BP IRONBARK

Exploration Drilling

Environment Plan

AU001-HS-PLN-600-00001
Rev.A03

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Abbreviations and Acronyms

1 µPa	**Micropascal (root-mean-square sound pressure)**
1 µPa @ 1 m	Micropascal at one metre
$1 \mu Pa^2$	Mean-square sound pressure
$1 \mu Pa^2.s$	Sound exposure
ABSTIA	Australian Southern Bluefin Tuna Industry Association
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
AHS	Australian Hydrographic Service
AHTS	Anchor handling, tow and support (vessels)
AICS	Australian Inventory of Chemical Substances
ALARP	As low as reasonably practicable
AMOSC	Australian Marine Oil Spill Centre
AMP	Australian Marine Park
AMSA	Australian Maritime Safety Authority
APPEA	Australian Petroleum Production and Exploration Association
API	American Petroleum Institute
ASTM	American Society for Testing and Materials
bbls	Standard Barrels (unit)
Beach	Beach Energy Limited
BIA	Biologically important area
BOD	Biological oxygen demand
BOEM	US Bureau of Ocean Energy Management
BOP	Blow-out preventer
BP	BP Developments Australia Pty Ltd
BPMF	Broome Prawn Managed Fishery
Cd	Cadmium
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CFA	Commonwealth Fisheries Association
CH_4	Methane
CHARM	Chemical Hazard and Risk Management
CO_2	Carbon dioxide
Cue	Cue Exploration Pty Ltd

DAWE	Department of Agriculture, Water and Environment
dB	Decibels
DBCA	Department of Biodiversity, Conservation and Attractions
dB PK	dB re 1µPa PK
dB RMS	dB re 1 µPa @ 1 m RMS
dB SEL	dB SEL re 1µPa^2.s
dB SEL_{cum} 24 hr	Cumulative SEL over 24 hours
DotEE	Department of the Environment and Energy
DP	Dynamically Positioned
DPLH	Department of Planning, Lands and Heritage
DPIRD	Department of Primary Industries and Regional Development
DPZ	Distinct Permeable Zones
ECS	Elemental Capture Spectroscopy sonde
EEZ	Exclusive Economic Zone
EMBA	Environment that May Be Affected
EP	Environment Plan
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ERP	Emergency Response Plan
ESD	Ecologically Sustainable Development
FLNG	Floating Liquefied Natural Gas
GOO	Global Operations Organisation
GWO	Global Wells Organisation
HF	High-Frequency
Hg	Mercury
Hz	Hertz
HSSE	Health, Safety, Security and Environment
IADC	International Association of Drilling Contractors
IAP	Incident Action Plan
IAPP	International Air Pollution Prevention
ICUN	International Union for Conservation of Nature
IEE	International energy efficiency
IMCRA	Integrated Marine and Coastal Regionalisation of Australia
IMO	International Martime Organisation
IMS	Invasive marine species

IMT	Incident Management Team
IOPP	International Oil Pollution Prevention
IOT	Indian Ocean Territories
IPA	Indigenous Protected Area
IRIS	BP's database for incident action tracking
JPDA	Joint Petroleum Development Area
JRCC	AMSA's Joint Rescue Coordination Centre
KEF	Key Ecological Feature
kHz	Kilohertz
KPMF	Kimberley Prawn Managed Fishery
LCM	Lost circulation materials
LEL	Lower Explosive Limits
LF	Low-Frequency
LOWC	Loss of well control
LWD	Logging while drilling
m	Metre
MAFMF	Marine Aquarium Fish Managed Fishery
MARS	Maritime Arrivals Reporting System
MDO	Marine Diesel Oil
MES	Monitoring, Evaluation and Surveillance
MF	Mid-Frequency
MFO	Marine Fauna Observer
MMA	Marine Management Area
MMscf	One million standard cubic feet
MNES	Matters of National Environmental Significance
MO	Marine Order
MoC	Management of Change
MODU	Mobile Offshore Drilling Unit
MoU	Memorandum of Understanding
MP	Marine Park
MSDS	Material Safety Data Sheet
MPA	Marine Protected Areas
NatPlan	National Plan for Maritime Environmental Emergencies
NBPMF	Nickol Bay Prawn Managed Fishery

NEPM	Australian Ambient Air Quality National Environmental Protection (Air Quality) Measures
NICNAS	National Industrial Chemicals Notification and Assessment Scheme
NMR	Nuclear Magnetic Resonance
NOEC	No Observed Effect Concentration
Non-CHARMable	Products not applicable to CHARM model
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NOx	Oxides of nitrogen
NT	Northern Territory
NWMR	North West Marine Region
NWS	North West Shelf
NWSTF	North West Slope Trawl Fishery
NZOG	NZOG (Ironbark) Pty Ltd
OCNS	Offshore Chemical Notification Scheme
ODME	Oil Discharge Monitoring Equipment
OGUK	Oil and Gas United Kingdom
OIE	Offset Installation Equipment
OMS	Operating Management System
OPEP	Oil Pollution Emergency Plan
OPGGS Act	*Offshore Petroleum and Greenhouse Gas Storage Act 2006*
OPGGS(E)R	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
OPMF	Onslow Prawn Managed Fishery
OSMP	Operational Scientific Monitoring Program
OSRL	Oil Spill Response Limited
OWR	Oiled Wildlife Response
OWS	Oily Water Separator
P&IDs	Piping and Instrumentation Drawings
PK	Peak
PM	Particulate Matter
PMS	Preventative Maintenance System
PNEC	Predicted no effect concentration
ppm	Parts per million
PTS	Permanent Threshold Shift

