Merrnine, Marnine, Munning [66664]	Vulnerable	Species or species habitat known to occur within area
Leporillus conditor Wopilkara, Greater Stick-nest Rat [137]	Vulnerable	Translocated population known to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat known to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Mesembriomys gouldii gouldii Black-footed Tree-rat (Kimberley and mainland Northern Territory), Djintamoonga, Manbul [87618]	Endangered	Species or species habitat may occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Breeding known to occur within area
Osphranter robustus isabellinus Barrow Island Wallaroo, Barrow Island Euro [89262]	Vulnerable	Species or species habitat likely to occur within area
Parantechinus apicalis Dibbler [313]	Endangered	Species or species habitat known to occur within area
Perameles bougainville bougainville Western Barred Bandicoot (Shark Bay) [66631]	Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Petrogale concinna monastria Nabarlek (Kimberley) [87607]	Endangered	Species or species habitat known to occur within area
Petrogale lateralis lateralis Black-flanked Rock-wallaby, Moororong, Black-footed Rock Wallaby [66647]	Endangered	Species or species habitat known to occur within area
Phascogale calura Red-tailed Phascogale, Red-tailed Wambenger, Kenngoor [316]	Vulnerable	Species or species habitat may occur within area
Phascogale tapoatafa kimberleyensis Kimberley brush-tailed phascogale, Brush-tailed Phascogale (Kimberley) [88453]	Vulnerable	Species or species habitat likely to occur within area
Pipistrellus murrayi Christmas Island Pipistrelle [64383]	Critically Endangered	Species or species habitat known to occur within area
Potorous gilbertii Gilbert's Potoroo, Ngilkat [66642]	Critically Endangered	Species or species habitat known to occur within area
Pseudocheirus occidentalis Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Critically Endangered	Breeding known to occur within area
Pseudomys fieldi Shark Bay Mouse, Djoongari, Alice Springs Mouse [113]	Vulnerable	Species or species habitat likely to occur within area
Pseudomys shortridgei Heath Mouse, Dayang, Heath Rat [77]	Endangered	Species or species habitat may occur within area
Pteropus natalis Christmas Island Flying-fox, Christmas Island Fruit-bat [87611]	Critically Endangered	Roosting known to occur within area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat known to occur within area
Saccolaimus saccolaimus nudicluniatus Bare-rumped Sheath-tailed Bat, Bare-rumped Sheathtail Bat [66889]	Vulnerable	Species or species habitat likely to occur within area
Setonix brachyurus Quokka [229]	Vulnerable	Species or species habitat known to occur within area
Xeromys myoides Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat may occur within area
Other		
Idiosoma nigrum Shield-backed Trapdoor Spider, Black Rugose Trapdoor Spider [66798]	Vulnerable	Species or species habitat may occur within area
Kumonga exleyi Cape Range Remipede [86875]	Vulnerable	Species or species habitat likely to occur within area
Westralunio carteri Carter's Freshwater Mussel, Freshwater Mussel [86266]	Vulnerable	Species or species habitat known to occur within area
Plants		
Adenanthos dobagii Fitzgerald Woollybush [21253]	Endangered	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat may occur within area
Androcalva bivillosa Straggling Androcalva [87807]	Critically Endangered	Species or species habitat may occur within area
Asplenium listeri Christmas Island Spleenwort [65865]	Critically Endangered	Species or species habitat known to occur within area
Banksia brownii Brown's Banksia, Feather-leaved Banksia [8277]	Endangered	Species or species habitat known to occur within area
Banksia nivea subsp. uliginosa Swamp Honeypot [82766]	Endangered	Species or species habitat likely to occur within area
Banksia pseudoplumosa False Plumed-Banksia [82760]	Endangered	Species or species habitat may occur within area
Banksia squarrosa subsp. argillacea Whicher Range Dryandra [82769]	Vulnerable	Species or species habitat may occur within area
Banksia verticillata Granite Banksia, Albany Banksia, River Banksia [8333]	Vulnerable	Species or species habitat likely to occur within area
Beyeria lepidopetala Small-petalled Beyeria, Short-petalled Beyeria [18362]	Endangered	Species or species habitat likely to occur within area
Boronia clavata Bremer Boronia [5538]	Endangered	Species or species habitat likely to occur within area
Caladenia barbarella Small Dragon Orchid, Common Dragon Orchid [68686]	Endangered	Species or species habitat may occur within area
Caladenia bryceana subsp. cracens Northern Dwarf Spider-orchid [64556]	Vulnerable	Species or species habitat known to occur within area
Caladenia busselliana Bussell's Spider-orchid [24369]	Endangered	Species or species habitat likely to occur within area
Caladenia caesarea subsp. maritima Cape Spider-orchid [64856]	Endangered	Species or species habitat known to occur within area
Caladenia elegans Elegant Spider-orchid [56775]	Endangered	Species or species habitat likely to occur within area
Caladenia excelsa Giant Spider-orchid [56717]	Endangered	Species or species habitat likely to occur within area
Caladenia granitora [65292]	Endangered	Species or species habitat known to occur within area
Caladenia hoffmanii Hoffman's Spider-orchid [56719]	Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Caladenia huegelii King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat likely to occur within area
Caladenia lodgeana Lodge's Spider-orchid [68664]	Critically Endangered	Species or species habitat known to occur within area
Caladenia procera Carbunup King Spider Orchid [68679]	Critically Endangered	Species or species habitat may occur within area
Caladenia viridescens Dunsborough Spider-orchid [56776]	Endangered	Species or species habitat known to occur within area
Calectasia cyanea Blue Tinsel Lily [7669]	Critically Endangered	Species or species habitat known to occur within area
Chamelaucium sp. S coastal plain (R.D.Royce 4872) Royce's Waxflower [87814]	Vulnerable	Species or species habitat may occur within area
Chordifex abortivus Manypeaks Rush [64868]	Endangered	Species or species habitat known to occur within area
Chorizema varium Limestone Pea [16981]	Endangered	Species or species habitat known to occur within area
Conostylis micrantha Small-flowered Conostylis [17635]	Endangered	Species or species habitat may occur within area
Conostylis misera Grass Conostylis [21320]	Endangered	Species or species habitat may occur within area
Diuris drummondii Tall Donkey Orchid [4365]	Vulnerable	Species or species habitat known to occur within area
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat likely to occur within area
Diuris purdiei Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat may occur within area
Drakaea elastica Glossy-leafed Hammer Orchid, Glossy-leaved Hammer Orchid, Warty Hammer Orchid [16753]	Endangered	Species or species habitat likely to occur within area
Drakaea micrantha Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat likely to occur within area
Drummondita ericoides Morseby Range Drummondita [9193]	Endangered	Species or species habitat known to occur within area
Eucalyptus argutifolia Yanchep Mallee, Wabling Hill Mallee [24263]	Vulnerable	Species or species habitat known to occur within area
Eucalyptus cuprea Mallee Box [56773]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Eucalyptus x phylacis Meelup Mallee [87817]	Endangered	Species or species habitat known to occur within area
Gastrolobium papilio Butterfly-leaved Gastrolobium [78415]	Endangered	Species or species habitat may occur within area
Grevillea batrachioides Mt Lesueur Grevillea [21735]	Endangered	Species or species habitat may occur within area
Grevillea brachystylis subsp. australis [55525]	Vulnerable	Species or species habitat may occur within area
Grevillea humifusa Spreading Grevillea [61182]	Endangered	Species or species habitat may occur within area
Hemiandra gardneri Red Snakebush [7945]	Endangered	Species or species habitat likely to occur within area
Isopogon uncinatus Albany Cone Bush, Hook-leaf Isopogon [20871]	Endangered	Species or species habitat known to occur within area
Kennedia glabrata Northcliffe Kennedia [16452]	Vulnerable	Species or species habitat likely to occur within area
Kennedia lateritia Augusta Kennedia [45985]	Endangered	Species or species habitat likely to occur within area
Lambertia echinata subsp. occidentalis Western Prickly Honeysuckle [64528]	Endangered	Species or species habitat may occur within area
Lambertia orbifolia Roundleaf Honeysuckle [15725]	Endangered	Species or species habitat likely to occur within area
Lechenaultia chlorantha Kalbarri Leschenaultia [16763]	Vulnerable	Species or species habitat likely to occur within area
Leptomeria dielsiana Diels' Currant Bush [5146]	Vulnerable	Species or species habitat known to occur within area
Leucopogon obtectus Hidden Beard-heath [19614]	Endangered	Species or species habitat may occur within area
Marianthus paralius [83925]	Endangered	Species or species habitat known to occur within area
Pityrodia augustensis Mt Augustus Foxglove [4962]	Vulnerable	Species or species habitat likely to occur within area
Pneumatopteris truncata fern [68812]	Critically Endangered	Species or species habitat known to occur within area
Reedia spathacea Reedia [2995]	Critically Endangered	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Seringia exastia Fringed Fire-bush [88920]	Critically Endangered	Species or species habitat known to occur within area
Sphenotoma drummondii Mountain Paper-heath [21160]	Endangered	Species or species habitat likely to occur within area
Stachystemon nematophorus Three-flowered Stachystemon [81447]	Vulnerable	Species or species habitat known to occur within area
Tectaria devexa [14767]	Endangered	Species or species habitat likely to occur within area
Thelymitra stellata Star Sun-orchid [7060]	Endangered	Species or species habitat may occur within area
Verticordia apecta Hay River Featherflower, Scruffy Verticordia [65545]	Critically Endangered	Species or species habitat may occur within area
Verticordia plumosa var. vassensis Vasse Featherflower [55804]	Endangered	Species or species habitat may occur within area
Wurmbea calcicola Naturaliste Nancy [64691]	Endangered	Species or species habitat known to occur within area
Wurmbea tubulosa Long-flowered Nancy [12739]	Endangered	Species or species habitat known to occur within area
Reptiles		
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Cryptoblepharus egeriae Christmas Island Blue-tailed Skink, Blue-tailed Snake-eyed Skink [1526]	Critically Endangered	Species or species habitat likely to occur within area
Ctenotus lancelini Lancelin Island Skink [1482]	Vulnerable	Species or species habitat known to occur within area
Ctenotus zastictus Hamelin Ctenotus [25570]	Vulnerable	Species or species habitat known to occur within area
Cyrtodactylus sadleiri Christmas Island Giant Gecko [86865]	Endangered	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Egernia stokesii badia Western Spiny-tailed Skink, Baudin Island Spiny-	Endangered	Species or species

Name	Status	Type of Presence
tailed Skink [64483]		habitat known to occur within area
Emoia nativitatis Christmas Island Forest Skink, Christmas Island Whiptail-skink [1400]	Critically Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour known to occur within area
Lepidodactylus listeri Christmas Island Gecko, Lister's Gecko [1711]	Critically Endangered	Species or species habitat known to occur within area
Lerista nevinae Nevin's Slider [85296]	Endangered	Species or species habitat known to occur within area
Liasis olivaceus barroni Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat known to occur within area
Liopholis pulchra longicauda Jurien Bay Skink, Jurien Bay Rock-skink [83162]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Ramphotyphlops exocoeti Christmas Island Blind Snake, Christmas Island Pink Blind Snake [1262]	Vulnerable	Species or species habitat likely to occur within area
Sharks		
Carcharias taurus (west coast population) Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Glyphis garricki Northern River Shark, New Guinea River Shark [82454]	Endangered	Breeding likely to occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Breeding known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Listed Migratory Species [Resource Information]

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

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Breeding known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species

Name	Threatened	Type of Presence
		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]		Species or species habitat may occur within area
Ardenna pacifica Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat 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 andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Breeding known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Breeding 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	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Onychoprion anaethetus Bridled Tern [82845]		Breeding known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		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

Name	Threatened	Type of Presence
Sterna dougallii Roseate Tern [817]		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
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	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
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat known to occur within area
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Breeding known to occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour 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	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or

Name	Threatened	Type of Presence
		related behaviour known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding 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	Foraging, feeding or related behaviour known to occur within area
Dugong dugon Dugong [28]		Breeding known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding 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	Foraging, feeding or related behaviour 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	Breeding known to occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Foraging, feeding or related behaviour known to occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Breeding known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River	Vulnerable	Species or species

Name	Threatened	Type of Presence
Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]		habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Breeding known to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Migratory Terrestrial Species		
Cecropis daurica Red-rumped Swallow [80610]		Species or species habitat known to occur within area
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat known to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat known to occur within area
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

Name	Threatened	Type of Presence
		within area
Calidris subminuta Long-toed Stint [861]		Species or species habitat 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
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Roosting known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
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
Phalaropus lobatus Red-necked Phalarope [838]		Roosting 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

Name	Threatened	Type of Presence
		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
Tringa totanus Common Redshank, Redshank [835]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

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

Name
Commonwealth Land -
Commonwealth Land - Christmas Island National Park
Defence - EXMOUTH VLF TRANSMITTER STATION
Defence - GERALDTON TRAINING DEPOT "A" Company 16th Battalion
Defence - GREENOUGH RIFLE RANGE
Defence - HMAS STIRLING-ROCKINGHAM ;HMAS STIRLING - GARDEN ISLAND
Defence - LANCELIN TRAINING AREA
Defence - LEARMONTH - AIR WEAPONS RANGE
Defence - YAMPI SOUND TRAINING AREA

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
Ashmore Reef National Nature Reserve	EXT	Listed place
Christmas Island Natural Areas	EXT	Listed place
Garden Island	WA	Listed place
Lancelin Defence Training Area	WA	Listed place
Learmonth Air Weapons Range Facility	WA	Listed place
Mermaid Reef - Rowley Shoals	WA	Listed place
Ningaloo Marine Area - Commonwealth Waters	WA	Listed place
Scott Reef and Surrounds - Commonwealth Area	EXT	Listed place
Yampi Defence Area	WA	Listed place
Historic		
Administrators House Precinct	EXT	Listed place
Bungalow 702	EXT	Listed place
Cape Leeuwin Lighthouse	WA	Listed place
Cliff Point Historic Site	WA	Listed place
Drumsite Industrial Area	EXT	Listed place
Geraldton Drill Hall Complex	WA	Listed place
HMAS Sydney II and HSK Kormoran Shipwreck Sites	EXT	Listed place
Industrial and Administrative Group	EXT	Listed place
J Gun Battery	WA	Listed place
Malay Kampong Group	EXT	Listed place
Malay Kampong Precinct	EXT	Listed place
Phosphate Hill Historic Area	EXT	Listed place
Poon Saan Group	EXT	Listed place
Settlement Christmas Island	EXT	Listed place
South Point Settlement Remains	EXT	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		
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat known to occur within area
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
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	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]		Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Catharacta skua Great Skua [59472]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Cereopsis novaehollandiae grisea Cape Barren Goose (south-western), Recherche Cape Barren Goose [25978]	Vulnerable	Species or species habitat 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
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 amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Eudyptula minor Little Penguin [1085]		Breeding known to occur within area
Fregata andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Breeding known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Breeding known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Glareola maldivarum Oriental Pratincole [840]		Roosting known to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species

Name	Threatened	Type of Presence
		habitat 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
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area
Hirundo daurica Red-rumped Swallow [59480]		Species or species habitat known to occur within area
Hirundo rustica Barn Swallow [662]		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
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	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat 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

Name	Threatened	Type of Presence
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat known to occur within area
Pelagodroma marina White-faced Storm-Petrel [1016]		Breeding known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Breeding known to occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Breeding likely to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Phalacrocorax fuscescens Black-faced Cormorant [59660]		Breeding likely to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Roosting 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
Pterodroma macroptera Great-winged Petrel [1035]		Breeding known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour 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]		Species or species habitat may occur within area
Puffinus huttoni Hutton's Shearwater [1025]		Foraging, feeding or related behaviour known to occur within area
Puffinus pacificus Wedge-tailed Shearwater [1027]		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

Name	Threatened	Type of Presence
		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 bengalensis Lesser Crested Tern [815]		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
Stiltia isabella Australian Pratincole [818]		Roosting known to occur within area
Sula dactylatra Masked Booby [1021]		Breeding known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	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
Thinornis rubricollis Hooded Plover [59510]		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

Name	Threatened	Type of Presence
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Tringa totanus Common Redshank, Redshank [835]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area
Fish		
Acentronura australe Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within area
Bhanotia fasciolata Corrugated Pipefish, Barbed Pipefish [66188]		Species or species habitat may occur within area
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area
Campichthys galei Gale's Pipefish [66191]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		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
Choeroichthys latispinosus Muiron Island Pipefish [66196]		Species or species habitat may occur within area
Choeroichthys sculptus Sculptured Pipefish [66197]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		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 schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Cosmocampus maxweberi Maxweber's Pipefish [66209]		Species or species habitat may occur within area
Doryrhamphus baldwini Redstripe Pipefish [66718]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		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
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Doryrhamphus multiannulatus Many-banded Pipefish [66717]		Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish [66216]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		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 macrorhynchus Whiskered Pipefish, Ornate Pipefish [66222]		Species or species habitat may occur within area
Halicampus mataafae Samoan Pipefish [66223]		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
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		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

Name	Threatened	Type of Presence
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
Hippichthys spicifer Belly-barred Pipefish, Banded Freshwater Pipefish [66232]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		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 histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Hippocampus subelongatus West Australian Seahorse [66722]		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
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		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 fatiloquus Prophet's Pipefish [66250]		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

Name	Threatened	Type of Presence
Micrognathus brevirostris thorntail Pipefish, Thorn-tailed Pipefish [66254]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Mitotichthys meraculus Western Crested Pipefish [66259]		Species or species habitat may occur within area
Nannocampus subosseus Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phoxocampus belcheri Black Rock Pipefish [66719]		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 hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		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
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
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
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		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
Dugong dugon Dugong [28]		Breeding known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Breeding known to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to 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 foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus fuscus Dusky Seasnake [1119]		Species or species habitat known to occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Aipysurus pooleorum Shark Bay Seasnake [66061]		Species or species habitat may occur within area
Aipysurus tenuis Brown-lined Seasnake [1121]		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	Breeding known to occur within area
Crocodylus johnstoni Freshwater Crocodile, Johnston's Crocodile, Johnston's River Crocodile [1773]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
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	Foraging, feeding or related behaviour 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
Enhydrina schistosa Beaked Seasnake [1126]		Species or species habitat may occur within area
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Hydrelaps darwiniensis Black-ringed Seasnake [1100]		Species or species habitat may occur within area
Hydrophis atriceps Black-headed Seasnake [1101]		Species or species habitat may occur within area
Hydrophis coggeri Slender-necked Seasnake [25925]		Species or species habitat may occur within area
Hydrophis czeblukovi Fine-spined Seasnake [59233]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis inornatus Plain Seasnake [1107]		Species or species habitat may occur within area
Hydrophis mcdowelli null [25926]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Lapemis hardwickii Spine-bellied Seasnake [1113]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur

Name	Threatened	Type of Presence
		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	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Berardius arnuxii Arnoux's Beaked Whale [70]		Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
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
Indopacetus pacificus Longman's Beaked Whale [72]		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
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		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 habitat may occur within area
Orcaella brevirostris Irrawaddy Dolphin [45]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Foraging, feeding or related behaviour known to 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

Name	Status	Type of Presence
		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 aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known 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

Commonwealth ReservesTerrestrial [Resource Information]

Name	State	Type
Christmas Island	EXT	National Park (Commonwealth)

Australian Marine Parks [Resource Information]

Name	Label
Abrolhos	Habitat Protection Zone (IUCN IV)
Abrolhos	Multiple Use Zone (IUCN VI)
Abrolhos	National Park Zone (IUCN II)
Abrolhos	Special Purpose Zone (IUCN VI)
Argo-Rowley Terrace	Multiple Use Zone (IUCN VI)
Argo-Rowley Terrace	National Park Zone (IUCN II)
Argo-Rowley Terrace	Special Purpose Zone (Trawl) (IUCN VI)
Ashmore Reef	Recreational Use Zone (IUCN IV)
Ashmore Reef	Sanctuary Zone (IUCN Ia)
Bremer	National Park Zone (IUCN II)
Bremer	Special Purpose Zone (Mining
Carnarvon Canyon	Habitat Protection Zone (IUCN IV)
Cartier Island	Sanctuary Zone (IUCN Ia)
Dampier	Habitat Protection Zone (IUCN IV)
Dampier	Multiple Use Zone (IUCN VI)
Dampier	National Park Zone (IUCN II)
Eighty Mile Beach	Multiple Use Zone (IUCN VI)
Gascoyne	Habitat Protection Zone (IUCN IV)
Gascoyne	Multiple Use Zone (IUCN VI)
Gascoyne	National Park Zone (IUCN II)
Geographe	Habitat Protection Zone (IUCN IV)
Geographe	Multiple Use Zone (IUCN VI)
Geographe	Special Purpose Zone (Mining
Jurien	National Park Zone (IUCN II)

Name	Label
Jurien	Special Purpose Zone (IUCN VI)
Kimberley	Habitat Protection Zone (IUCN IV)
Kimberley	Multiple Use Zone (IUCN VI)
Kimberley	National Park Zone (IUCN II)
Mermaid Reef	National Park Zone (IUCN II)
Montebello	Multiple Use Zone (IUCN VI)
Ningaloo	National Park Zone (IUCN II)
Ningaloo	Recreational Use Zone (IUCN IV)
Oceanic Shoals	Multiple Use Zone (IUCN VI)
Perth Canyon	Habitat Protection Zone (IUCN IV)
Perth Canyon	Multiple Use Zone (IUCN VI)
Perth Canyon	National Park Zone (IUCN II)
Roebuck	Multiple Use Zone (IUCN VI)
Shark Bay	Multiple Use Zone (IUCN VI)
South-west Corner	Habitat Protection Zone (IUCN IV)
South-west Corner	Multiple Use Zone (IUCN VI)
South-west Corner	National Park Zone (IUCN II)
South-west Corner	Special Purpose Zone (IUCN VI)
South-west Corner	Special Purpose Zone (Mining
Two Rocks	Multiple Use Zone (IUCN VI)
Two Rocks	National Park Zone (IUCN II)

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Adele Island	WA
Airlie Island	WA
Arpenteur	WA
Bald Island	WA
Bardi Jawi	WA
Barrow Island	WA
Bedout Island	WA
Beekeepers	WA
Bernier And Dorre Islands	WA
Bessieres Island	WA
Boodie, Double Middle Islands	WA
Boullanger, Whitlock, Favourite, Tern And Osprey Islands	WA
Breaksea Island	WA
Browse Island	WA
Burnside And Simpson Island	WA
Cape Range	WA
Carnac Island	WA
Chatham Island	WA
Coulomb Point	WA
D'Entrecasteaux	WA
Dambimangari	WA
Dambimangari	WA
Dirk Hartog Island	WA
Doubtful Islands	WA
Eclipse Island	WA
Escape Island	WA
Fitzgerald River	WA
Flinders Bay	WA
Freycinet, Double Islands etc	WA
Glasse Island	WA
Gnandaroo Island	WA
Hamelin Island	WA
Jarrkunpungu	WA
Jinmarnkur	WA
Jinmarnkur Kulja	WA
Jurabi Coastal Park	WA
Kalbarri	WA
Karajarri	WA
Koks Island	WA
Kujungurru Warrarn	WA

Name	State
Lacepede Islands	WA
Lancelin And Edwards Islands	WA
Leeuwin-Naturaliste	WA
Lesueur	WA
Little Rocky Island	WA
Locker Island	WA
Low Rocks	WA
Lowendal Islands	WA
Michaelmas Island	WA
Montebello Islands	WA
Mount Manypeaks	WA
Muiron Islands	WA
Murujuga	WA
NTWA Bushland covenant (0005)	WA
NTWA Bushland covenant (0013)	WA
NTWA Bushland covenant (0090)	WA
Nambung	WA
Nilgen	WA
North Sandy Island	WA
North Turtle Island	WA
Nyangumarta Warrarn	WA
One Tree Point	WA
Prince Regent	WA
Quagering	WA
Quarram	WA
Rottnest Island	WA
Round Island	WA
Scott	WA
Seal Island (WA25645)	WA
Seal Island (WA32199)	WA
Serrurier Island	WA
Southern Beekeepers	WA
St Alouarn Island	WA
Sugar Loaf Rock	WA
Swan Island	WA
Tamala Pastoral Lease (Part)	WA
Tanner Island	WA
Tent Island	WA
Torndirrup	WA
Two Peoples Bay	WA
Unnamed WA11883	WA
Unnamed WA11962	WA
Unnamed WA15185	WA
Unnamed WA26400	WA
Unnamed WA28968	WA
Unnamed WA32478	WA
Unnamed WA33799	WA
Unnamed WA34039	WA
Unnamed WA36907	WA
Unnamed WA36909	WA
Unnamed WA36910	WA
Unnamed WA36913	WA
Unnamed WA36915	WA
Unnamed WA37168	WA
Unnamed WA37338	WA
Unnamed WA37383	WA
Unnamed WA37500	WA
Unnamed WA40322	WA
Unnamed WA40828	WA
Unnamed WA40877	WA
Unnamed WA41080	WA
Unnamed WA41775	WA
Unnamed WA42030	WA
Unnamed WA44665	WA
Unnamed WA44667	WA
Unnamed WA44669	WA

Name	State
Unnamed WA44672	WA
Unnamed WA44673	WA
Unnamed WA44676	WA
Unnamed WA44682	WA
Unnamed WA44685	WA
Unnamed WA44688	WA
Unnamed WA44690	WA
Unnamed WA44709	WA
Unnamed WA46982	WA
Unnamed WA46983	WA
Unnamed WA46984	WA
Unnamed WA48205	WA
Unnamed WA48858	WA
Unnamed WA48968	WA
Unnamed WA49994	WA
Unnamed WA51105	WA
Unnamed WA51162	WA
Unnamed WA51617	WA
Unnamed WA51932	WA
Unnamed WA53015	WA
Utcha Well	WA
Uunguu	WA
Victor Island	WA
Walpole-Nornalup	WA
Wanagarren	WA
Waychinicup	WA
Wedge Island	WA
Weld Island	WA
West Cape Howe	WA
Y Island	WA
Yalgorup	WA
Yampi	WA
Yawuru	WA
Zuytdorp	WA

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
South West WA RFA	Western Australia

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
Anas platyrhynchos		
Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis		
European Goldfinch [403]		Species or species habitat likely to occur within area
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

Name	Status	Type of Presence
Lonchura oryzivora Java Sparrow [59586]		Species or species habitat likely to occur within area
Meleagris gallopavo Wild Turkey [64380]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Pavo cristatus Indian Peafowl, Peacock [919]		Species or species habitat likely to occur within area
Phasianus colchicus Common Pheasant [920]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		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
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Camelus dromedarius Dromedary, Camel [7]		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 asinus Donkey, Ass [4]		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

Name	Status	Type of Presence
		within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Funambulus pennantii Northern Palm Squirrel, Five-striped Palm Squirrel [129]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus 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		
Andropogon gayanus Gamba Grass [66895]		Species or species habitat likely to occur within area
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Asparagus declinatus Bridal Veil, Bridal Veil Creeper, Pale Berry Asparagus Fern, Asparagus Fern, South African Creeper [66908]		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
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur

Name	Status	Type of Presence
		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
Cylindropuntia spp.		
Prickly Pears [85131]		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
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
Jatropha gossypifolia		
Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		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
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
Parkinsonia aculeata		
Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		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
Prosopis spp.		
Mesquite, Algaroba [68407]		Species or species habitat likely to occur within area
Rubus fruticosus aggregate		
Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii		
Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta		
Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Tamarix aphylla		
Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering		Species or species habitat likely to occur

Name	Status	Type of Presence
Cypress, Salt Cedar [16018]		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
Lycodon aulicus Wolf Snake, Common Wolf Snake, Asian Wolf Snake [83178]		Species or species habitat likely to occur within area
Lygosoma bowringii Christmas Island Grass-skink [1312]		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
"The Dales", Christmas Island	EXT
Ashmore Reef	EXT
Cape Leeuwin System	WA
Cape Range Subterranean Waterways	WA
Doggerup Creek System	WA
Eighty Mile Beach System	WA
Exmouth Gulf East	WA
Hosine's Spring, Christmas Island	EXT
Hutt Lagoon System	WA
Lake MacLeod	WA
Lake Thetis	WA
Learmonth Air Weapons Range - Saline Coastal Flats	WA
Leslie (Port Hedland) Saltfields System	WA
Mermaid Reef	EXT
Prince Regent River System	WA
Roebuck Bay	WA
Rottnest Island Lakes	WA
Shark Bay East	WA
Yalgorup Lakes System	WA

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
Ancient coastline at 125 m depth contour	North-west
Ashmore Reef and Cartier Island and surrounding	North-west
Canyons linking the Argo Abyssal Plain with the	North-west
Canyons linking the Cuvier Abyssal Plain and the	North-west
Carbonate bank and terrace system of the Sahul	North-west
Commonwealth waters adjacent to Ningaloo Reef	North-west
Continental Slope Demersal Fish Communities	North-west
Exmouth Plateau	North-west
Glomar Shoals	North-west
Mermaid Reef and Commonwealth waters	North-west
Pinnacles of the Bonaparte Basin	North-west
Seringapatam Reef and Commonwealth waters in	North-west
Wallaby Saddle	North-west
Albany Canyons group and adjacent shelf break	South-west
Ancient coastline at 90-120m depth	South-west
Cape Mentelle upwelling	South-west
Commonwealth marine environment surrounding	South-west

Name	Region
Commonwealth marine environment within and	South-west
Commonwealth marine environment within and	South-west
Diamantina Fracture Zone	South-west
Naturaliste Plateau	South-west
Perth Canyon and adjacent shelf break, and other	South-west
Western demersal slope and associated fish	South-west
Western rock lobster	South-west

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

-9.178 123.297452,-9.727655 123.186807,-10.039286 121.994911,-9.610169 121.577399,-9.773757 121.205608,-9.285968 119.959365,-9.369249 119.171169,-9.547708 118.915377,-9.726168 119.093836,-9.828816 119.685285,-10.463801 120.250849,-9.758885 121.63986,-10.660106 121.526835,-10.612517 121.916472,-10.115162 122.152333,-10.371597 123.091331,-10.788002 122.799847,-10.90995 122.835539,-10.921847 123.106202,-10.461818 123.784349,-10.366639 126.663497,-13.579298 128.763491,-14.253489 128.287479,-13.700264 127.326771,-13.774622 126.737855,-14.479538 125.217974,-15.169581 125.051412,-15.496699 124.4434,-15.829882 124.414906,-16.12434 124.602289,-16.341466 124.209677,-16.1063 123.6265,-16.650796 123.549377,-16.900639 123.86763,-17.14156 123.828964,-17.028535 123.585069,-17.195098 123.644555,-17.563914 123.567223,-16.668642 123.016973,-16.389055 122.990204,-16.549669 122.793898,-16.769769 122.820667,-16.915511 122.481594,-17.153454 122.277908,-17.47171 122.148469,-17.983294 122.202007,-17.986268 122.371544,-18.117139 122.362621,-18.44134 121.952164,-18.453238 121.818319,-18.944002 121.589296,-19.34851 121.33053,-19.610251 121.024174,-19.858977 120.337626,-19.96717 119.780906,-20.071271 119.596497,-19.96717 119.129528,-20.283799 118.7463,-20.350858 118.171795,-20.669111 117.764312,-20.743469 117.410368,-20.701828 117.208113,-20.615573 117.160524,-20.734546 116.901758,-20.669111 116.791708,-20.410344 116.880938,-20.710751 116.663812,-20.871365 116.312841,-20.850545 116.205765,-20.963569 116.170074,-21.079568 115.902384,-21.237207 115.825052,-21.879662 114.635321,-22.10571 114.516348,-22.138152 114.085576,-21.812128 114.189649,-21.793406 114.09102,-21.942122 113.954201,-22.278221 113.835227,-22.560782 113.659742,-23.024777 113.835227,-23.494721 113.772767,-23.628565 113.609179,-24.223431 113.400976,-24.4703 113.40395,-24.752861 113.629999,-25.032447 113.67164,-25.701671 113.326618,-26.614789 113.7341,-26.654997 113.678699,-26.144845 113.433693,-26.141871 113.151132,-26.421458 113.317695,-26.647507 113.567538,-27.054989 113.856048,-27.513035 114.105891,-28.067424 114.163805,-28.497537 114.519322,-29.131069 114.837575,-29.574244 114.968446,-30.567669 115.090393,-31.739553 115.726899,-32.887643 115.628746,-33.655019 115.209366,-33.530097 115.004138,-33.964349 114.974394,-34.26773 115.042804,-34.35696 115.161777,-34.270705 115.140957,-34.306397 115.212341,-34.333166 115.393774,-34.526497 115.717976,-35.011312 116.283098,-35.088644 117.921952,-34.383729 119.471576,-34.258807 119.528088,-34.276653 119.724393,-34.530152 119.736291,-35.393778 118.181763,-35.946499 116.558145,-35.946499 114.174535,-35.048328 110.478213,-26.515697 101.220136,-20.228495 100.943775,-14.976211 104.641889,-9.532837 101.579516,-7.998084 106.619215,-8.309853 111.745828,-8.771169 114.570899,-8.438285 114.816755,-8.521566 114.998189,-8.694077 115.126085,-8.827921 115.584131,-8.408541 115.706079,-8.004033 115.759617,-7.99511 115.991614,-8.753563 116.065972,-8.747615 115.839923,-8.783306 115.822077,-8.875511 115.985665,-9.110482 117.053448,-8.884434 118.439484,-8.741666 119.12358,-8.509668 119.349628,-8.804127 119.858238,-9.178 123.297452

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-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