PVT	Pressure Volume Temperature
RAAF	Royal Australian Air Force
re	Reference
RMS	Root mean square
RO	Reverse Osmosis
ROV	Remotely operated vehicle
SBM	Synthetic based muds
SBTF	Southern Bluefin Tuna Fishery
SEEMP	Ship Energy Efficiency Management Plan
SEL	Sound Exposure Level
SIMA	Spill Impact Mitigation Assessment
SIMAP	Spill Impact Mapping and Analysis Program
SMPEP	Shipboard Marine Pollution Emergency Plan
SOC	Synthetic on Cuttings
SOPEP	Shipboard Oil Pollution Emergency Plan
SORC	Safety and Operational Risk Committee
SOx	Oxides of sulphur
SPL	Sound Pressure Level
SPRAT	Species Profile and Threats (Database)
SSMF	Specimen Shell Managed Fishery
T	Tonnes
TD	Target Depth
TSS	Total Suspended Solids
TTS	Temporary Threshold Shift
UAV	Unmanned Aerial Vehicles
UNCLOS	United Nations Law of the Sea Convention
VSP	Vertical seismic profiling
WA	Western Australia
WAFIC	Western Australian Fishing Industry Council
WBG	World Bank Group
WBM	Water-based muds
WCD	Worst-case discharges
WDTF	Western Deepwater Trawl Fishery
WHA	World Heritage Area

WOMP	Well Operations Management Plan
WSTF	Western Skipjack Tuna Fishery
WTBF	Western Tuna and Billfish Fishery

1 Introduction

1.1 Environment Plan Summary

The Ironbark Exploration Drilling Environment Plan (EP) Summary has been prepared from material provided in this EP. The summary consists of the following as required by Regulation 11(4) of the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E)R).

Table 1-1: EP Summary Requirements

EP Summary Material Requirement	Relevant Section of EP Containing EP Summary Material
The location of the activity	Section 2.1.1
A description of the receiving environment	Section 3 and Appendix A
A description of the activity	Section 2
Details of the environmental impacts and risks	Section 5 and Section 6; Appendix B and Appendix C
The control measures for the activity	Section 5 and Section 6
The arrangements for ongoing monitoring of the titleholder's environmental performance	Section 5, Section 6 and Section 7
Response arrangements in the oil pollution emergency plan	Section 7.5;Appendix D and Appendix E
Consultation already undertaken and plans for ongoing consultation	Section 7.11; Appendix F
Details of the titleholders nominated liaison person for the activity	Section 1.5

1.2 Background

BP Developments Australia Pty Ltd (BP) has entered into a Joint Operating Agreement with Cue Exploration Pty Ltd (Cue), Beach Energy Limited (Beach) and NZOG (Ironbark) Pty Ltd (NZOG) covering Exploration Permit WA-359-P. BP, Cue, Beach and NZOG are the titleholders of WA-359-P and have agreed to form a joint venture to further explore the Ironbark prospect in WA-359-P (Figure 1-1). BP is the titleholder nominated to undertake eligible voluntary actions on behalf of all titleholders, and is also the operator under the Joint Operating Agreement.

To meet their work program obligations under the title, the titleholders are required to drill a single exploration well within WA-359-P.