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

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Appendix B: MNES Register

Table B-1: MNES Review Register

Taxon	2019 Version (Rev6 19/03/2020)	2020 Review (Rev 7 30/11/2020)	Reason for Change	Sections Updated within this Document
Threatened Species				
Birds	Not listed	Addition of Grey Falcon (*Falco hypoleucos*) listed as Vulnerable species	Was newly listed as Vulnerable under EPBC Act 9 July 2020	No change required as species is not expected to occur in significant numbers in marine and coastal environments in the EMBA due to their terrestrial distribution
Birds	Shy Albatross (*Thalassarche cauta cauta*)	Shy Albatross (*Thalassarche cauta*)	Upgraded from subspecies to species	Table 8-1, Section 8.2
Birds	White-capped Albatross (*Thalassarche cauta steadi*)	White-capped Albatross (*Thalassarche steadi*)	Upgraded from subspecies to species	Table 8-1, Section 8.2
Birds	Shy Albatross (Thalassarche cauta) listed as Vulnerable	Shy Albatross (*Thalassarche cauta*) now listed as Endangered	Upgraded to Endangered under EPBC Act 3 July 2020	Table 8-1, Section 8.2
Birds	Conservation advice for Christmas Island Frigatebird (2016)	Updated conservation advice for Christmas Island Frigatebird (2020)	New published conservation advice	Section 8.2, Table 8.6, Table 13.1
Birds	Conservation advice for Australasian Bittern (2011)	Updated conservation advice for Australasian Bittern (2019)	New published conservation advice	Section 8.2, Table 8.6, Table 13.1
Birds	Conservation advice for Abbott's Booby (2015)	Updated conservation advice for Abbott's Booby (2020)	New published conservation advice	Section 8.2, Table 8.6, Table 13.1
Birds	No conservation advice for Shy Albatross	New conservation advice for Shy Albatross (2020)	New published conservation advice	Section 8.2, Table 8.6, Table 13.1
Plants	*Darwinia oxylepis*	Not listed	Species or species habitat considered not to occur within area	No change required as it is a plant species not expected to occur in marine and coastal environments in the EMBA due to their terrestrial distribution
Plants	*Darwinia wittwerorum*	Not listed	Species or species habitat considered not to occur within area	No change required as it is a plant species not expected to occur in marine and coastal environments in the EMBA due to their terrestrial distribution

Taxon	2019 Version (Rev6 19/03/2020)	2020 Review (Rev 7 30/11/2020)	Reason for Change	Sections Updated within this Document
Plants	*Daviesia obovata*	Not listed	Species or species habitat considered not to occur within area	No change required as it is a plant species not expected to occur in marine and coastal environments in the EMBA due to their terrestrial distribution
Plants	*Keraudrenia exastia*	*Seringia exastia*	Genus name change	No change required as it is a plant species not expected to occur in marine and coastal environments in the EMBA due to their terrestrial distribution
Plants	*Lepidosperma rostratum*	Not listed	Species or species habitat considered not to occur within area	No change required as it is a plant species not expected to occur in marine and coastal environments in the EMBA due to their terrestrial distribution
Migratory Species				
Sharks	Not listed	Addition of oceanic whitetip shark (*Carcharhinus longimanus*) listed as Migratory Marine species	Amendment to list of migratory species under EPBC Act 21 October 2020	Table 5-5-1, Section 5.3, Section 5.3.9
Other Specially Protected Species under WA *Biodiversity Conservation Act 2016*				
Birds	Greater sand plover (*Charadrius leschenaultii*) listed as specially protected under BC Act 2016	Greater sand plover (*Charadrius leschenaultii*) listed as Vulnerable under BC Act 2016	Listing upgraded to be consistent with EPBC Act listing	Table 8-1
National Reserves				
Coastal National Park	Not included	Addition of Houtman Abrolhos Islands National Park	Houtman Abrolhos Islands National Park was created in July 2019	Table 9-2
Biologically Important Areas (BIAs)				
Various	National Conservation Values Atlas	Spatial data layers were last updated in 2016	No change	No change
Threatened Ecological COmmunities				
TEC	Lake Clifton included in Wetlands of National Importance and Ramsar wetland but the associated TEC was not listed	Addition of Thrombolite (microbialite) Community of a Coastal Brackish Lake (Lake Clifton)	This TEC is associated with the wetland system listed as a Nationally Important Wetland and Ramsar wetland and may be	Section 9.7.4

Taxon	2019 Version (Rev6 19/03/2020)	2020 Review (Rev 7 30/11/2020)	Reason for Change	Sections Updated within this Document
			influence from inflows from a potential hydrocarbon spill	

Appendix D – EPBC PMST Reports

Australian Government
Department of Agriculture, Water and the Environment

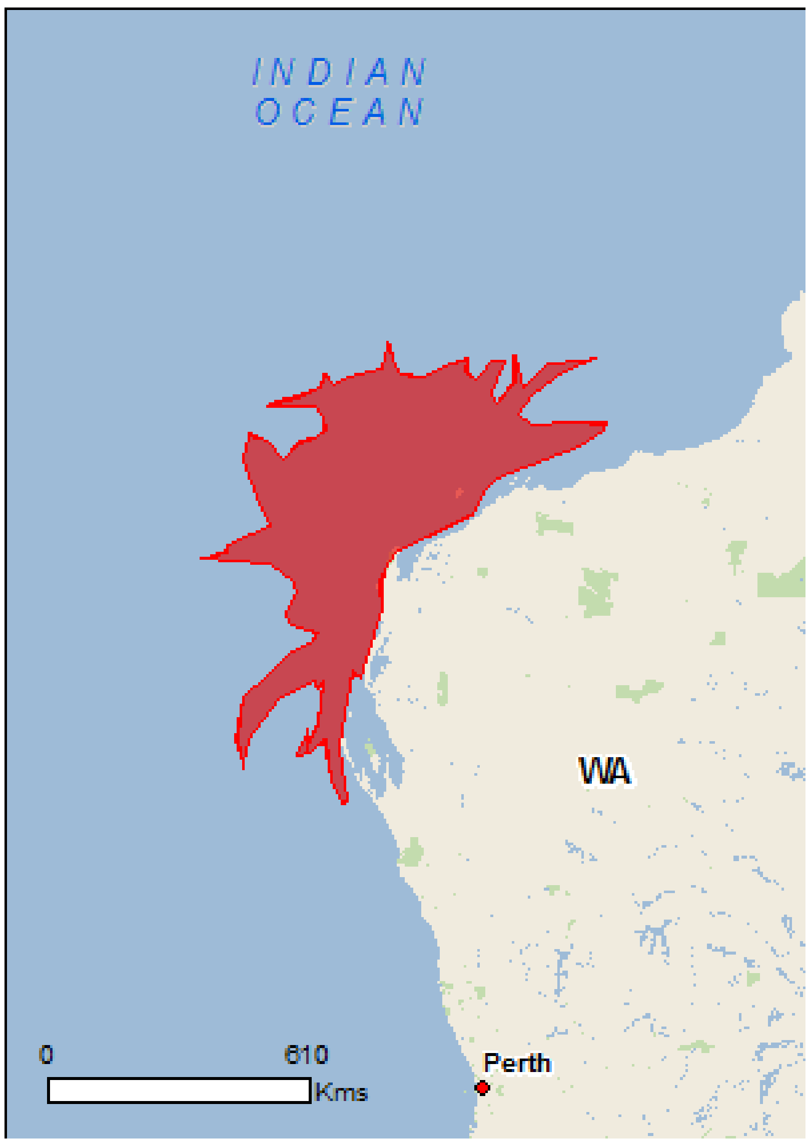
EPBC Act Protected Matters Report

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: 01/10/21 17:07:02



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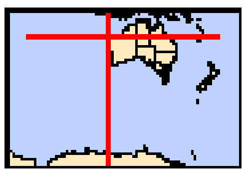

Summary

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:	2
National Heritage Places:	2
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	52
Listed Migratory Species:	65

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	5
Commonwealth Heritage Places:	2
Listed Marine Species:	116
Whales and Other Cetaceans:	32
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	7

Extra Information

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

State and Territory Reserves:	18
Regional Forest Agreements:	None
Invasive Species:	11
Nationally Important Wetlands:	3
Key Ecological Features (Marine)	7

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Status
Shark Bay, Western Australia	WA	Declared property
The Ningaloo Coast	WA	Declared property

National Heritage Properties [Resource Information]

Name	State	Status
Natural		
Shark Bay, Western Australia	WA	Listed place
The Ningaloo Coast	WA	Listed place

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
North-west
South-west

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may 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
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat may occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat may occur within area

Name	Status	Type of Presence
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432]	Critically Endangered	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Malurus leucopterus edouardi White-winged Fairy-wren (Barrow Island), Barrow Island Black-and-white Fairy-wren [26194]	Vulnerable	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	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		
Milyeringa veritas Blind Gudgeon [66676]	Vulnerable	Species or species habitat known to occur within area

Name	Status	Type of Presence
Ophisternon candidum		
Blind Cave Eel [66678]	Vulnerable	Species or species habitat known 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	Migration route known to occur within area
Balaenoptera physalus		
Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Bettongia lesueur Barrow and Boodie Islands subspecies		
Boodie, Burrowing Bettong (Barrow and Boodie Islands) [88021]	Vulnerable	Species or species habitat known to occur within area
Dasyurus hallucatus		
Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat may occur within area
Eubalaena australis		
Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Isoodon auratus barrowensis		
Golden Bandicoot (Barrow Island) [66666]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes conspicillatus conspicillatus		
Spectacled Hare-wallaby (Barrow Island) [66661]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes hirsutus Central Australian subspecies		
Mala, Rufous Hare-Wallaby (Central Australia) [88019]	Endangered	Translocated population known to occur within area
Megaptera novaeangliae		
Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Osphranter robustus isabellinus		
Barrow Island Wallaroo, Barrow Island Euro [89262]	Vulnerable	Species or species habitat likely to occur within area
Petrogale lateralis lateralis		
Black-flanked Rock-wallaby, Moororong, Black-footed Rock Wallaby [66647]	Endangered	Species or species habitat known to occur within area
Rhinonicteris aurantia (Pilbara form)		
Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat known to occur within area
Other		
Kumonga exleyi		
Cape Range Remipede [86875]	Vulnerable	Species or species habitat known to occur within area
Reptiles		
Aipysurus apraefrontalis		
Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus foliosquama		
Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area

Name	Status	Type of Presence
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Ctenotus zastictus		
Hamelin Ctenotus [25570]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Eretmochelys imbricata		
Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Sharks		
Carcharias taurus (west coast population)		
Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Pristis clavata		
Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron		
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Listed Migratory Species [Resource Information]

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

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus		
Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes		
Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna pacifica		
Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Calonectris leucomelas		
Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Diomedea amsterdamensis		
Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea exulans		
Wandering Albatross [89223]	Vulnerable	Species or species habitat may occur within area
Fregata ariel		
Lesser Frigatebird, Least Frigatebird [1012]		Species or species

Name	Threatened	Type of Presence
		habitat known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Onychoprion anaethetus Bridled Tern [82845]		Breeding known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Foraging, feeding or related behaviour likely to occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	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
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat known to occur within area
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat likely 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	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or

Name	Threatened	Type of Presence
		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	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Dugong dugon Dugong [28]		Breeding known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding 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
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may 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	Breeding known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Name	Threatened	Type of Presence
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat known to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Migratory Terrestrial Species		
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Limnodromus semipalmatus Asian Dowitcher [843]		Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Thalasseus bergii Greater Crested Tern [83000]		Breeding known to occur within area

Name	Threatened	Type of Presence
Tringa nebularia		
Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

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

Name
Commonwealth Land -
Defence - EXMOUTH ADMIN & HF TRANSMITTING
Defence - EXMOUTH VLF TRANSMITTER STATION
Defence - LEARMONTH - AIR WEAPONS RANGE
Defence - LEARMONTH RADAR SITE - VLAMING HEAD EXMOUTH

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
Learmonth Air Weapons Range Facility	WA	Listed place
Ningaloo Marine Area - Commonwealth Waters	WA	Listed place

Listed Marine Species [Resource Information]

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

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus		
Common Noddy [825]		Species or species habitat likely to occur within area
Anous tenuirostris melanops		
Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata		
Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus		
Red Knot, Knot [855]	Endangered	Species or species

Name	Threatened	Type of Presence
		habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat may 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 may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may 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
Limnodromus semipalmatus Asian Dowitcher [843]		Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Foraging, feeding or related behaviour likely to occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus pacificus Wedge-tailed Shearwater [1027]		Breeding known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Sterna anaethetus Bridled Tern [814]		Breeding known to occur within area
Sterna bengalensis Lesser Crested Tern [815]		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

Name	Threatened	Type of Presence
Sterna nereis Fairy Tern [796]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	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
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area
Fish		
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within area
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area
Campichthys galei Gale's Pipefish [66191]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		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
Choeroichthys latispinosus Muiron Island Pipefish [66196]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		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
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		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

Name	Threatened	Type of Presence
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Doryrhamphus multiannulatus Many-banded Pipefish [66717]		Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish [66216]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		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
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		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 angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		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
Lissocampus fatiloquus Prophet's Pipefish [66250]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Nannocampus subosseus Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species habitat may occur within area
Phoxocampus belcheri Black Rock Pipefish [66719]		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 lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		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
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		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
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Breeding known to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to 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 foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Aipysurus pooleorum Shark Bay Seasnake [66061]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Aipysurus tenuis Brown-lined Seasnake [1121]		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	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour 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
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Hydrelaps darwiniensis Black-ringed Seasnake [1100]		Species or species habitat may occur within area
Hydrophis czeblukovi Fine-spined Seasnake [59233]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis mcdowelli null [25926]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding 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

Name	Status	Type of Presence
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	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	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 likely to occur within area
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
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Indopacetus pacificus Longman's Beaked Whale [72]		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
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to 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
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within

Name	Status	Type of Presence
		area
Peponocephala electra Melon-headed Whale [47]		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]		Species or species habitat 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
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks [Resource Information]

Name	Label
Gascoyne	Habitat Protection Zone (IUCN IV)
Gascoyne	Multiple Use Zone (IUCN VI)
Gascoyne	National Park Zone (IUCN II)
Montebello	Multiple Use Zone (IUCN VI)
Ningaloo	National Park Zone (IUCN II)
Ningaloo	Recreational Use Zone (IUCN IV)
Shark Bay	Multiple Use Zone (IUCN VI)

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Airlie Island	WA
Barrow Island	WA
Bessieres Island	WA
Boodie, Double Middle Islands	WA
Bundegi Coastal Park	WA
Cape Range	WA
Jurabi Coastal Park	WA
Lowendal Islands	WA
Montebello Islands	WA
Muiron Islands	WA
North Sandy Island	WA
Round Island	WA
Serrurier Island	WA
Unnamed WA40322	WA
Unnamed WA40828	WA
Unnamed WA41080	WA
Unnamed WA44665	WA
Unnamed WA44667	WA

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		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Mammals		
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
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 rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Plants		
Cenchrus ciliaris		
Buffel-grass, Black Buffel-grass [20213]		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

Nationally Important Wetlands [Resource Information]

Name	State
Bundera Sinkhole	WA
Cape Range Subterranean Waterways	WA
Learmonth Air Weapons Range - Saline Coastal Flats	WA

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
Ancient coastline at 125 m depth contour	North-west
Canyons linking the Cuvier Abyssal Plain and the	North-west
Commonwealth waters adjacent to Ningaloo Reef	North-west
Continental Slope Demersal Fish Communities	North-west
Exmouth Plateau	North-west
Glomar Shoals	North-west
Western demersal slope and associated fish	South-west

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

-18.48333 114.675855,-18.198988 115.221078,-18.121578 115.540239,-18.366499 115.520506,-18.505818 115.749478,-18.372612 115.893036,-18.170093 116.062011,-18.134944 116.326637,-18.810998 116.061872,-18.99876 116.166957,-18.582977 116.541496,-18.068972 116.536088,-18.692401 116.727373,-18.220025 117.244119,-18.14196 118.030891,-18.082345 118.266654,-18.367126 117.559711,-18.790037 116.971652,-19.19148 116.631199,-19.415306 116.916587,-19.358093 117.741969,-19.396824 118.458395,-19.525643 118.427482,-19.853477 117.881417,-20.123102 117.181082,-20.463637 116.149081,-20.68016 115.93861,-21.175632 115.666248,-21.621022 114.723893,-21.892749 114.070067,-22.124938 113.881832,-22.528983 113.73224,-23.030017 113.754634,-23.850634 113.471578,-24.373689 113.298183,-24.225715 113.156793,-24.776336 113.010753,-25.688425 112.853332,-26.668895 113.033786,-26.730636 112.944734,-26.262023 112.696469,-25.508826 112.557628,-25.760289 112.269049,-25.823654 111.987412,-25.39322 112.200514,-25.659528 112.186684,-25.235823 112.417164,-24.41384 112.532338,-24.552775 112.417399,-24.401972 112.334651,-24.758771 111.577812,-25.547326 110.936375,-25.959682 110.858258,-25.533331 110.713696,-24.720675 110.848096,-24.326633 111.34485,-23.887976 111.820576,-23.649286 112.304249,-23.487828 112.397435,-23.336102 111.877275,-23.118417 111.747136,-22.724995 111.955131,-22.495273 111.933512,-22.125237 111.393265,-22.084487 110.629614,-22.023633 110.073265,-21.912993 110.53654,-21.802118 110.532586,-21.588432 111.020983,-21.41346 111.422188,-20.822835 111.136923,-20.105728 110.855905,-19.873131 110.919186,-19.60745 110.942344,-19.722764 111.326211,-20.120914 111.696237,-19.767906 112.00753,-19.676292 112.3666,-19.51593 112.565604,-19.277895 112.544328,-19.04024 112.348624,-19.062296 111.525946,-19.025813 111.405463,-18.817131 112.154589,-18.697862 112.497871,-18.441714 112.564488,-18.652666 112.772318,-18.462126 113.014582,-18.436764 113.324765,-18.294393 113.754565,-17.83039 113.898889,-18.097247 114.004359,-18.41837 114.169099,-18.48333 114.675855

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- -Office of Environment and Heritage, New South Wales
- -Department of Environment and Primary Industries, Victoria
- -Department of Primary Industries, Parks, Water and Environment, Tasmania
- -Department of Environment, Water and Natural Resources, South Australia
- -Department of Land and Resource Management, Northern Territory
- -Department of Environmental and Heritage Protection, Queensland
- -Department of Parks and Wildlife, Western Australia
- -Environment and Planning Directorate, ACT
- -Birdlife Australia
- -Australian Bird and Bat Banding Scheme
- -Australian National Wildlife Collection
- -Natural history museums of Australia
- -Museum Victoria
- -Australian Museum
- -South Australian Museum
- -Queensland Museum
- -Online Zoological Collections of Australian Museums
- -Queensland Herbarium
- -National Herbarium of NSW
- -Royal Botanic Gardens and National Herbarium of Victoria
- -Tasmanian Herbarium
- -State Herbarium of South Australia
- -Northern Territory Herbarium
- -Western Australian Herbarium
- -Australian National Herbarium, Canberra
- -University of New England
- -Ocean Biogeographic Information System
- -Australian Government, Department of Defence
- Forestry Corporation, NSW
- -Geoscience Australia
- -CSIRO
- -Australian Tropical Herbarium, Cairns
- -eBird Australia
- -Australian Government – Australian Antarctic Data Centre
- -Museum and Art Gallery of the Northern Territory
- -Australian Government National Environmental Science Program
- -Australian Institute of Marine Science
- -Reef Life Survey Australia
- -American Museum of Natural History
- -Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
- -Tasmanian Museum and Art Gallery, Hobart, Tasmania
- -Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

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

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Department of Agriculture, Water and the Environment

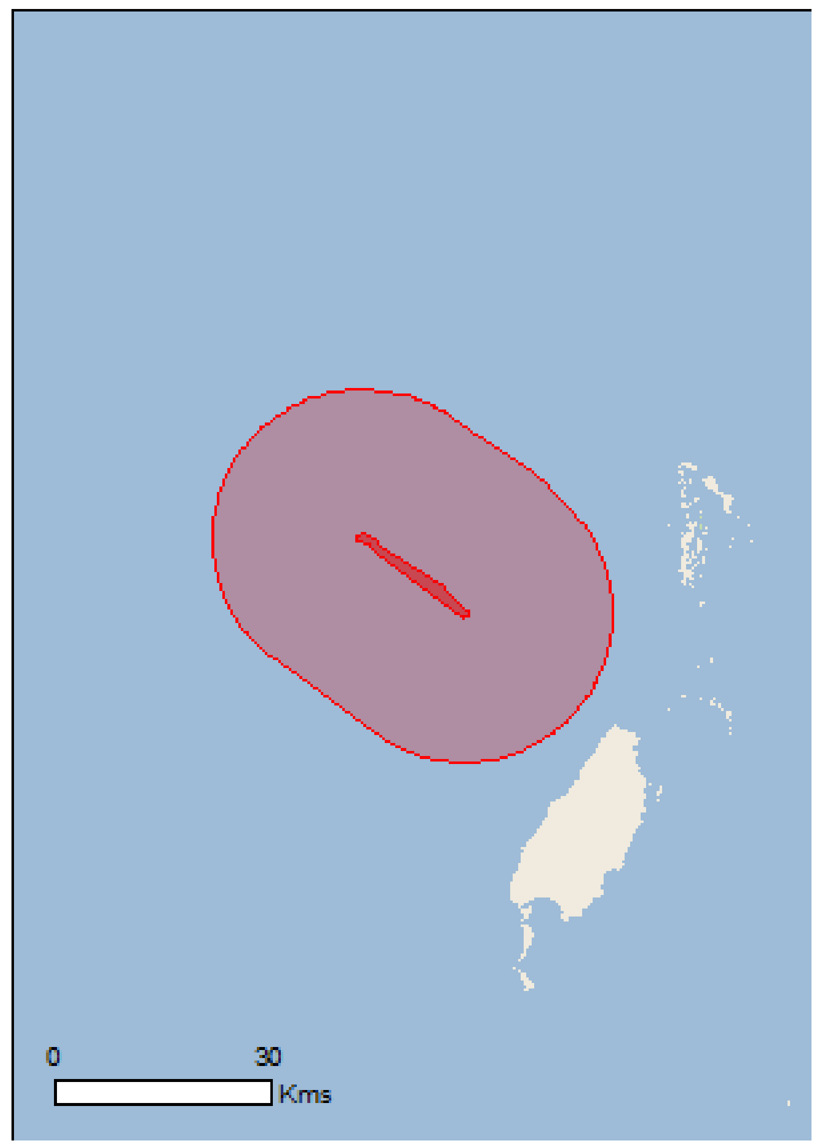
EPBC Act Protected Matters Report

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.

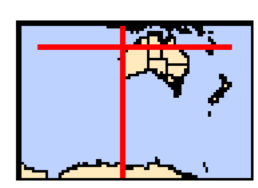
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 01/10/21 17:30:32



Coordinates

Buffer: 20.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	22
Listed Migratory Species:	38

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	67
Whales and Other Cetaceans:	27
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	1

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
North-west

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
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	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
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Breeding known to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	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	Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Reptiles		
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
Aipysurus foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Congregation or aggregation known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Congregation or aggregation known to 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	Congregation or aggregation known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area
Sharks		
Carcharias taurus (west coast population) Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Listed Migratory Species [Resource Information]

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

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		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
Sterna dougallii Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat 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	Species or species habitat 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	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Congregation or aggregation known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Congregation or aggregation known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Dugong dugon Dugong [28]		Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Congregation or aggregation 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
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

Name	Threatened	Type of Presence
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat may occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
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
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		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
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
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Species or species habitat may occur within area
Sterna bengalensis Lesser Crested Tern [815]		Breeding known to occur within area
Sterna dougallii Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area
Fish		
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		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
Choeroichthys latispinosus Muiron Island Pipefish [66196]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Doryrhamphus multiannulatus Many-banded Pipefish [66717]		Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish [66216]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		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
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		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 angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		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
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Phoxocampus belcheri Black Rock Pipefish [66719]		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 lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		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
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
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Species or species habitat known to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to 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 foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur

Name	Threatened	Type of Presence
		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	Congregation or aggregation known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Congregation or aggregation known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely 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
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Congregation or aggregation known to occur within area
Hydrophis czeblukovi Fine-spined Seasnake [59233]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Congregation or aggregation 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 borealis Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area

Name	Status	Type of Presence
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	Species or species habitat likely to occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
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
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
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		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]		Species or species habitat may 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

Name	Status	Type of Presence
		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
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks [Resource Information]

Name	Label
Montebello	Multiple Use Zone (IUCN VI)

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
Ancient coastline at 125 m depth contour	North-west

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

-20.53919 115.248098,-20.539174 115.247576,-20.539105 115.247058,-20.538982 115.246552,-20.538809 115.246063,-20.538586 115.245596,-20.538317 115.245159,-20.537982 115.244728,-20.463853 115.138686,-20.462584 115.137142,-20.4611 115.135654,-20.45486 115.130736,-20.451838 115.119594,-20.451726 115.119086,-20.451563 115.118593,-20.45135 115.118122,-20.45109 115.117678,-20.450786 115.117267,-20.450441 115.116894,-20.450061 115.116562,-20.449648 115.116277,-20.449209 115.116041,-20.448748 115.115857,-20.448271 115.115727,-20.447784 115.115653,-20.447292 115.115636,-20.446801 115.115676,-20.446317 115.115772,-20.445846 115.115924,-20.445393 115.116129,-20.444964 115.116385,-20.444563 115.11669,-20.444197 115.117038,-20.443868 115.117427,-20.443581 115.117852,-20.44334 115.118307,-20.443146 115.118788,-20.443003 115.119288,-20.442913 115.119801,-20.442875 115.120322,-20.442924 115.121137,-20.444177 115.129742,-20.444973 115.132313,-20.445186 115.132784,-20.446701 115.135477,-20.446966 115.135865,-20.447288 115.136245,-20.449008 115.138047,-20.456019 115.143727,-20.504859 115.223905,-20.505264 115.224381,-20.531926 115.251797,-20.532332 115.252092,-20.532766 115.252534,-20.533697 115.252674,-20.534183 115.25276,-20.534675 115.252788,-20.535167 115.25276,-20.535652 115.252674,-20.536127 115.252534,-20.536584 115.252339,-20.537018 115.252093,-20.537424 115.251797,-20.537798 115.251457,-20.538135 115.251076,-20.53843 115.250657,-20.538681 115.250208,-20.538884 115.249731,-20.539037 115.249235,-20.539139 115.248723,-20.539187 115.248203,-20.53919 115.248098

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

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

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Santos

Appendix E – Environment Plan Consultation

[redacted]

From: Consultation, Santos
Sent: Wednesday, 8 September 2021 8:50 PM
To: 'resourcesandenergy@industry.gov.au'
Subject: Santos Consultation - Revision to the Varanus Island Hub Operations Environment Plan
Attachments: Spartan Development Consultation Information.pdf

Dear stakeholder

Santos is preparing a revision to the existing Varanus Island (VI) Hub Operations Environment Plan (EP) for Commonwealth Waters as part of Santos' plans for development of its Spartan discovery, located in Commonwealth waters, approximately 125 km north-west of Karratha.

The Spartan development activities consist of drilling the Spartan development well, installation of subsea equipment and pre-commissioning activities to connect the new well to the existing John Brookes Wellhead Platform (WHP) via a new flexible subsea flowline.

This EP is being developed in accordance with the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 and we are seeking your feedback on our proposed activities.

The information attached provides more detail on the proposed activities, including a location map and a summary of potential risks, impacts and management measures.

Activity Summary

Activity Name	Varanus Island (VI) Hub Operations Environment Plan Revision (Commonwealth waters)	
Activity Summary	Santos is proposing to drill the Spartan development well, install subsea equipment and undertake pre-commissioning activities to connect the new well to the existing John Brookes Wellhead Platform (WHP) via a new flexible subsea flowline.	
Location	Approx. 125 km northwest of Karratha. Please see attached Consultation Information for location map.	
	Drilling	**Subsea installation and pre-commissioning**
Permit Number	WA-33-R	WA-33-R, WA-11-PL, WA 214-P and WA-29-L
Approximate Water Depth	Approx. 48 m to 60 m	Approx. 50 m to 60 m
Estimated Start Date	Drilling of the Spartan development well is planned to commence in Q2-Q3 2022.	Subsea installation and pre-commissioning are planned to commence in Q3 2022.
Total Duration	Allowing for potential down time, for example due to weather, the activity may extend to up to 70 days. Activities will be undertaken 24 hours per day.	Allowing for potential down time, for example due to weather, the activity may extend to up to 25 days. Activities will be undertaken 24 hours per day.
Vessels	Jack-up Mobile Offshore Drilling Unit (MODU) supported by up to four support vessels.	Installation Support Vessel (ISV).

Exclusion Zones	A temporary 500 m Petroleum Safety Zone (PSZ) around MODU (for duration of drilling activities).	A temporary 500 m Petroleum Safety Zone (PSZ) around ISV (for duration of activities).	
Drilling Operational Coordinates	Point 1	20° 55' 26.40" S	115° 22' 88.41" E
	Point 2	20° 51' 65.10" S	115° 22' 88.41" E
	Point 3	20° 51' 65.10" S	115° 26' 72.14" E
	Point 4	20° 55' 26.40" S	115° 26' 72.14" E
Spartan development well coordinates	20° 32’ 4.47” S	115° 14’ 52.90” E	
John Brookes WHP coordinates	20° 26' 50" S	116° 07' 13" E	

Please contact Santos by **13 October 2021** if you wish to comment on Santos’ proposed activities or if you require additional information about the proposed activities.

The Environment Regulations require NOPSEMA to publish the environment plan submitted by the titleholder for assessment, and to publish the final accepted version of an environment plan. Environment plans are published in full, with the exception of sensitive information from the consultation process and transcripts of correspondence between stakeholders and the titleholder. This information is used by NOPSEMA during the assessment, but is not published for wider review.

If you do not wish for your comments to be published in this environment plan, or wish to provide your comments anonymously, please make this known to Santos as soon as possible.

We look forward to hearing from you.

Regards

[redacted]

Santos

[redacted]
Stakeholder Adviser

As a service provider to

Santos Limited, Level 7, 100 St Georges Tce
Perth WA 6000
[redacted]

https://www.santos.com/

STAKEHOLDER CONSULTATION

Santos

Spartan Development Activities

Overview

Santos proposes to develop the Spartan discovery, located in Commonwealth waters, approximately 125 km north-west of Karratha. The Spartan development activities consist of drilling the Spartan development well, installation of subsea equipment and pre-commissioning activities to connect the new well to the existing John Brookes Wellhead Platform (WHP) via a new flexible subsea flowline. The Spartan development well will be drilled in Permit Area WA-33-R in water depths of approximately 50m. Subsea installation and pre-commissioning activities will take place in Permit Areas WA-33-R, WA-11-PL, WA 214-P and WA-29-L in water depths ranging from 48 m to 60 m. **Figure 1** shows the location of the proposed activities, including operational areas.

A revision to the existing Varanus Island (VI) Hub Operations EP in Commonwealth Waters will be made to allow for the Spartan development activities and operation of the new Spartan well and subsea infrastructure via the existing John Brookes WHP. The revised EP will be in accordance with the *Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E)R)* for acceptance by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).

Santos will be undertaking stakeholder consultation to inform activity planning and development of the EP prior to submission of the EP for assessment.

Activity description

Drilling

The drilling activity will be undertaken using a jack-up mobile offshore drilling unit (MODU) at the Spartan development well location, with a 2 km by 2 km operational area around the MODU.

Drilling activities include the following:

+ Pre-MODU positioning survey using a remotely operated vehicle (ROV) or side-scan sonar (SSS) undertaken by a vessel prior to the MODU arriving.
+ Positioning the jack-up MODU on site using one or more support vessels.
+ A temporary 500m Petroleum Safety Zone (PSZ) (exclusion zone) will exist around the MODU once on site (for the duration of drilling activities).
+ The Spartan development well will be drilled using water-based drilling muds only. No synthetic or non-aqueous drilling fluids will be used.
+ The well will be "cleaned-up" to the MODU by short-term flowing and disposing of well fluids and hydrocarbons utilising a temporary well-test package on the MODU.

Subsea installation and pre-commissioning

The subsea installation and pre-commissioning activities will be undertaken using an installation support vessel (ISV), with an operational area 250m either side of the flowline route and a 500m radius around the John Brookes Platform (consistent with the in-force VI Hub Operations EP).

Subsea installation and pre-commissioning activities include the following:

+ A temporary 500m PSZ (exclusion zone) will exist around the ISV during subsea installation and pre-commissioning activities.
+ A pre-lay survey using either an ROV, SSS or multi-beam echo sounder.
+ Installation of stabilisation mattresses.
+ Installation of subsea infrastructure, including the flexible flowline and umbilical
+ Pre-commissioning and commissioning activities.
+ Dewatering the flexible flowline back to Varanus Island facility (no discharge to the marine environment).
+ John Brookes WHP activities.

A summary of the Spartan development activities and potential risks and management measures are provided in **Table 1 and Table 2** (Drilling) and **Table 3 and Table 4** (Subsea Installation and Pre-commissioning).