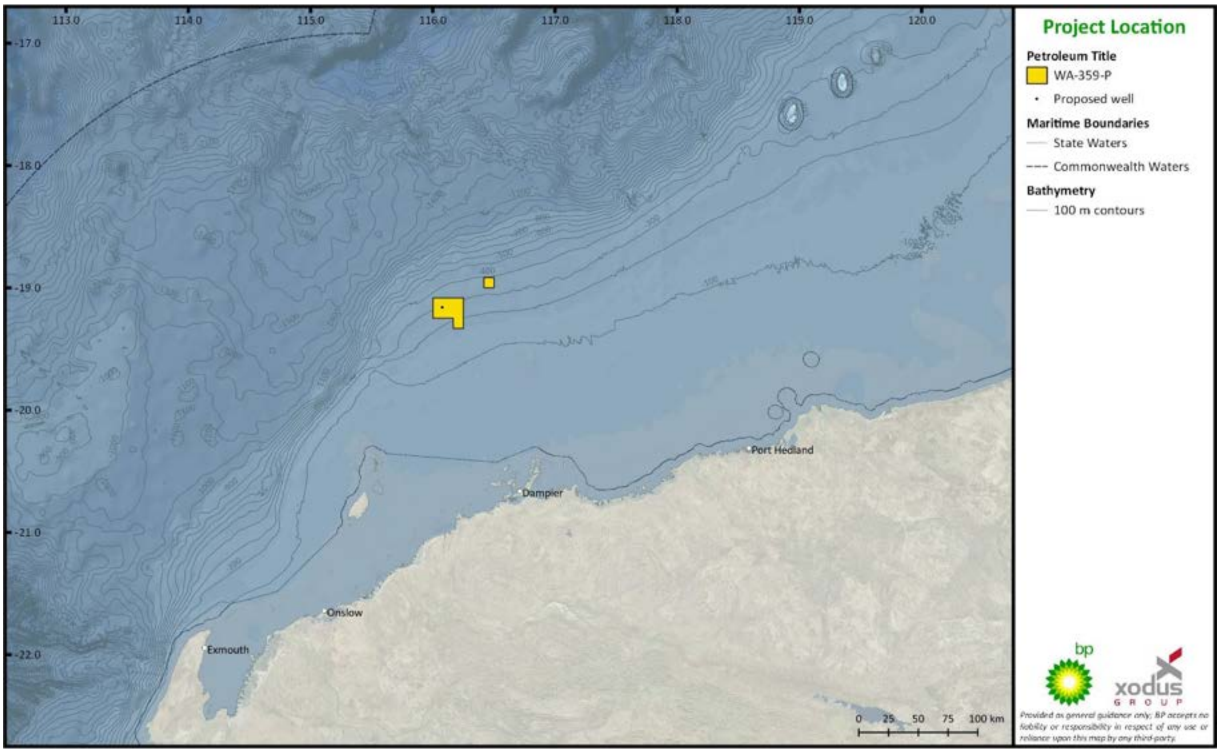


Figure 1-1: Location of WA-359-P

1.3 Purpose

The Ironbark prospect is in Commonwealth waters. Accordingly, this EP has been prepared to meet the requirements of Commonwealth legislation, namely the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (OPGGS(E)R).

1.4 Scope

This EP includes exploration drilling and associated activities to be undertaken by BP with a Mobile Offshore Drilling Unit (MODU) as defined in Section 2.3 within the Operational Area as defined in Section 2.1.2.

Excluded from the scope of this EP are vessels transiting to or from the Operational Area. These vessels are deemed to be operating under the Commonwealth *Navigation Act 2012* and not performing a petroleum activity.

1.5 Titleholder Details

The participating interests in WA-359-P are presented in Table 1-2 and the liaison person for this petroleum activity is included in Table 1-3. If the titleholder or titleholder's nominated liaison person or contact details for the nominated liaison person changes, BP will notify the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) in accordance with Regulation 15(3) of the OPGGS(E)R. Specifically, a written notification including any changes to Table 1-2 and Table 1-3 will be provided to NOPSEMA as soon practicable after the change occurs.

Table 1-2: Titleholder Participating Interests and Operatorship

Title	Titleholder	Operator
WA-359-P	BP 42.5% (ACN 081 102 856)	BP
	Cue 21.5% (ACN 004431850)	
	Beach 21% (ACN 007 617 969)	
	NZOG 15% (ACN 629599766)	

Table 1-3: Details of Titleholder and Liaison Person

Titleholder	
Company Name	BP Developments Australia Pty Ltd
ACN	081 102 856
Registered Business Address	GPO Box 5222 Melbourne, VIC 3008 Australia
Nominated Liaison Person	
Name	Tzila Katzel
Position	Director Environmental and Community Affairs
Telephone Number	08 9420 1828
Email Address	Tzila.Katzel@se1.bp.com

1.6 Requirements

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

The activity is located in Commonwealth waters.

Table 1-4 details the Commonwealth requirements and any codes or guidelines applicable to the activity, and Table 1-5 details the Recovery Plans, Threat Abatement Plans and Species Conservation Advices relevant to those species that have been identified to be present within the extent of the Environment that May Be Affected (EMBA) by the activity (Section 3).

Table 1-4: Summary of Requirements Relevant to the Activity

Requirement	Scope	Application to Activity	Administering Authority
Australian Maritime Safety Authority Act 1990	Facilitates international cooperation and mutual assistance in preparing and responding to major oil spill incidents and encourages countries to develop and maintain an adequate capability to deal with oil pollution emergencies.	In Commonwealth waters Australian Maritime Safety Authority (AMSA) is the Statutory Agency for vessels and must be notified of all incidents involving a vessel. In Commonwealth waters AMSA is the Control Agency for all ship-sourced marine pollution incidents and will respond in accordance with its Marine Pollution Response Plan.	AMSA
Australian Ballast Water Management Requirements (DAWR 2017)	The Australian Ballast Water Management Requirements set out the obligations on vessel operators with regards to the management of ballast water and ballast tank sediment when operating within Australian seas.	Provides requirements on how vessel operators should manage ballast water when operating within Australian seas to comply with the *Biosecurity Act 2015*. Section 6.3 details these requirements in relation to the management of ballast water.	Department of Agriculture, Water and Environment (DAWE)
Biosecurity Act 2015 **Biosecurity Regulations 2016**	The objects of this Act include the provision to manage risks related to ballast water and biosecurity emergencies.	The Biosecurity Act and regulations apply to 'Australian territory' which is the airspace over and the coastal seas out to 12 nm from the coastline. For the activity it regulates vessels entering Australian territory regarding ballast water and hull fouling. Biosecurity risks associated with the activity are detailed in Section 6.3.	DAWE
Environment Protection and Biodiversity Conservation Act 1999 **(EPBC Act)**	The Act aims to: • Protect matters of national environmental significance (MNES); • Provides for Commonwealth environmental assessment and approval processes; and • Provides an integrated system for biodiversity conservation and management of protected areas. MNES are: • World heritage properties; • RAMSAR wetlands;	Petroleum activities are excluded from within the boundaries of a World Heritage Area (Sub regulation 10A(f). The activity is not within a World Heritage Area. The EP must describe matters protected under Part 3 of the EPBC Act and assess any impacts and risks to these. Section 3 describes matters protected under Part 3 of the EPBC Act. The EP must assess any actual or potential impacts or risks to MNES from the activity. Section 5 and Section 6 provides an assessment of any impacts and risks to matters protected under Part 3 of the EPBC Act.	DAWE