Figure 1: Proposed Spartan development activities location map

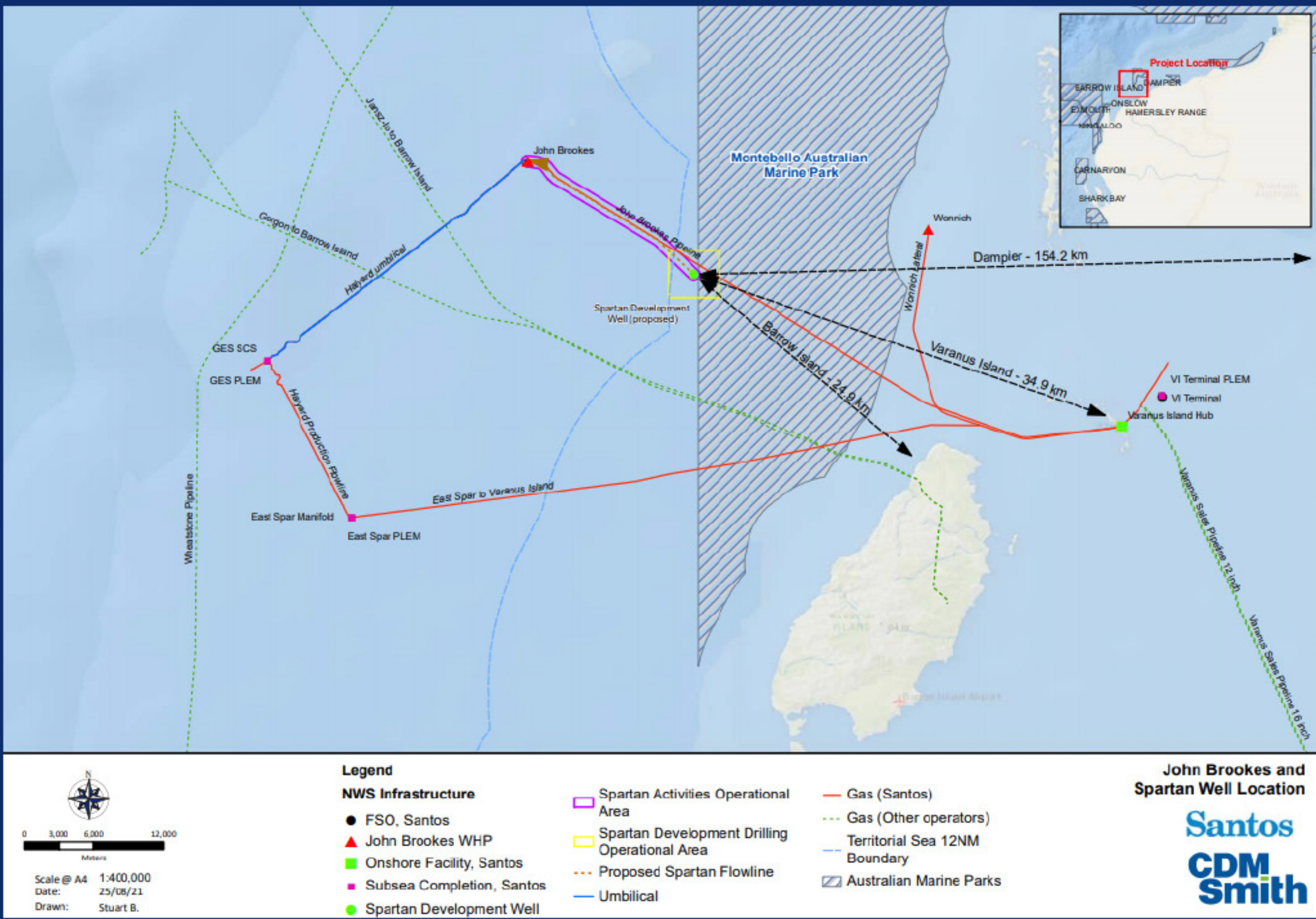


Table 1: Drilling activity summary

ACTIVITY DETAILS			
Permit number	WA-33-R.		
Water depth	Approx. 50m.		
Exclusion zone	500m PSZ established around MODU (for duration of drilling activities)		
Drilling operational area	Points	Latitude (GDA 94)	Longitude (GDA 94)
	Point 1	20° 55' 26.40" S	115° 22' 88.41" E
	Point 2	20° 51' 65.10" S	115° 22' 88.41" E
	Point 3	20° 51' 65.10" S	115° 26' 72.14" E
	Point 4	20° 55' 26.40" S	115° 26' 72.14" E
Equipment	· Jack-up Mobile Offshore Drilling Unit (MODU) · MODU supported by up to four support vessels and helicopters		
Description of natural environment	The operational area for the drilling of the Spartan development well overlaps the Northwest Shelf Provincial Bioregion (based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) Version 4.0).		
Timing and duration	Drilling of the Spartan development well is planned to commence in Q2-Q3 2022. Allowing for potential down time, for example due to weather, the activity may extend to up to 70 days. Activities will be undertaken 24 hours per day.		
Proximity to key regional features	Regional feature		Approximate distance from the operational area
	Varanus Island		34.9 km SE
	Barrow Island		24.9 km SE
	Closest Montebello Island		30 km E
	Dampier		154.2 km E
	Closest mainland point		110 km SE (Cape Preston)
	Montebello Marine Park (Australian Marine Park)		0 km (intersects operational area)
	Montebello Islands Marine Park (State)		18 km E
	Barrow Island Marine Management Area (State)		18 km E
Worst case hydrocarbon spill scenario	53,811 m^3 of Spartan condensate released at either the surface or seabed for a duration of 11 weeks.		
Response tier required	In the event of a loss of Spartan condensate, a Tier 3 response would be implemented as defined in the activity-specific Oil Pollution Emergency Plan.		

Santos has conducted the following assessment of potential environmental risks and impacts from the drilling activity.

Table 2: Potential risks and management measures – drilling

POTENTIAL RISKS AND IMPACTS	MANAGEMENT MEASURES
Interaction with commercial fishers and other marine users	· If requested, stakeholders will be notified prior to the commencement and on cessation of each activity. · Relevant maritime notices issued. · A 500 m radius PSZ (exclusion zone) will be in place around the MODU for the duration of the activity. · A visual and radar watch will be maintained on the support vessel bridge at all times. · Santos vessels (including the MODU) will be prohibited from recreational fishing within the operational area. · Santos commits to reducing impacts on commercial fishers through the provision of timely activity information to enable advance planning and avoidance of unexpected interference.
Hydrocarbon release	· NOPSEMA-accepted MODU safety case and Santos Well Operations Management Plan (WOMP) in place. · Prior to drilling there will be a relief well plan in place. · Appropriate refuelling procedures and equipment will be used to prevent spills to the marine environment. · NOPSEMA approved Oil Pollution Emergency Plan (OPEP), equipment and materials will be in place and maintained. · Conventional live well intervention and well test activities performed under minimum two barrier requirement as per Santos Technical Standards and accepted regulatory plans (e.g. WOMPs).
Drilling discharge	· Drilling and cement chemicals potentially discharged to sea are Gold/Silver/D or E rated through OCNS, or PLONOR substances listed by OSPAR, or have a completed Santos risk assessment so that only environmentally acceptable products are used. · Only water-based drilling fluid systems will be used.
Marine fauna interactions	· Implementation of *EPBC Regulations (Part 8)* for interacting with cetaceans to minimise the disturbance to fauna caused by marine vessels and helicopters.
Light emissions	· MODU/vessels navigation lighting and equipment is compliant with COLREGS / Marine Orders 30: Prevention of Collisions, and with Marine Orders 21: Safety of Navigation and Emergency Procedures.
Atmospheric emissions	· Vessel fuel oil sulphur content is compliant with MARPOL. · Pursuant to MARPOL Annex VI, vessels will maintain a current International Air Pollution Prevention (IAPP) Certificate as relevant to vessel class.
Seabed disturbance	· Site survey prior to MODU arrival to identify and avoid any environmentally sensitive seabed features. · No vessel or MODU anchoring, unless in an emergency. · Objects dropped overboard are recovered where possible and safe to do so) to mitigate the environmental consequences from objects remaining in the marine environment
Operational MODU and vessel discharges	· Routine vessel discharge (sewage, bilge water, food waste) will meet MARPOL requirements. · Deck cleaning products that may be discharged to the ocean will meet MARPOL requirements.
Biosecurity risk management	· MODU and vessels are managed to low risk in accordance with the Santos Invasive Marine Species Management Plan prior to movement/transit into or within the invasive marine species management zone, which requires: - assessment of applicable MODU/vessels using the DPIRD Vessel Check Tool; and - the management of immersible equipment to low risk.
Spill response operations	· In the event of a hydrocarbon spill, the OPEP requirements are implemented to mitigate environmental impacts.

Installation and pre-commissioning

The proposed installation and pre-commissioning activity is summarised below.

Table 3: Subsea installation and pre-commissioning activity summary

EXPLORATION DRILLING ACTIVITY DETAILS			
Permit numbers	WA-33-R, WA-11-PL, WA 214-P and WA-29-L.		
Water depth	Approx. 50 to 60m.		
Exclusion zone	500m around the ISV at all times during the activity.		
Location		Latitude	Longitude
	Spartan development well location	20° 32' 4.47" S	115° 14' 52.90" E
	John Brookes WHP	20° 26' 50" S	116° 07' 13" E
Spartan subsea flexible production flowline	17 km in length from the Spartan development well location to the John Brookes WHP.		
Equipment	An Installation Support Vessel (ISV) will be the primary vessel undertaking activities.		
Description of natural environment	The operational area for the Spartan development well overlaps the Northwest Shelf Provincial Bioregion (based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) Version 4.0).		
Timing and duration	The activity is planned to commence in Q3 2022 and are expected to take 25 days, dependant on operational down time and weather delays.		
Nearest proximity to key regional features	Regional feature	Approximate distance from the operational area	
	Varanus Island	35 km SE	
	Barrow Island	25 km SE	
	Closest Montebello Island	30 km E	
	Dampier	154 km E	
	Closest mainland point	110 km SE (Cape Preston)	
	Montebello Marine Park (Australian Marine Park)	0.135 km	
	Montebello Islands Marine Park (State)	18 km E	
	Barrow Island Marine Management Area (State)	18 km E	
Hydrocarbon type	Marine diesel		
Worst case hydrocarbon spill scenario	329 m^3 of marine diesel from a vessel collision.		
Oil spill response level required	In the event of a diesel spill, a Level 3 response would be implemented as defined in the activity-specific Oil Pollution Emergency Plan.		

Santos has conducted the following assessment of potential environmental risks and impacts from the installation and pre-commissioning activities.

Table 4: Potential risks and management measures – subsea installation and pre-commissioning

POTENTIAL RISKS AND/OR IMPACTS	MANAGEMENT MEASURES
Interaction with other commercial fishers and other marine users	• Relevant stakeholders will be notified prior to the commencement and on cessation of each activity. • Relevant maritime notices issued. • A visual and radar watch will be maintained on the vessel bridge. • Santos vessels will be prohibited from recreational fishing within the operational area. • A 500 m radius PSZ (exclusion zone) will be in place around the ISV for the duration of the activity • Santos commits to reducing impacts on commercial fishers through the provision of timely activity information to enable advance planning and avoidance of unexpected interference.
Marine fauna interactions	• Implementation of *EPBC Regulations (Part 8)* for interacting with cetaceans to minimise the disturbance to fauna caused by marine vessels and helicopters.
Light emissions	• Vessel navigation lighting and equipment is compliant with COLREGS / Marine Orders 30: Prevention of Collisions, and with Marine Orders 21: Safety of Navigation and Emergency Procedures.
Atmospheric emissions	• Vessel fuel oil sulphur content is compliant with MARPOL. • Pursuant to MARPOL Annex VI, vessels will maintain a current International Air Pollution Prevention (IAPP) Certificate as relevant to vessel class
Seabed disturbance	• No vessel anchoring, unless in an emergency. • Objects dropped overboard are recovered where possible and safe to do so) to mitigate the environmental consequences from objects remaining in the marine environment.
Operational vessel discharges	• Routine vessel discharge (sewage, bilge water, food waste) will meet MARPOL requirements. • Deck cleaning products that may be discharged to the ocean will meet MARPOL requirements.
Planned discharges from installation activities	• Chemicals potentially discharged to sea meet the criteria for not being harmful to the marine environment according to MARPOL Annex V, or; • Chemicals potentially discharged to sea are Gold/Silver/D or E rated through OCNS, or PLONOR substances listed by OSPAR, or have a completed Santos risk assessment so that only environmentally acceptable products are used.
Biosecurity risk management	• Vessel and immersible equipment is managed to low risk in accordance with the Santos Invasive Marine Species Management Plan prior to movement/transit into or within the invasive marine species management zone, which requires: - assessment of applicable vessels using the DPIRD Vessel Check Tool; and - the management of immersible equipment to low risk.
Spill response operations	• In the event of a hydrocarbon spill, the Oil Pollution Emergency Plan requirements are implemented to mitigate environmental impacts.

Consultation

If you wish to comment on Santos' Spartan Development Activities, or if you require additional information, please contact Santos on the contact details below. Santos would appreciate your feedback by **13 October 2021**.

Santos
PO Box 5624, Perth, 6831
Email: Offshore.Consultation@Santos.com

Santos Consultation

8 September 2021

Dear Fishery Licence Holder

Santos is preparing a revision to the existing Varanus Island (VI) Hub Operations Environment Plan (EP) for Commonwealth Waters as part of Santos' plans for development of its Spartan discovery, located in Commonwealth waters, approximately 125 km north-west of Karratha.

The Spartan development activities consist of drilling the Spartan development well, installation of subsea equipment and pre-commissioning activities to connect the new well to the existing John Brookes Wellhead Platform (WHP) via a new flexible subsea flowline.

Location:	Approx. 125 km northwest of Karratha. Please see attached Consultation Information for location map.
Water Depth:	Approx. 48 m to 60 m
Schedule:	Drilling of the Spartan development well is planned to commence in Q2-Q3 2022. Subsea installation and pre-commissioning are planned to commence in Q3 2022.
Activity Duration:	Allowing for potential down time, for example due to weather, the drilling activity may extend to up to 70 Days and the subsea installation and pre-commissioning activities may extend up 25 days.
Support Vessels:	A Jack-up Mobile Offshore Drilling Unit (MODU) supported by up to four support vessels will undertake the drilling activities and an Installation Support Vessel (ISV) will undertake the subsea installation and pre-commissioning activities.
Exclusion Zone:	A temporary 500 m Petroleum Safety Zone (PSZ) around MODU (for duration of drilling activities). A temporary 500 m Petroleum Safety Zone (PSZ) around ISV (for duration of activities).

Please be in contact via the phone or email details below if you have any questions on any of the activities outlined in the attached Consultation Information.

Kind regards

[redacted]

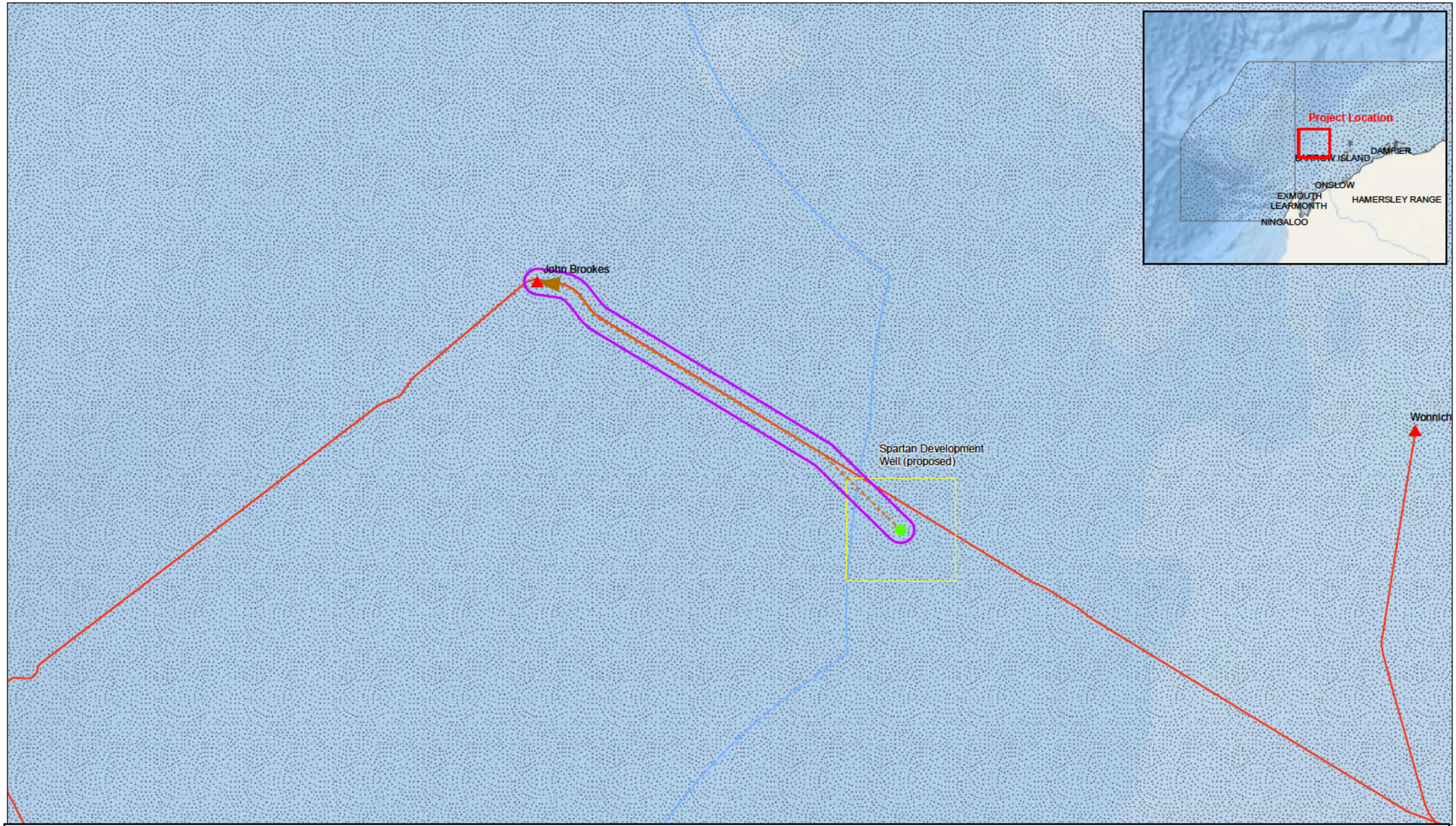
Stakeholder Adviser

Santos Limited,

Level 7 100 St Georges Tce, Perth WA 6000

[redacted]

e: offshore.consultation@Santos.com



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Date: 26/08/21
Drawn: Stuart B.

Legend

Active State Fisheries

Mackerel Managed Fishery

NWS Infrastructure

John Brookes WHP

Spartan Development Well

Spartan Development Drilling Operational Area

Spartan Activities Operational Area

Proposed Spartan Flowline

Santos Operated Pipelines

Territorial Sea 12NM Boundary

Active State Fisheries (WA) Mackeral Managed Fishery

Santos

CDM Smith

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[redacted]

From: Consultation, Santos
Sent: Monday, 29 November 2021 2:44 PM
To: 'pestmarine@agriculture.gov.au'; 'seaports@agriculture.gov.au'
Subject: FW: Santos Consultation - Revision to the Varanus Island Hub Operations Environment Plan
Attachments: Spartan Development Consultation Information.pdf; Spartan Commmonwealth Fisheries.pdf

Dear DAWE

Apologies but we appear to have overlooked consulting DAWE on biosecurity matters in our initial consultation with respect to the Revision of Santos' Varanus Island Hub Operations Environment Plan.

Please get back to us if you require any additional information about proposed activities.

Regards

[redacted]

Santos

[redacted]
Stakeholder Adviser

As a service provider to

Santos Limited, Level 7, 100 St Georges Tce
Perth WA 6000
[redacted]

https://www.santos.com/

From: Consultation, Santos
Sent: Wednesday, 8 September 2021 8:47 PM
To: 'Petroleum&Fisheries@agriculture.gov.au' <Petroleum&Fisheries@agriculture.gov.au>
Subject: Santos Consultation - Revision to the Varanus Island Hub Operations Environment Plan

Dear stakeholder

Santos is preparing a revision to the existing Varanus Island (VI) Hub Operations Environment Plan (EP) for Commonwealth Waters as part of Santos' plans for development of its Spartan discovery, located in Commonwealth waters, approximately 125 km north-west of Karratha.

The Spartan development activities consist of drilling the Spartan development well, installation of subsea equipment and pre-commissioning activities to connect the new well to the existing John Brookes Wellhead Platform (WHP) via a new flexible subsea flowline.

This EP is being developed in accordance with the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 and we are seeking your feedback on our proposed activities.

The information attached provides more detail on the proposed activities, including a location map and a summary of potential risks, impacts and management measures.

Also attached is a map showing the proposed operational area in relation to Commonwealth fisheries. Our assessment of these fisheries is that there has been no active fishing in the Operational Area.

We have, however, provided information about the proposed activities to commercial fishing representative organisations relevant to the drilling of the Spartan development well and associated subsea infrastructure as part of our broader engagement program.

Activity Summary

<table>
<tr><td>Activity Name</td><td colspan="4">Varanus Island (VI) Hub Operations Environment Plan Revision (Commonwealth waters)</td></tr>
<tr><td>Activity Summary</td><td colspan="4">Santos is proposing to drill the Spartan development well, install subsea equipment and undertake pre-commissioning activities to connect the new well to the existing John Brookes Wellhead Platform (WHP) via a new flexible subsea flowline.</td></tr>
<tr><td>Location</td><td colspan="4">Approx. 125 km northwest of Karratha. Please see attached Consultation Information for location map.</td></tr>
<tr><td></td><td colspan="2">Drilling</td><td colspan="2">Subsea installation and pre-commissioning</td></tr>
<tr><td>Permit Number</td><td colspan="2">WA-33-R</td><td colspan="2">WA-33-R, WA-11-PL, WA 214-P and WA-29-L</td></tr>
<tr><td>Approximate Water Depth</td><td colspan="2">Approx. 48 m to 60 m</td><td colspan="2">Approx. 50 m to 60 m</td></tr>
<tr><td>Estimated Start Date</td><td colspan="2">Drilling of the Spartan development well is planned to commence in Q2-Q3 2022.</td><td colspan="2">Subsea installation and pre-commissioning are planned to commence in Q3 2022.</td></tr>
<tr><td>Total Duration</td><td colspan="2">Allowing for potential down time, for example due to weather, the activity may extend to up to 70 days. Activities will be undertaken 24 hours per day.</td><td colspan="2">Allowing for potential down time, for example due to weather, the activity may extend to up to 25 days. Activities will be undertaken 24 hours per day.</td></tr>
<tr><td>Vessels</td><td colspan="2">Jack-up Mobile Offshore Drilling Unit (MODU) supported by up to four support vessels.</td><td colspan="2">Installation Support Vessel (ISV).</td></tr>
<tr><td>Exclusion Zones</td><td colspan="2">A temporary 500 m Petroleum Safety Zone (PSZ) around MODU (for duration of drilling activities).</td><td colspan="2">A temporary 500 m Petroleum Safety Zone (PSZ) around ISV (for duration of activities).</td></tr>
<tr><td rowspan="4">Drilling Operational Coordinates</td><td>Point 1</td><td colspan="2">20° 55' 26.40" S</td><td>115° 22' 88.41" E</td></tr>
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</table>

Please contact Santos by **13 October 2021** if you wish to comment on Santos’ proposed activities or if you require additional information about the proposed activities.

The Environment Regulations require NOPSEMA to publish the environment plan submitted by the titleholder for assessment, and to publish the final accepted version of an environment plan. Environment plans are published in full, with the exception of sensitive information from the consultation process and transcripts of correspondence between stakeholders and the titleholder. This information is used by NOPSEMA during the assessment, but is not published for wider review.

If you do not wish for your comments to be published in this environment plan, or wish to provide your comments anonymously, please make this known to Santos as soon as possible.

We look forward to hearing from you.

Regards

[redacted]

[redacted]
Stakeholder Adviser

As a service provider to

Santos Limited, Level 7, 100 St Georges Tce
Perth WA 6000
[redacted]

https://www.santos.com/

Appendix F – Environmental Consequence Descriptors

Excerpt from Offshore Division Environmental Hazard Identification and Assessment Guideline (EA-91-IG-00004), Revision 5 (Issued October 2020).

	Consequence Level	I	II	III	IV	V	VI
	Acceptability	Acceptable	Acceptable	Unacceptable	Unacceptable	Unacceptable	Unacceptable
	Severity Description	Negligible *No impact or negligible impact*	Minor *Detectable but insignificant change to local population, industry or ecosystem factors. Localised effect*	Moderate *Significant impact to local population, industry or ecosystem factors*	Major *Major long-term effect on local population, industry or ecosystem factors*	Severe *Complete loss of local population, industry or ecosystem factors AND/OR extensive regional impacts with slow recovery*	Critical *Irreversible impact to regional population, industry or ecosystem factors*
Environmental Receptors	Fauna In particular, EPBC Act listed threatened/migratory fauna or *WA Biodiversity Conservation Act 2016* specially protected fauna	Short term behavioural impacts only to small proportion of local population and not during critical lifecycle activity; No decrease in local population size; No reduction in area of occupancy of species; No loss/disruption of habitat critical to survival of a species; No disruption to the breeding cycle of any individual; No introduction of disease likely to cause a detectable population decline.	Detectable but insignificant decrease in local population size; Insignificant reduction in area of occupancy of species; Insignificant loss/disruption of habitat critical to survival of a species; Insignificant disruption to the breeding cycle of local population.	Significant decrease in local population size but no threat to overall population viability; Significant behavioural disruption to local population; Significant disruption to the breeding cycle of a local population; Significant reduction in area of occupancy of species; Significant loss of habitat critical to survival of a species; Modify, destroy, remove, isolate or decrease availability of quality of habitat to the extent that a significant decline in local population is likely; Introduce disease likely to cause a significant population decline.	Long term decrease in local population size and threat to local population viability; Major disruption to the breeding cycle of local population; Major reduction in area of occupancy of species; Fragmentation of existing population; Major loss of habitat critical to survival of a species; Modify, destroy, remove, isolate or decrease availability of quality of habitat to the extent that a long term decline in local population is likely; Introduce disease likely to cause a long term population decline.	Complete loss of local population; Complete loss of habitat critical to survival of local population; Wide spread (regional) decline in population size or habitat critical to regional population.	Complete loss of regional population; Complete loss of habitat critical to survival of regional population.
	Physical Environment/Habitat Includes: air quality; water quality; benthic habitat (biotic/abiotic), particularly habitats that are rare or unique; habitat that represents a Key Ecological Feature[10]; habitat within a protected area; habitats that include benthic primary producers[11] and/or epi-fauna[12]	No or negligible reduction in physical environment/habitat area/function.	Detectable but localised and insignificant loss of area/function of physical environment/habitat. Rapid recovery evident within approximately two years (two season recovery).	Significant loss of area and/or function of local physical environment/habitat. Recovery over medium term (2–10 years)	Major, large-scale loss of area and/or function of physical environment/local habitat. Slow recovery over decades.	Extensive destruction of local physical environment/habitat with no recovery; Long term (decades) and wide spread loss of area or function of primary producers on a regional scale.	Complete destruction of regional physical environment/habitat with no recovery. Complete loss of area or function of primary producers on a regional scale.
	Threatened ecological communities (EPBC Act listed ecological communities)	No decline in threatened ecological community population size, diversity or function; No reduction in area of threatened ecological community; No introduction of disease likely to cause decline in threatened ecological community population size, diversity or function.	Detectable but insignificant decline in threatened ecological community population size, diversity or function; Insignificant reduction in area of threatened ecological community.	Significant decline in threatened ecological community population size, diversity or function; Significant reduction in area of threatened ecological community; Introduction of disease likely to cause significant decline in threatened ecological community population size, diversity or function.	Major, long term decline in threatened ecological community population size, diversity or function; Major reduction in area of threatened ecological community; Fragmentation of threatened ecological community; Introduce disease likely to cause long term decline in threatened ecological community population size, diversity or function.	Extensive, long term decline in threatened ecological community population size, diversity or function; Complete loss of threatened ecological community.	Complete loss of threatened ecological community with no recovery.

Consequence Level		I	II	III	IV	V	VI
Acceptability		Acceptable	Acceptable	Unacceptable	Unacceptable	Unacceptable	Unacceptable
Severity Description		**Negligible** *No impact or negligible impact*	**Minor** *Detectable but insignificant change to local population, industry or ecosystem factors. Localised effect*	**Moderate** *Significant impact to local population,industry or ecosystem factors*	**Major** *Major long-term effect on local population, industry or ecosystem factors*	**Severe** *Complete loss of local population,industry or ecosystem factors AND/OR extensive regional impacts with slow recovery*	**Critical** *Irreversible impact to regional population, industry or ecosystem factors*
	Protected Areas Includes: World Heritage Properties; Ramsar wetlands; Commonwealth/National Heritage Areas; Land/Marine Conservation Reserves.	No or negligible impact on protected area values; No decline in species population within protected area; No or negligible alteration, modification, obscuring or diminishing of protected area values.*	Detectable but insignificant impact on one of more of protected area's values. Detectable but insignificant decline in species population within protected area. Detectable but insignificant alteration, modification, obscuring or diminishing of protected area values.*	Significant impact on one of more of protected area's values; Significant decrease in population within protected area; Significant alteration, modification, obscuring or diminishing of protected area values.	Major long_term effect on one of more of protected area's values; Long-term decrease in species population contained within protected area and threat to that population's viability; Major alteration, modification, obscuring or diminishing of protected area values.	Extensive loss of one or more of protected area's values; Extensive loss of species population contained within protected area.	Complete loss of one or more of protected area's values with no recovery; Complete loss of species population contained within protected area with no recovery.
	Socio-economic receptors Includes: fisheries (commercial and recreational); tourism; oil and gas; defence; commercial shipping.	No or negligible loss of value of the local industry; No or negligible reduction in key natural features or populations supporting the activity.	Detectable but insignificant short-term loss of value of the local industry. Detectable but insignificant reduction in key natural features or population supporting the local activity.	Significant loss of value of the local industry; Significant medium term reduction of key natural features or populations supporting the local activity.	Major long-term loss of value of the local industry and threat to viability; Major reduction of key natural features or populations supporting the local activity.	Shutdown of local industry or widespread major damage to regional industry; Extensive loss of key natural features or populations supporting the local industry.	Permanent shutdown of local or regional industry; Permanent loss of key natural features or populations supporting the local or regional industry.

Appendix G – Spill Modelling Results

Appendix G1: Stochastic Spill Modelling Results for:

- **A LOWC at the Spartan well location with the release of 53,811 m^3 of Spartan condensate at the seabed; and**
- **A LOWC at the Spartan well location with the release of 53,291 m^3 of Spartan condensate at the sea surface.**
- **329 m^3 MDO release and subsea release of hydrocarbons in the event of a loss of well control**

Appendix G2: High Environmental Value Consequence Summary

Santos

Appendix G1: Stochastic Spill Modelling Results

Spill modelling results A LOWC at the Spartan well location with the release of 53,811 m³ of Spartan condensate at the seabed

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m²)	Surface hydrocarbons (10 g/m²)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m²)	Surface hydrocarbons (50 g/m²)	Shoreline accumulation (g/m²)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m²)	Shoreline accumulation (100 g/m²)
Ningaloo - Outer Coast North*	Submerged	NA	NC	240	240	NA	NC	NA	245	526	NA	NA
Ashmore Reef AMP	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Muiron Islands	Emergent	215	NC	200	200	NC	NC	478	174	289	18	5
Ningaloo Coast North	Emergent	274	NC	265	265	NC	NC	517	119	373	54	16
Exmouth Gulf Coast	Emergent	NC	NC	NC	NC	NC	NC	1	13	31	<1	NC
Eighty Mile Beach	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	<1	NC	NC
Carnarvon - Inner Shark Bay	Emergent	NC	NC	NC	NC	NC	NC	2	<1	8	<1	NC
Mermaid Reef AMP*	Intertidal	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Broome - Roebuck	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Abrolhos West*	Submerged	NA	NC	NC	NC	NA	NC	NA	<1	2	NA	NA
Abrolhos Islands Wallabi Group	Emergent	NC	NC	NC	NC	NC	NC	2	NC	<1	<1	NC
Abrolhos Islands Easter Group	Emergent	NC	NC	NC	NC	NC	NC	1	NC	<1	<1	NC
Abrolhos Islands Pelsaert Group	Emergent	NC	NC	NC	NC	NC	NC	1	NC	<1	<1	NC
Jurien AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	<1	NA	NA
Two Rocks AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	<1	NA	NA
Perth Canyon AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Geographe Bay	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	<1	<1	NC
Geographe - Offshore Augusta 1*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	<1	NA	NA
Barrow-Montebello Surrounds*	Intertidal	NA	NC	75	75	NA	NC	NA	456	308	NA	NA
Barrow Island	Emergent	425	NC	255	255	NC	NC	243	314	235	17	6

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Montebello Islands	Emergent	166	NC	269	269	NC	NC	342	446	203	33	11
Lowendal Islands	Emergent	593	NC	NC	NC	NC	NC	182	38	83	8	2
Dampier Archipelago	Emergent	NC	NC	NC	NC	NC	NC	1	<1	<1	<1	NC
Ningaloo - Outer NW*	Submerged	NA	NC	292	292	NA	NC	NA	246	499	NA	NA
Ningaloo Coast South	Emergent	NC	NC	NC	NC	NC	NC	10	2	32	9	NC
Imperieuse Reef MP	Emergent	NC	NC	NC	NC	NC	NC	2	NC	<1	NC	NC
Shark Bay - Coast Outer	Emergent	NC	NC	NC	NC	NC	NC	6	<1	9	3	NC
Clerke Reef MP	Emergent	NC	NC	NC	NC	NC	NC	<1	NC	NC	NC	NC
Zuytdorp Cliffs - Kalbarri	Emergent	NC	NC	NC	NC	NC	NC	0	NC	<1	<1	NC
Kimberley AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Kalbarri - Geraldton	Emergent	NC	NC	NC	NC	NC	NC	0	NC	<1	<1	NC