Requirement	Scope	Application to Activity	Administering Authority
	• Listed threatened species and communities; • Migratory species under international agreements; • Nuclear actions, • Commonwealth marine environment; • Great Barrier Reef Marine Park; and • Water trigger for coal seam gas and coal mining developments. The assessment process is overseen by NOPSEMA as the delegated authority under the EPBC Act.		
Underwater Cultural Heritage Act 2018 ***Underwater Cultural Heritage (Consequential and Transitional Provisions) Act 2018***	Protects the heritage values of Australia's shipwrecks, sunken aircraft and other types of underwater cultural heritage.	Anyone who finds the remains of a vessel or aircraft, or an article associated with a vessel or aircraft, needs to notify the relevant authorities, as soon as possible but ideally no later than after one week, and to give them information about what has been found and its location. Section 3.4.8.3 details that there are no historic shipwrecks, sunken aircraft or other known cultural heritage site or artefact near or within the Operational Area.	DAWE
National Biofouling Management Guidance for the Petroleum Production and Exploration Industry 2009	The guidance document provides recommendations for the management of biofouling hazards by the petroleum industry.	Applying the recommendations within this document and implementing effective biofouling controls can reduce the risk of the introduction of an introduced marine species. Section 6.3 details the requirements applicable to vessel activities.	DAWE
National Environment Protection Measures (Implementation) Act 1998 (and associated regulations)	The Act provides for the implementation of national environment protection measures (NEPMs) in respect of certain activities carried on by or on behalf of the Commonwealth and Commonwealth authorities, and for related purposes. Specific objects of the Act are: • to make provision for the implementation of national environment protection measures in respect of certain activities carried on, by or on behalf of	The act enables implementation of National Environment Protection Measures (NEPMs), which are a set of national objectives designed to assist in protecting or managing aspects of the environment. National objectives are concerned with; air toxics, ambient air quality, assessment of site contamination, diesel vehicle emissions, movement of controlled waste, national pollutant inventory and used packaging. Demonstration that the activity will be undertaken in line with the principles of ecologically sustainable development, and that impacts and risks resulting from these activities relevant to NEPM	DAWE

Requirement	Scope	Application to Activity	Administering Authority
	the Commonwealth and Commonwealth authorities; • to protect, restore and enhance the quality of the environment in Australia, having regard to the need to maintain ecologically sustainable development; and • to ensure that the community has access to relevant and meaningful information about pollution.	national objectives are ALARP and acceptable is provided in Section 5.6.	
Navigation Act 2012	Regulates international ship and seafarer safety, shipping aspects of protecting the marine environment and the actions of seafarers in Australian waters. It gives effect to the relevant international conventions (MARPOL 73/78, COLREGS 1972) relating to maritime issues to which Australia is a signatory. The Act also has subordinate legislation contained in Regulations and Marine Orders.	All ships involved in petroleum activities in Australian waters are required to abide to the requirements under this Act. Several Marine Orders (MO) are enacted under this Act which relate to offshore petroleum activities, including: • MO 21: Safety of navigation and emergency procedures • MO 30: Prevention of collisions • MO 31: Vessel surveys and certification • MO 59: Offshore industry vessel operations Sections 5.5, 5.6,5.7,6.2 and 6.3 detail the requirements applicable to vessel activities.	AMSA
Offshore Petroleum and Greenhouse Gas Storage Act 2006 **(OPGGS Act)** **OPGGS(E)R**	The Act addresses all licensing, health, safety, environmental and royalty issues for offshore petroleum exploration and development operations extending beyond the three-nautical mile limit. Part 2 of the OPGGS(E)R specifies that an EP must be prepared for any petroleum activity and that activities are undertaken in an ecologically sustainable manner and in accordance with an accepted EP.	The OPGGS Act provides the regulatory framework for all offshore petroleum exploration and production activities in Commonwealth waters, to ensure that these activities are carried out: • Consistent with the principles of ecologically sustainable development as set out in section 3A of the EPBC Act. • So that environmental impacts and risks of the activity are reduced to ALARP and are of an acceptable level. Demonstration that the activity will be undertaken in line with the principles of ecologically sustainable development, and that impacts and risks resulting from these activities are ALARP and acceptable is provided in Section 5 and Section 6.	NOPSEMA
Offshore Petroleum and Greenhouse Gas	These Regulations ensure that facilities are designed, constructed, installed, operated, modified and decommissioned in Commonwealth	All offshore petroleum exploration activities in Commonwealth waters, are required to be conducted in accordance with Accepted	NOPSEMA