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Abrolhos - Outer Island Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	<1	7	NA	NA
Geraldton - Jurien Bay	Emergent	NC	NC	NC	NC	NC	NC	0	NC	<1	<1	NC
Scott Reef South	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Scott Reef North*	Intertidal	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Camden Sound	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Jurien Bay - Yanchep	Emergent	NC	NC	NC	NC	NC	NC	0	NC	<1	<1	NC
Kimberley Coast PMZ	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Perth Northern Coast	Emergent	NC	NC	NC	NC	NC	NC	0	NC	<1	NC	NC
Johnson Bank*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Cartier Island AMP	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Perth Southern Coast	Emergent	NC	NC	NC	NC	NC	NC	0	NC	<1	NC	NC

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Mandurah - Dawesville	Emergent	NC	NC	NC	NC	NC	NC	0	NC	<1	NC	NC
Geographe - Outer*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	<1	NA	NA
Geographe - Offshore Augusta 2*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	<1	NA	NA
Geographe - Augusta Deep*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	<1	NA	NA
Montebello AMP*	Submerged	NA	81	2	2	NA	NC	NA	2131	2791	NA	NA
Ningaloo - Offshore*	Submerged	NA	NC	118	118	NA	NC	NA	597	661	NA	NA
Dampier AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	<1	<1	NA	NA
Eighty Mile Beach AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	4	NA	NA
Rowley Shoals surrounds*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	2	NA	NA
Shark Bay AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	2	25	NA	NA
Abrolhos - Offshore NW*	Submerged	NA	NC	NC	NC	NA	NC	NA	2	13	NA	NA

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Broome North Coast	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Abrolhos - Nearshore*	Submerged	NA	NC	NC	NC	NA	NC	NA	<1	<1	NA	NA
Lacepede Islands	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
King Sound	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Abrolhos - Offshore Perth North*	Submerged	NA	NC	NC	NC	NA	NC	NA	<1	3	NA	NA
Seringapatam Reef*	Intertidal	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Ashmore/Cartier - Outer*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Perth South - Geographe - Offshore*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	<1	NA	NA
Dawesville - Bunbury	Emergent	NC	NC	NC	NC	NC	NC	1	NC	<1	NC	NC
Geographe Bay - Augusta	Emergent	NC	NC	NC	NC	NC	NC	0	NC	<1	<1	NC
South-west corner AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	<1	NA	NA

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
JBG West Coast	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Van Cloon/Deep Shaols*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
JBG South Coast	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Joseph Bonaparte Gulf AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Christmas Island	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Augusta - Walpole	Emergent	NC	NC	NC	NC	NC	NC	0	NC	<1	<1	NC
Bremer AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
The Boxers Area*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Twilight AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Eastern Recherche AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Van Dieman Gulf Coast*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Southern Arafura AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Arnhem AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Wessel AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Middle Islands Coast	Emergent	NC	NC	NC	NC	NC	NC	78	2	18	3	NC
Northern Islands Coast	Emergent	NC	NC	NC	NC	NC	NC	3	<1	12	<1	NC
Southern Islands Coast	Emergent	563	NC	307	307	NC	NC	298	97	138	7	2
Rankin Bank*	Submerged	NA	NC	1625	1625	NA	NC	NA	124	124	NA	NA
Thevenard Islands	Emergent	NC	NC	333	333	NC	NC	98	90	129	4	NC
Karratha-Port Hedland	Emergent	NC	NC	NC	NC	NC	NC	NC	<1	<1	NC	NC
Glomar Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	<1	47	NA	NA
Port Hedland-Eighty Mile Beach	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	<1	NC	NC

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Bedout Island	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	<1	NC	NC
Roebuck - Eighty Mile Beach	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Adele Island	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Browse Island	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Echuca Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Heywood Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Woodbine Bank*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Barracouta Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Rottnest Island	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	<1	<1	NC
Hibernia Reef*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Vulcan Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Fantome Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Penguin Shoal*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Sahul Banks*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Gale Bank*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Albany - Esperance	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Walpole - Albany	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Esperance - Cape Arid NP	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
JBG East Coast	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Echo Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Margaret Harries Bank*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Flat Top Bank*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Newby Shoal*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Beagle Gulf-Darwin Coast*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Sunrise Bank*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Tiwi Islands	Emergent	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Vernon Islands CR	Emergent	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Djukbinj NP	Emergent	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Cobourg Peninsula- Nhulunbuy	Emergent	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Nhulunbuy-Borroloola	Emergent	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Christmas Island	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Indonesia - East	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Indonesia - West	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC

Spill modelling results: A LOWC at the Spartan well location with the release of 53,291 m^3 of Spartan condensate at the sea surface.

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Ningaloo - Outer Coast North*	Submerged	NA	NC	213	213	NA	NC	NA	121	821	NA	NA
Ashmore Reef AMP	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Muiron Islands	Emergent	216	NC	131	131	NC	NC	209	69	480	9	3
Ningaloo Coast North	Emergent	753	NC	244	244	NC	NC	179	55	581	23	6
Exmouth Gulf Coast	Emergent	NC	NC	NC	NC	NC	NC	1	5	44	<1	NC
Eighty Mile Beach	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Carnarvon - Inner Shark Bay	Emergent	NC	NC	NC	NC	NC	NC	2	<1	10	<1	NC
Mermaid Reef AMP*	Intertidal	NA	NC	NC	NC	NA	NC	NA	NC	<1	NA	NA
Broome - Roebuck	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Abrolhos West*	Submerged	NA	NC	NC	NC	NA	NC	NA	<1	2	NA	NA
Abrolhos Islands Wallabi Group	Emergent	NC	NC	NC	NC	NC	NC	1	<1	<1	<1	NC
Abrolhos Islands Easter Group	Emergent	NC	NC	NC	NC	NC	NC	<1	<1	<1	<1	NC

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Abrolhos Islands Pelsaert Group	Emergent	NC	NC	NC	NC	NC	NC	1	NC	<1	<1	NC
Jurien AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	<1	<1	NA	NA
Two Rocks AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	<1	NA	NA
Perth Canyon AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	<1	3	NA	NA
Geographe Bay	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	<1	NC	NC
Geographe - Offshore Augusta 1*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	<1	NA	NA
Barrow-Montebello Surrounds*	Intertidal	NA	NC	58	58	NA	NC	NA	254	494	NA	NA
Barrow Island	Emergent	456	NC	97	97	NC	NC	130	118	405	7	2
Montebello Islands	Emergent	572	NC	156	156	NC	NC	165	249	286	13	3
Lowendal Islands	Emergent	NC	NC	569	569	NC	NC	74	24	117	3	NC
Dampier Archipelago	Emergent	NC	NC	NC	NC	NC	NC	<1	<1	2	<1	NC
Ningaloo - Outer NW*	Submerged	NA	NC	228	228	NA	NC	NA	124	779	NA	NA
Ningaloo Coast South	Emergent	NC	NC	NC	NC	NC	NC	20	2	45	5	NC

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m²)	Surface hydrocarbons (10 g/m²)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m²)	Surface hydrocarbons (50 g/m²)	Shoreline accumulation (g/m²)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m²)	Shoreline accumulation (100 g/m²)
Imperieuse Reef MP	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	2	NC	NC
Shark Bay - Coast Outer	Emergent	NC	NC	NC	NC	NC	NC	5	<1	12	2	NC
Clerke Reef MP	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Zuytdorp Cliffs - Kalbarri	Emergent	NC	NC	NC	NC	NC	NC	<1	<1	<1	<1	NC
Kimberley AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	<1	NA	NA
Kalbarri - Geraldton	Emergent	NC	NC	NC	NC	NC	NC	<1	NC	<1	<1	NC
Abrolhos - Outer Island Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	<1	9	NA	NA
Geraldton - Jurien Bay	Emergent	NC	NC	NC	NC	NC	NC	<1	NC	<1	<1	NC
Scott Reef South	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Scott Reef North*	Intertidal	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Camden Sound	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Jurien Bay - Yanchep	Emergent	NC	NC	NC	NC	NC	NC	<1	NC	<1	<1	NC
Kimberley Coast PMZ	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Perth Northern Coast	Emergent	NC	NC	NC	NC	NC	NC	<1	NC	<1	<1	NC
Johnson Bank*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Cartier Island AMP	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Perth Southern Coast	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	<1	NC	NC
Mandurah - Dawesville	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	<1	NC	NC
Geographe - Outer*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	<1	NA	NA
Geographe - Offshore Augusta 2*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	<1	NA	NA
Geographe - Augusta Deep*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	<1	NA	NA
Montebello AMP*	Submerged	NA	81	2	2	NA	NC	NA	852	4868	NA	NA
Ningaloo - Offshore*	Submerged	NA	NC	109	109	NA	NC	NA	356	1071	NA	NA
Dampier AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	<1	2	NA	NA
Eighty Mile Beach AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	<1	5	NA	NA
Rowley Shoals surrounds*	Submerged	NA	NC	NC	NC	NA	NC	NA	<1	3	NA	NA

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Shark Bay AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	2	36	NA	NA
Abrolhos - Offshore NW*	Submerged	NA	NC	NC	NC	NA	NC	NA	<1	16	NA	NA
Broome North Coast	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Abrolhos - Nearshore*	Submerged	NA	NC	NC	NC	NA	NC	NA	<1	<1	NA	NA
Lacepede Islands	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
King Sound	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Abrolhos - Offshore Perth North*	Submerged	NA	NC	NC	NC	NA	NC	NA	<1	3	NA	NA
Seringapatam Reef*	Intertidal	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Ashmore/Cartier - Outer*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Perth South - Geographe - Offshore*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	<1	NA	NA
Dawesville - Bunbury	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	<1	<1	NC
Geographe Bay - Augusta	Emergent	NC	NC	NC	NC	NC	NC	<1	NC	<1	<1	NC
South-west corner AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	<1	NA	NA

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
JBG West Coast	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Van Cloon/Deep Shaols*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
JBG South Coast	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Joseph Bonaparte Gulf AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Christmas Island	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Augusta - Walpole	Emergent	NC	NC	NC	NC	NC	NC	<1	NC	<1	<1	NC
Bremer AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
The Boxers Area*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Twilight AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Eastern Recherche AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Van Dieman Gulf Coast*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Southern Arafura AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Arnhem AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA

Santos

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Wessel AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Middle Islands Coast	Emergent	NC	NC	NC	NC	NC	NC	51	3	25	2	NC
Northern Islands Coast	Emergent	NC	NC	NC	NC	NC	NC	3	3	16	<1	NC
Southern Islands Coast	Emergent	939	NC	213	213	NC	NC	118	59	229	4	1
Rankin Bank*	Submerged	NA	NC	NC	NC	NA	NC	NA	30	184	NA	NA
Thevenard Islands	Emergent	NC	NC	320	320	NC	NC	54	38	200	3	NC
Karratha-Port Hedland	Emergent	NC	NC	NC	NC	NC	NC	NC	<1	<1	NC	NC
Glomar Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	<1	66	NA	NA
Port Hedland-Eighty Mile Beach	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	<1	NC	NC
Bedout Island	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	2	NC	NC
Roebuck - Eighty Mile Beach	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	<1	NC	NC
Adele Island	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Browse Island	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m²)	Surface hydrocarbons (10 g/m²)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m²)	Surface hydrocarbons (50 g/m²)	Shoreline accumulation (g/m²)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m²)	Shoreline accumulation (100 g/m²)
Echuca Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Heywood Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Woodbine Bank*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Barracouta Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Rottnest Island	Emergent	NC	NC	NC	NC	NC	NC	1	NC	<1	<1	NC
Hibernia Reef*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Vulcan Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Fantome Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Penguin Shoal*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Sahul Banks*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Gale Bank*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Albany - Esperance	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Walpole - Albany	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Esperance - Cape Arid NP	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
JBG East Coast	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Echo Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Margaret Harries Bank*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Flat Top Bank*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Newby Shoal*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Beagle Gulf-Darwin Coast*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Sunrise Bank*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Tiwi Islands	Emergent	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Vernon Islands CR	Emergent	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Djukbinj NP	Emergent	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Cobourg Peninsula- Nhulunbuy	Emergent	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Nhulunbuy-Borroloola	Emergent	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Christmas Island	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Indonesia - East	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Indonesia - West	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC

Spill modelling results: Surface release of 329 m^3 of MDO

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Ningaloo - Outer Coast North*	Submerged	NA	NC	187	187	NA	NC	NA	44	650	NA	NA
Ashmore Reef AMP	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Muiron Islands	Emergent	NC	NC	144	144	NC	NC	5	60	790	<1	NC
Ningaloo Coast North	Emergent	NC	NC	197	197	NC	NC	7	20	417	<1	NC
Exmouth Gulf Coast	Emergent	NC	NC	NC	NC	NC	NC	NC	4	54	NC	NC
Eighty Mile Beach	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Carnarvon - Inner Shark Bay	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Mermaid Reef AMP*	Intertidal	NC	NC	NC	NC	NA	NC	NC	NC	NC	NC	NC
Broome - Roebuck	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Abrolhos West*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Abrolhos Islands Wallabi Group	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA

Santos

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Abrolhos Islands Easter Group	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Abrolhos Islands Pelsaert Group	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Jurien AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Two Rocks AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Perth Canyon AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Geographe Bay	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Geographe - Offshore Augusta 1*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Barrow-Montebello Surrounds*	Intertidal	NA	37	92	92	NA	NC	NA	64	1365	NA	NA
Barrow Island	Emergent	NC	39	109	109	NC	NC	39	59	1011	<1	NC
Montebello Islands	Emergent	NC	NC	86	86	NC	NC	11	29	429	<1	NC
Lowendal Islands	Emergent	NC	NC	NC	NC	NC	NC	2	3	67	<1	NC
Dampier Archipelago	Emergent	NC	NC	NC	NC	NC	NC	NC	<1	<1	NC	NC

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m²)	Surface hydrocarbons (10 g/m²)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m²)	Surface hydrocarbons (50 g/m²)	Shoreline accumulation (g/m²)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m²)	Shoreline accumulation (100 g/m²)
Ningaloo - Outer NW*	Submerged	NA	NC	290	290	NA	NC	NA	27	385	NA	NA
Ningaloo Coast South	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Imperieuse Reef MP	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Shark Bay - Coast Outer	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Clerke Reef MP	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Zuytdorp Cliffs - Kalbarri	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Kimberley AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Kalbarri - Geraldton	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Abrolhos - Outer Island Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Geraldton - Jurien Bay	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Scott Reef South	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Scott Reef North*	Intertidal	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Camden Sound	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Jurien Bay - Yanchep	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Kimberley Coast PMZ	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Perth Northern Coast	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Johnson Bank*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Cartier Island AMP	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Perth Southern Coast	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Mandurah - Dawesville	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Geographe - Outer*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Geographe - Offshore Augusta 2*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Geographe - Augusta Deep*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Montebello AMP*	Submerged	NA	1	1	1	NA	NC	NA	383	47744	NA	NA

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Ningaloo - Offshore*	Submerged	NA	NC	112	112	NA	NC	NA	109	1576	NA	NA
Dampier AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	<1	<1	NA	NA
Eighty Mile Beach AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Rowley Shoals surrounds*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Shark Bay AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Abrolhos - Offshore NW*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Broome North Coast	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Abrolhos - Nearshore*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Lacepede Islands	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
King Sound	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Abrolhos - Offshore Perth North*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Seringapatam Reef*	Intertidal	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Ashmore/Cartier - Outer*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Perth South - Geographe - Offshore*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Dawesville - Bunbury	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Geographe Bay - Augusta	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
South-west corner AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
JBG West Coast	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Van Cloon/Deep Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
JBG South Coast	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Joseph Bonaparte Gulf AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Christmas Island	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Augusta - Walpole	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Bremer AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
The Boxers Area*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Twilight AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Eastern Recherche AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Van Dieman Gulf Coast*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Southern Arafura AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Arnhem AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Wessel AMP*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Middle Islands Coast	Emergent	NC	NC	NC	NC	NC	NC	NC	<1	8	NC	NC
Northern Islands Coast	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	2	NC	NC
Southern Islands Coast	Emergent	NC	NC	280	280	NC	NC	4	41	514	<1	NC
Rankin Bank*	Submerged	NA	NC	NC	NC	NA	NC	NA	2	81	NA	NA
Thevenard Islands	Emergent	NC	NC	NC	NC	NC	NC	3	19	297	<1	NC

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Karratha-Port Hedland	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Glomar Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	2	63	NA	NA
Port Hedland-Eighty Mile Beach	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Bedout Island	Emergent	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Roebuck - Eighty Mile Beach	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Adele Island	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Browse Island	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Echuca Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Heywood Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Woodbine Bank*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Barracouta Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Rottnest Island	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Hibernia Reef*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Vulcan Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Fantome Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Penguin Shoal*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Sahul Banks*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Gale Bank*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Albany - Esperance	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Walpole - Albany	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Esperance - Cape Arid NP	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
JBG East Coast	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Echo Shoals*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Margaret Harries Bank*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA

Receptor	Receptor type	Minimum time to contact (Hours)						Maximum Hydrocarbon Concentration			Maximum oil ashore (m3)	Maximum length of oiled shoreline (km)
		Moderate Exposure Values				High Exposure Values						
		Shoreline accumulation (100 g/m^2)	Surface hydrocarbons (10 g/m^2)	Dissolved hydrocarbons (50 ppb)	Entrained hydrocarbons (100 ppb)	Shoreline accumulation (1000g/m^2)	Surface hydrocarbons (50 g/m^2)	Shoreline accumulation (g/m^2)	Dissolved hydrocarbons (ppb)	Entrained hydrocarbons (ppb)	Shoreline accumulation (100 g/m^2)	Shoreline accumulation (100 g/m^2)
Flat Top Bank*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Newby Shoal*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Beagle Gulf-Darwin Coast*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Sunrise Bank*	Submerged	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Tiwi Islands	Emergent	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Vernon Islands CR	Emergent	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Djukbinj NP	Emergent	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Cobourg Peninsula- Nhulunbuy	Emergent	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Nhulunbuy-Borroloola	Emergent	NA	NC	NC	NC	NA	NC	NA	NC	NC	NA	NA
Christmas Island	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Indonesia - East	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA
Indonesia - West	Emergent	NA	NC	NC	NC	NC	NC	NA	NC	NC	NA	NA

Appendix G2: High Environmental Value Consequence Summary

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
Outer Ningaloo Coast North (submerged)	1	<u>Habitats</u> The Ningaloo Reef itself and its juxtaposition with coastal terraces, limestone plains, reef sediments. The contact of the reef by entrained oil may reduce the aesthetic appeal and diminish these values. <u>Marine mammals</u> Seasonal aggregations of whale sharks, manta rays, sea turtles and rays. Whale sharks March-July Logger head turtles Green Turtles Dec-March Low density Hawksbill turtles Pygmy Blue Whale feeding <u>Socio-economic and heritage values</u> Very significant for recreational fishing, game	Probability of contact by floating oil at 10 g/m^2	(%)	NC	NC	Threatened/ Migratory Fauna Physical Environment/ Habitat Protected Areas Socio-Economic Receptors	II II II II	II
			Minimum time to contact by floating oil 10 g/m^2	Time (days)	NC	NC			
			Maximum accumulated oil ashore >100 g/m^2	m^3	NC	NC			
			Maximum accumulated concentration >100 g/m^2	g/m^2	NC	NC			
			Maximum length of shoreline oiled (>100 g/m^2)	(km)	NC	NC			
			Maximum concentration	(ppb)	526	821			

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		fishing and charter boat tourism Protected Areas World Heritage Areas Australian Marine Park	of entrained oil >100 ppb						
			Maximum concentration of dissolved hydrocarbon >50 ppb	(ppb)	245	121			
Muiron Islands (emergent)	2	The Muiron Islands are part of the Ningaloo World Heritage Area. Physical habitats Coral reefs + Soft coral communities dominate the reefs on the western side of the Muiron Islands whilst habitats on the eastern side of the Muiron Islands are more sheltered, consisting of sandy beaches and shallow lagoons with diverse soft and hard coral communities (Cassata & Collins, 2008)	Probability of contact by floating oil at 10 g/m²	(%)	NC	NC	Threatened/ Migratory Fauna Physical Environment/ Habitat Protected Areas Socio-Economic Receptors	IV IV IV III	IV
			Minimum time to contact by floating oil 10 g/m²	Time (days)	NC	NC			
			Maximum accumulated oil ashore >100 g/m²	m³	18	9			
			Maximum accumulated concentration >100 g/m²	g/m²	478	209			
			Maximum length of	(km)	5	3			

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		+ The northern boundary substrate can be described as a combination of sand covered limestone pavement (Quadrant Energy, 2016) Seagrasses + Identified on the eastern side of the Muiron Islands Macroalgae + Seagrass and macroalgal habitats are present within the NWS region including Muiron Islands (eastern side) Sandy beaches + The western shores comprise sandy beaches sloping away to the shelf backed by low dunes	shoreline oiled (>100 g/m²)						
			Maximum concentration of entrained oil >100 ppb	(ppb)	289	480			
			Maximum concentration of dissolved hydrocarbon >50 ppb	(ppb)	174	69			

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		Marine fauna Invertebrates + Not identified within the area although noted in the deeper offshore environment or the more protected environment of the nearby Exmouth Gulf (refer Ningaloo Hot Spot) Fish and sharks + Shark aggregations are seasonally reported and manta rays are commonly found in the area Seabirds + Significant bird breeding. Several BIAs for breeding/nesting/roosting, foraging and resting include the Murion Islands + there are five known rookeries as well							

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		isolated rookeries on the Muiron and Sunday Islands Marine reptiles – turtles + Provides important aggregation and nesting areas for turtle populations, including the loggerhead (Caretta caretta) and green (*Chelonia mydas*) + The North West Cape and Muiron Islands are major nesting sites for loggerhead turtles, with approximately 400 and 600 females nesting annually on the Ningaloo Coast (particularly, North West Cape area) and Muiron Islands respectively (DEP, 2001) + The Recovery Plan for Marine Turtles in Australia (2003)							

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		identifies the Muiron Islands (as a principal rookery), and all waters within a 20 km radius as habitat critical to the survival of loggerhead turtles + The Muiron Islands are minor nesting sites for flatback and hawksbill turtles (DEC 2009a) Marine mammals + Seasonal aggregations of whale sharks, manta rays, sea turtles and rays. + Whale sharks Mar to Jul + Pygmy Blue Whale feeding <u>Protected areas</u> + The Ningaloo Coast World Heritage Area (WHA) also includes the Muiron Islands as having outstanding universal value for the							

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		Ningaloo Coast (Refer to Ningaloo Coast Hot Spot) + The Ningaloo Coast WHA includes Muiron Island Marine Management Area (including the Muiron Islands) category IA – Sanctuary Zone (islands) and II – Marine National Park Zone <u>Socio-economic and heritage values</u> + Significant for recreational fishing and charter boat tourism Social amenities and other tourism such as commercial dive charters + The unclassified waters of the Muiron Islands Marine Management area are also open to							

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		commercial fishing in accordance with the *Fish Resources Management Act 1994* (FRM Act) + The Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area (2005 to 2015) identifies that the area has significant indigenous heritage value associated with historical and current use but the linkage appears to be directly related to the Ningaloo Reef and the adjacent foreshore as opposed to the Muiron Islands							
Ningaloo Coast North (Emergent)	2	<u>Habitats</u> Contains part of the largest fringing reef in Australia	Probability of contact by floating oil at 10 g/m^2	(%)	NC	NC	Threatened/Migratory Fauna	IV IV IV	IV

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		Lagoonal., intertidal and subtidal coral communities Nine species of seagrass + macroalgae beds Mangrove bay – Significant for mangroves Yardie Creek – Significant mangroves and tidal creek <u>Marine mammals</u> Seasonal aggregations of whale sharks, manta rays, sea turtles and rays. Whale sharks March-July Loggerhead turtles Green Turtles Dec-March Low density Hawksbill turtles Pygmy Blue whale feeding <u>Seabirds</u> 33 species of seabirds and avifauna. Main breeding areas at Mangrove Bay, Mangrove Point, Point Maud, the Mildura Wreck Site and Fraser Island <u>Protected Areas</u>	Minimum time to contact by floating oil 10 g/m²	Time (days)	NC	NC	Physical Environment/ Habitat Protected Areas Socio-Economic Receptors	II	
			Maximum accumulated oil ashore >100 g/m²	m^3	54	23			
			Maximum accumulated concentration >100 g/m²	g/m²	517	179			
			Maximum length of shoreline oiled (>100 g/m²)	(km)	16	6			
			Maximum concentration of entrained oil >100 ppb	(ppb)	373	581			
			Maximum concentration of dissolved hydrocarbon >50 ppb	(ppb)	119	55			

Santos

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		Includes 13 out of the 18 sanctuary zones under the state MP. World Heritage Areas Exmouth Peninsula Karst System is an official value of the National Heritage Area <u>Socio-economic and heritage values</u> Tourism Recreational Fishing fishing and charter boat tourism							
Barrow-Montebello Surrounds (Intertidal)	3	<u>Habitats</u> Coral reefs habitat <u>Seabirds</u> Migratory birds <u>Turtles</u> Internesting <u>Whales</u> Humpback/pygmy blue whale migration	Probability of contact by floating oil at 10 g/m²	(%)	NC	NC	Threatened/Migratory Fauna Physical Environment/ Habitat Protected Areas Socio-Economic Receptors	III II II II Fauna consequence allocated III due to turtle nesting	III
			Minimum time to contact by floating oil 10 g/m²	Time (days)	NC	NC			
			Maximum accumulated	m^3	NC	NC			

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		<u>Socio-economic</u> Significant for recreational fishing and charter boat tourism	oil ashore >100 g/m²						
			Maximum accumulated concentration >100 g/m²	g/m²	NC	NC			
			Maximum length of shoreline oiled (>100 g/m²)	(km)	NC	NC			
			Maximum concentration of entrained oil >100 ppb	(ppb)	308	494			
			Maximum concentration of dissolved hydrocarbon >50 ppb	(ppb)	456	254			
Montebello Islands (Emergent)	3	<u>Habitats</u> Reefs – coral spawning: Mar & Oct Algae (40%)	Probability of contact by floating oil at 10 g/m²	(%)	NC	NC	Threatened/Migratory Fauna Physical Environment/ Habitat Protected Areas	IV IV IV III	IV
			Minimum time to contact by	Time (days)	NC	NC			

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		Mangroves (considered globally unique as they are offshore) Fish habitat Intertidal sand flat communities <u>Turtles</u> Loggerhead and green (significant rookery), hawksbill, flatback turtles – Loggerhead turtle nesting: Dec-Jan; green turtle nesting: Nov to Apr, peak period from Jan-Feb; flatback turtle nesting: Dec-Jan; hawksbill turtle nesting: Oct to Jan Northwest and Eastern Trimouille Islands (hawksbill) Western Reef and Southern Bay at Northwest Island (green) <u>Seabirds</u> Migratory and threatened seabirds – 14 species	floating oil 10 g/m²				Socio-Economic Receptors		
			Maximum accumulated oil ashore >100 g/m²	m^3	33	13			
			Maximum accumulated concentration >100 g/m²	g/m²	342	165			
			Maximum length of shoreline oiled (>100 g/m²)	(km)	11	3			
			Maximum concentration of entrained oil >100 ppb	(ppb)	203	286			
			Maximum concentration of dissolved hydrocarbon >50 ppb	(ppb)	446	249			

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		Significant nesting (Sept to Feb), foraging and resting areas Whales Humpback (Jun to Jul), Pygmy blue (Apr to Aug) whale migration Socio-economic Pearling (inactive/pearling zones) Very significant for recreational fishing and charter boat tourism Social amenities and other tourism Nominated place (national heritage)							
Lowendal Islands (Emergent)	3	Habitats Important shallow lagoons with seagrass for dugongs Deep-water benthic (soft-sediment) habitats Dugong Reef and Batman Reef (eastern side Island)	Probability of contact by floating oil at 10 g/m²	(%)	NC	NC	Threatened/Migratory Fauna Physical Environment/ Habitat Protected Areas Socio-Economic Receptors	IV IV IV III	IV
			Minimum time to contact by floating oil 10 g/m²	Time (days)	NC	NC			

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		Mangroves are considered globally unique as they are offshore Macroalgal reefs (40%) <u>Turtles</u> Important hawksbill (Beacon, Parakeelya, Kaia and Pipeline), loggerhead and green turtle nesting (minor) Varanus pipeline, Harriet and Andersons Beaches) Nesting is reported to occur throughout the year in WA, peaking between October and January Significant flatback rookery, nesting season for flatback turtles peaks in December and January with subsequent peak hatchling emergence in February and March <u>Seabirds</u> Approximately 89 species of avifauna, 12 to 14	Maximum accumulated oil ashore >100 g/m²	m^3	8	3			
			Maximum accumulated concentration >100 g/m²	g/m²	182	74			
			Maximum length of shoreline oiled (>100 g/m²)	(km)	2	NC			
			Maximum concentration of entrained oil >100 ppb	(ppb)	83	117			
			Maximum concentration of dissolved hydrocarbon >50 ppb	(ppb)	38	24			

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		species of migratory and threatened seabirds Marine mammals Seagrass beds around the Lowendal Islands thought to provide valuable food source for dugongs Protected areas The Barrow Island Marine Management Area, most of the waters around Barrow Island, the Lowendal Islands and the Barrow Island Marine Park Socio-economic and heritage values Social amenities and other tourism, very significant for recreational fishing and charter boat tourism							
Barrow Island (Emergent)	3	Habitats Bandicoot Bay – conservation area *Fisheries Act* (benthic fauna/seabird	Probability of contact by floating oil at 10 g/m²	(%)	NC	NC	Threatened/Migratory Fauna	IV IV IV	IV

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		protection), mudflats, rock platforms, mangroves, clay pans Mangroves in Bandicoot Bay (considered globally unique) Coral reefs (eastern side) – Biggada Reef (coral spawning: Mar & Oct) Biggada Creek <u>Turtles</u> Regionally and nationally significant green turtle (western side) and flatback turtle (eastern side) nesting beaches Turtle Bay north beach North and west coasts – John Wayne Beach also loggerhead and hawksbill turtles. Peak turtle nesting periods – Loggerhead turtle nesting: Dec-Jan; green turtle nesting: Nov to Apr, peak period from Jan to Feb; flatback turtle nesting:	Minimum time to contact by floating oil 10 g/m²	Time (days)	NC	NC	Physical Environment/ Habitat Protected Areas Socio-Economic Receptors	III	
			Maximum accumulated oil ashore >100 g/m²	m^3	17	7			
			Maximum accumulated concentration >100 g/m²	g/m²	243	130			
			Maximum length of shoreline oiled (>100 g/m²)	(km)	6	2			
			Maximum concentration of entrained oil >100 ppb	(ppb)	235	405			
			Maximum concentration of dissolved hydrocarbon >50 ppb	(ppb)	314	118			

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		Dec to Jan; hawksbill turtle nesting: Oct to Jan Seabirds Migratory birds (important habitat) (important bird area) 10th of top 147 bird sites Highest population of migratory birds in Barrow Island Nature Reserve (south-southeast island) Double island important bird nesting (shearwaters, sea eagles) Whales Pygmy blue whale northern migration (Apr to Aug) Cultural heritage Important Aboriginal cultural: 13 listed sites incl. pearling camps Socio-economic Significant for recreational fishing and charter boat tourism							

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		Nominated place (national heritage)							
Outer NW Ningaloo (Submerged)	3	Physical habitats Coral reef Seagrasses Macroalgal beds Non-coral benthic habitats high and unique sponge biodiversity Marine fauna Invertebrates Cetacean migration Finfish and rays Whale sharks – migratory and aggregation site Manta rays aggregation 500 finfish species recorded Birds 33 species seabirds and avifauna present (13 resident and 20 migratory) 13 JAMBA/CAMBA species	Probability of contact by floating oil at 10 g/m²	(%)	NC	NC	Threatened/Migratory Fauna Physical Environment/ Habitat Protected Areas Socio-Economic Receptors	II II II II	II
			Minimum time to contact by floating oil 10 g/m²	Time (days)	NC	NC			
			Maximum accumulated oil ashore >100 g/m²	m^3	NC	NC			
			Maximum accumulated concentration >100 g/m²	g/m²	NC	NC			
			Maximum length of shoreline oiled (>100 g/m²)	(km)	NC	NC			
			Maximum concentration	(ppb)	499	779			

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
		Marine mammals 13 species of toothed whale and dolphin and seven species of baleen whale Protected area Key Ecological Feature (Commonwealth Waters adjacent to Ningaloo Reef) and Continental Slope Demersal Fish Communities Socio-economic and heritage values Sanctuary zones under state MP National Heritage Place Shipwrecks important as diving sites	of entrained oil >100 ppb						
			Maximum concentration of dissolved hydrocarbon >50 ppb	(ppb)	246	124			
Ningaloo Coast South (Emergent)	3	Refer Outer NW Ningaloo and Ningaloo Coast North	Probability of contact by floating oil at 10 g/m²	(%)	NC	NC	Threatened/Migratory Fauna Physical Environment/ Habitat Protected Areas	III III III II	III
			Minimum time to contact by	Time (days)	NC	NC			

Receptor (hotspot) name	HEV Ranking	Values	Oil Spill Modelling Parameter NC = No Contact		Subsea	Surface	Consequence Category	Consequence Ranking	Final
			floating oil 10 g/m²				Socio-Economic Receptors		
			Maximum accumulated oil ashore >100 g/m²	m^3	9	5			
			Maximum accumulated concentration >100 g/m²	g/m²	10	20			
			Maximum length of shoreline oiled (>100 g/m²)	(km)	NC	NC			
			Maximum concentration of entrained oil >100 ppb	(ppb)	32	45			
			Maximum concentration of dissolved hydrocarbon >50 ppb	(ppb)	2	2			