Requirement	Scope	Application to Activity	Administering Authority
Storage (Safety) Regulations 2009	waters only in accordance with safety cases that have been accepted by the Safety Authority. They also provide for hazard risk identification, analysis and monitoring.	safety case. As such environmental components described within this EP are required to be conducted safely. Demonstration that the activity will be undertaken in line with safe operating procedures is provided in Section 6.2 and 6.4.4.	
Ozone Protection and Synthetic Greenhouse Gas Management Act 1989 (and associated regulations)	The Act to provides for measures to protect the ozone layer and to minimise emissions of Synthetic Greenhouse Gases.The specific objectives of this act are to: • control the manufacture, import, export, use and disposal of substances that deplete ozone in the stratosphere and contribute to climate change; • achieve a faster and greater reduction in the levels of production and use of ozone depleting substances than are required under the Montreal Protocol; and • promote responsible management and handling of ozone depleting substances and synthetic greenhouse gases to minimise their impact on the atmosphere.	Ozone depleting gases are commonly used as refrigerants in refrigeration and air conditioning equipment and also in other uses including fire protection, foam blowing and aerosols, and for medical uses. Demonstration that the activity will be undertaken in line with the Act and considered ALARP and acceptable is provided in Section 5.6.	DoEE
Protection of the Sea (Powers of Intervention) Act 1981	An 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 for related purposes.	This Act gives AMSA appropriate powers to intervene in shipping operations to protect the Australian coastline. Demonstration that the activity will be undertaken in line with the Act and considered ALARP and acceptable is provided in section 6.4.4.	AMSA
Protection of the Sea (Prevention of Pollution from Ships) Act 1983	The Act aims to protect the marine environment from pollution by oil and other harmful substances discharged from ships in Australian waters. It also invokes certain requirements of the MARPOL Convention such as those relating to discharge of noxious liquid substances, sewage, garbage and air pollution.	All ships involved in petroleum activities in Australian waters are required to abide to the requirements under this Act. Several MOs are enacted under this Act relating to offshore petroleum activities, including: • MO Part 91: Marine Pollution Prevention – Oil • MO Part 93: Marine Pollution Prevention – Noxious Liquid Substances	AMSA

Requirement	Scope	Application to Activity	Administering Authority
	Requires ships greater than 400 gross tonnes to have pollution emergency plans in place and provides for emergency discharges from ships.	• MO Part 94: Marine Pollution Prevention – Harmful Substances in Packaged Forms • MO Part 95: Marine Pollution Prevention – Garbage • MO Part 96: Marine Pollution Prevention – Sewage • MO Part 97: Marine Pollution Prevention – Air Pollution • MO Part 98: Marine Pollution Prevention – Anti-fouling Systems. Section 5.7 and Section 6.3 detail the requirements applicable to vessel activities.	
Protection of the Sea (Harmful Antifouling Systems) Act 2006	The Act aims to protect the marine environment from the effects of harmful anti-fouling systems. Under this Act, it is an offence to engage in negligent conduct that results in a harmful anti-fouling compound being applied to a ship. This Act requires Australian ships to hold 'anti-fouling certificates', if they meet certain criteria.	All ships involved in offshore petroleum activities in Australian waters are required to abide to the requirements under this Act. The Marine Order MO 98: Marine Pollution Prevention – Anti-fouling Systems is enacted under this Act. Section 6.3 details the requirements applicable to vessel activities.	AMSA

Table 1-5: Recovery Plans, Threat Abatement Plans and Species Conservation Advices

Relevant Plan/Advice	Applicable Management Advice
Approved Conservation Advice for *Calidris canutus* (Red Knot)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Red Knot. **Marine pollution:** Evaluate risk of oil spill impact from the Ironbark Exploration Drilling Program to nest locations and, if required, appropriate mitigation measures are implemented (Section 3.3.4).
Approved Conservation Advice for *Calidris ferruginea* (Curlew Sandpiper)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Curlew Sandpiper. **Marine pollution:** Evaluate risk of oil spill impact from the Ironbark Exploration Drilling Program to nest locations and, if required, appropriate mitigation measures are implemented (Section 3.3.4).
Approved Conservation Advice for *Limosa lapponica bauera* (Bar-tailed Godwit (baueri))	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Bar-tailed Godwit. **Marine pollution:** Evaluate risk of oil spill impact from the Ironbark Exploration Drilling Program to nest locations and, if required, appropriate mitigation measures are implemented (Section 3.3.4).
Approved Conservation Advice for *Limosa lapponica menzbieri* (Bar-tailed Godwit (northern siberian))	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Northern Siberian Bar-tailed Godwit.

Relevant Plan/Advice	Applicable Management Advice
	Marine pollution: Evaluate risk of oil spill impact from the Ironbark Exploration Drilling Program to nest locations and, if required, appropriate mitigation measures are implemented (Section 6.4.4 and Section 6.4.5.4).
National recovery plan for threatened albatrosses and giant petrels 2011-2016	The overall objective of this recovery plan is to ensure the long term survival and recovery of albatross and giant petrel populations breeding and foraging in Australian jurisdiction by reducing or eliminating human related threats at sea and on land. **Marine pollution:** Evaluate risk of oil spill impact from the Ironbark Exploration Drilling Program to nest locations and, if required, appropriate mitigation measures are implemented (Section 6.4.4 and Section 6.4.5.4).
Approved Conservation Advice for *Numenius madagascariensis* (Eastern Curlew)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Eastern Curlew. **Marine pollution:** Evaluate risk of oil spill impact from the Ironbark Exploration Drilling Program to nest locations and, if required, appropriate mitigation measures are implemented (Section 6.4.4 and Section 6.4.5.4).
Approved Conservation Advice for *Papasula abbotti (*Abbott's Booby)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Abbot's Booby. **Marine pollution:** Evaluate risk of oil spill impact from the Ironbark Exploration Drilling Program to nest locations and, if required, appropriate mitigation measures are implemented (Section 6.4.4 and Section 6.4.5.4).
Approved Conservation Advice for *Sternula nereis nereis (*Australian Fairy Tern)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Australian Fairy Tern. Main identified potential threat identified to be relevant to the Ironbark Exploration Drilling Program: • Oil spills – Evaluate risk of oil spill impact from the Ironbark Exploration Drilling Program to nest locations and, if required, appropriate mitigation measures are implemented (Section 6.4.4 and Section 6.4.5.4).
Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*)	The overarching objective of this recovery plan is to assist the recovery of the grey nurse shark in the wild, throughout its range in Australian waters. Threat identified to be relevant to the Ironbark Exploration Drilling Program s: • None identified
Recovery Plan for the White Shark (*Carcharodon carcharias*)	The overarching objective of this recovery plan is to assist the recovery of the white shark in the wild throughout its range in Australian waters. Threats identified to be relevant to the Ironbark Exploration Drilling Program: • None identified.
Approved Conservation Advice for *Rhincodon typus* (Whale Shark)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the Whale Shark. Threats identified to be relevant to the Ironbark Exploration Drilling Program: • Vessel strike (Section 6.2.3), • Habitat disruption from mineral exploration, production and transportation (Section 5.3), • Marine debris (Section 6.4.1).

Relevant Plan/Advice	Applicable Management Advice
Sawfish and River Sharks Multispecies Recovery Plan **Approved Conservation Advice for *Pristis clavate* (Dwarf Sawfish)** **Approved Conservation Advice for Green Sawfish**	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of Sawfish. Threats identified to be relevant to the Ironbark Exploration Drilling Program: • None identified.
Recovery Plan for Marine Turtles in Australia, 2017-2027	The long-term recovery objective for marine turtles is to minimise anthropogenic threats to allow for the conservation status of marine turtles to improve so that they can be removed from the EPBC Act threatened species list. Threats identified to be relevant to the Ironbark Exploration Drilling Program: • Chemical and terrestrial discharge (Section 5.7 and Section 6.4) • Marine debris (Section 6.4.1), • Light pollution (Section 5.4), • Habitat modification (Section 6.2.3), • Vessel strike (Section 6.2.3), • Noise interference (Section 5.5), • Vessel disturbance (Section 5.5 and Section 6.2.3).
Approved Conservation Advice for *Dermochelys coriacea* (Leatherback Turtle)	See above for Recovery Plan for Marine Turtles in Australia, 2017-2027.
Conservation Management Plan for the Blue Whale, 2015-2025	The long-term recovery objective for blue whales is to minimise anthropogenic threats to allow for their conservation status to improve so that they can be removed from the EPBC Act threatened species list. Threats identified to be relevant to the Ironbark Exploration Drilling Program: • Noise interference: Evaluate risk of noise impacts and, if required, appropriate mitigation measures are implemented (Section 5.5). • Vessel disturbance: Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented (Section 5.5 and Section 6.2.3).
Approved Conservation Advice for *Balaenoptera borealis* (Sei Whale)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the Sei Whale. Threats identified to be relevant to the Ironbark Exploration Drilling Program: • Noise disturbance: Evaluate risk of noise impacts and, if required, appropriate mitigation measures are implemented (Section 5.5). • Vessel strike: Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented (Section 6.2.3).

Relevant Plan/Advice	Applicable Management Advice
Approved Conservation Advice for *Balaenoptera physalus* (Fin Whale)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the Fin Whale. Threats identified to be relevant to the Ironbark Exploration Drilling Program: • Noise disturbance: Evaluate risk of noise impacts and, if required, appropriate mitigation measures are implemented (Section 5.5) • Vessel strike: Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented (Section 6.2.3).
Approved Conservation Advice for *Megaptera novaeangliae* (Humpback Whale)	Conservation advice provides threat abatement activities that can be undertaken to ensure the conservation of the Humpback Whale. Threats identified to be relevant to the Ironbark Exploration Drilling Program: • Noise interference: Evaluate risk of noise impacts to cetaceans and, if required, appropriate mitigation measures are implemented (Section 5.5) • Vessel strike: Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented (Section 6.2.3).
Approved Conservation Advice for *Aipysurus apraefrontalis* (Short-nosed Seasnake)	Conservation advice provides management actions that can be undertaken to ensure the conservation of the Short-nosed Seasnake. Oil and gas exploration activities have coincided with the species' decline, although potential impacts from these activities on sea snakes have not been quantified.

2 Activity Description

In accordance with OPGGS(E)R Regulation 13(1) and OPGGSR Regulation 15(1)(c) this section provides a description of the petroleum activity, including:

- The proposed location of the drilling activity;
- An outline of the operational details of the drilling activity; and
- Additional information relevant to the consideration of potential environmental impacts and risks including an outline of the Ironbark prospect characteristics and credible worst-case discharges (WCD).

2.1 Overview

2.1.1 Activity Location

This EP provides for exploration drilling and associated activities (as described in Section 2.3, and thereafter referred to the 'drilling activities' or the 'Ironbark Exploration Drilling Program') for a single exploration well in the Carnarvon Basin off Western Australia's north-west coast, in an area where hydrocarbon exploration and production is well established (Figure 1-1).

The proposed well is located in Commonwealth waters and has a water depth of approximately 300 m. Indicative coordinates for the Ironbark-1 exploration well are provided in Table 2-1.

Table 2-1: Ironbark-1 Exploration Well Indicative Coordinates

Planned well	Longitude (E)	Latitude (S)	Approximate water depth
Ironbark-1	116° 04' 35.80	19° 09' 34.01"	~300 m

2.1.2 Operational Area

The "Operational Area" for the drilling activities is defined as the area within 10.5 km of the indicative well location; this area is defined to encompass both the 500m petroleum safety zone around the MODU (when on location) and support activities such as anchoring and resupply, which typically fall within 2 km of a well location. The transit activities of the MODU and support vessels outside this area is outside the scope of this EP and is managed under the Commonwealth *Navigation Act 2012* (Section 1.4).

2.1.3 Activity Timeframe

Drilling activities are planned to commence in Q3 of 2020, although depending on MODU availability, may commence between Q2 of 2020 and Q2 2021. Drilling activities are expected to take approximately 90-100 days (excluding weather and operational delays). Drilling and support activities will typically be conducted on a 24-hour basis. Activity is complete upon MODU moving outside the well location on tight tow.

2.2 Ironbark Prospect Characteristics

The properties of the Ironbark hydrocarbon prospect are discussed in the following subsections.

2.2.1 Hydrocarbon Composition

Given the absence of successful exploration wells penetrating the targeted formation at comparable depths, analogue reservoir data has been used to provide an indication of the expected hydrocarbon properties for the Ironbark-1 exploration well.

The Ironbark prospect is targeting multiple objectives within the Triassic Mungaroo Formation, which has been intensively explored at comparably shallower depths and includes the Gorgon, Julimar–Brunello, Iago, Goodwyn, Perseus and North Rankin gas fields. All of these fields are known to produce gas condensate. Goodwyn is the closest penetration on the reservoirs targeted by the drilling activities. Although the Goodwyn analogue occurs in shallower reservoirs, and the Ironbark prospect sits on a deeper fault block, the targeted prospect has been assessed to be otherwise geologically similar to those reservoirs producing hydrocarbons similar to the Goodwyn gas condensate.

Goodwyn 10 PVT has therefore been chosen as a suitable analogue given its proximity to the Ironbark prospect and indicative well location. The physical characteristics of the expected condensate (using the Goodwyn 10 PVT lab results as an analogue) are provided in Table 2-2.

Table 2-2: Expected Physical Characteristics of the Ironbark Hydrocarbon

Parameter		Hydrocarbon properties
Density @ 25 °C		773.1 kg/m^3
Dynamic Viscosity @ 21.1°C		0.912 cP
Wax content (%)		4.8 %
Pour Point (°C)		-30 °C
Boiling Point Curve (% mass)	Volatile (<180°C)	62.0%
	Semi-volatile (180-265°C)	22.0%
	Low Volatility (265-380°C)	13.6%
	Residual (>380°C)	2.4%
API		51.5

2.2.2 Flow Rate

Based upon the proposed well design and expected reservoir characteristics, BP has estimated the potential flow rate during a credible worst-case discharge due to a total loss of well control (a well blowout). Whilst the likelihood of a blowout during well construction is very low, using a worst-case credible spill scenario enables an environmentally conservative estimate to be made of the potential impacts associated with the Ironbark-1 exploration drilling program.

The Ironbark-1 estimates were derived following internal guidance consistent with the "Guidance for complying with BOEM NTL No. 2010-N06 on Worst Case Discharge for Offshore Wells" prepared by the Society of Petroleum Engineers. Assuming that the well is flowing through unobstructed 12 ¼" open hole and 13 5/8" casing string, it is estimated that the initial flowrate is 79,480 bbl/day (condensate rate), 1,236 bbl/day (water rate) and 883 MMscf/day (gas rate). Such flow rates would result in a total condensate spill volume of 6.267 MMstb (or 996,327.7 m3) based on an 83-day release duration corresponding to the time required to complete relief well drilling based on this well design.

2.3 Exploration Drilling Activity Description

This section outlines the planned drilling activities that have the potential to result in environmental aspects and impacts or risks to receptors.

2.3.1 MODU Positioning

The Ironbark exploration well is proposed to be drilled by a MODU. The MODU selected to complete the activities within this EP will be towed to location and anchored over the well site. Anchors may be placed on the seabed and tested by the support vessels before the MODU arrives on site.

Up to twelve anchors, run from the corners of the main deck of the MODU, will be set in place by support vessels. Anchoring operations consist of running and setting of rig anchors (typically weighing 12-15 t each and having a footprint of approximately 30 m^2 each). Anchors are attached to either wire, chain or a combination of both (typically 85 mm / R5 chain) at around 1,500 m – 2,000 m from the drilling location. The exact anchor spread will be dependent on the preliminary mooring analysis conducted during the planning phase of the drilling program, but will conform with the Australian Petroleum Production and Exploration Association (APPEA) MODU Mooring in Australia Tropical Waters Guideline.

Anchors may be fitted with acoustic transponders to monitor anchor position and seabed penetration during MODU positioning. If transponders are used they will typically be attached to clump weights and then lowered onto the seabed; the clump weights remain on the seabed after the transponders are retrieved. Transponders generate a ping type sound signal within a frequency range of 7 to 60 kHz, with a sound pressure level of 174 dB re 1 uPa @ 1 m RMS (Ward et al. 2001 cited in Seiche 2008).

2.3.2 MODU Operations

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

- Power generation systems supplied by diesel engines;
- 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).
- Remotely operated vehicle (ROV), which may be deployed to perform visual surveys, manipulate subsea valves, transfer or position subsea equipment and in response to an incident.

2.3.3 Well Design and Drilling Methodology

An indicative overview of the drilling design and methodology is described in this section. This process is subject to change, depending on individual well design requirements and the final location of the well. Well schematics are provided in the Well Operations Management Plan (WOMP) submitted to NOPSEMA for assessment prior to drilling.

Once the MODU has been safely positioned (Section 2.3.1) drilling operations will commence. The well construction scope comprises standard industry exploration drilling activities including open-water riserless top-hole drilling, casing running and cementing operations, installation and use of a Blow Out Preventer (BOP) for well control, use of specialist data acquisition tools for formation evaluation, installation of verified barriers to isolate Distinct Permeable Zones (DPZs) and permanent well abandonment.

The Ironbark-1 well will be constructed in stages. After each hole section has been drilled to a planned depth or geological reference point tubular steel (casing strings) will be run and cemented in place to provide essential structural support and in some cases also isolate permeable formations that are differently pressured.

The first two hole sections will be drilled in open-water. Once the wellhead is installed the MODU will connect a conduit, known as a marine riser. As is standard industry practice whilst drilling riser-less, small pieces of the drilled formation known as cuttings are dispersed at the seabed. These cuttings are removed from the wellbore by pumping through the drill string and fluid exiting the bit carries the drilled material up the annulus to the seabed.

Drilling fluid, which is composed of a base fluid plus additives e.g. weighting agents, viscosifiers, is commonly referred to as drilling mud. Several base fluids are available for use in drilling activities including water as well as non-aqueous fluids. Drill fluids are used for multiple purposes during standard drilling operations including, but not limited to (Hindwood et al 1994):

- Carrying cuttings to the surface
- Supplying hydraulic power to the bit
- Exerting a hydrostatic head to help prevent caving or sloughing of the formation
- Preventing flow of formation fluids into the borehole, or blowouts
- Suspension of cuttings and weight material such as barite when circulation is interrupted, as when adding a new joint of drill pipe
- Limiting fluid loss into permeable formations (formation of filter cake)

The drilling methodology proposed uses a combination of sea water with high-viscosity gel sweeps during riser-less drilling activities, water-based muds (WBM), and synthetic based muds (SBM) as outlined in Table 2-3 and Table 2-4. Where practicable the use of seawater or WBM is planned because it is considered the most environmentally benign. However, in the deeper portion of the Ironbark-1 well it is anticipated that SBM will be required to meet the technical challenges posed by the downhole conditions. Where this is necessary the SBM formulation will be engineered to minimise potential environmental impacts and managed using a chemical selection process (Section 7.3).

Once the first hole section has been drilled a string of casing referred to as the conductor is installed. On Ironbark-1 a 36” conductor will be cemented in place inside a 42” hole. Cement will be pumped into the annulus between the conductor and drilled formation (Section 2.3.6). As per standard industry practice, to create a solid structural foundation for the well an excess volume of cement is pumped to ensure that seawater is fully displaced, cement contamination levels remain low and any formation wash-outs are compensated for.

Next a 22” casing string, referred to as the surface casing, will be cemented in a 26” hole using a process similar to that outlined above. Once the surface casing is installed the BOP can be run on the marine riser and connected to the wellhead. Once the riser is installed, drilling cuttings and fluids are returned to the MODU where the drilling fluids will be separated using solids control equipment. Whilst drilling the remaining portion of the well, drilling fluid will be recirculated, conditioned and re-used. During the 17 1/2”x22” and 16 1/2” sections, where WBM is planned to be used, the cuttings will be discharged close to the water’s surface (via a chute which discharges below the water line).

Throughout the 12 1/4” and 8 1/2” prognosed reservoir intervals the cuttings will be dried prior to discharge to limit discharges of entrained SBM. No discharges of whole SBM are planned during normal well operations to minimise potential environmental impact.

Wireline data acquisition, including VSP (Section 2.3.7), is planned to evaluate the drilled formations and verify the presence and quantity of hydrocarbons. Following this, permanent barriers will be installed to isolate any identified DPZs from each other and the marine environment. In preparation for removing the riser the well will be displaced to seawater to avoid discharging SBM. Shallow portions of the casing strings will then be removed along with the wellhead as part of the well abandonment (Section 2.3.8).

Only one major SBM pit cleaning exercise is anticipated during planned well operations, which is during the well abandonment phase. Note that if the non-aqueous fluid content (e.g. SBM residue) of pit cleaning waste fluids is not <1% v/v oil, the waste water will not be discharged overboard. Prior to discharging, all fluids will be tested to confirm that the threshold has been met. Similarly, in the event of deteriorating weather conditions, it may be necessary to suspend the well and displace the riser contents to seawater, in preparation for potentially unlatching from the well. Any fluid used to displace the riser contents will also only be discharged if the fluid meets the <1% v/v oil threshold when tested.

Once operations are complete the MODU anchors will be recovered, a post operation ROV survey conducted (Section 2.3.9) and the MODU towed off location.

Table 2-3 Indicative Drilling Methodology

Hole size[a]	Approximate depth below seabed (m)	Hole length (m)	Casing Size	Cuttings Volume (m^3)	Estimated Fluid Volume discharged	Cuttings Discharge Location	Fluid Type to Drill Section
42”	84	84	36”	100	2,100 m^3 [a]	Seabed	Seawater with high-viscosity gel sweeps
26”	1284	1,200	22”	535		Seabed	Seawater with high-viscosity gel sweeps
17 1/2” x 22”	2809	1,525	18”	430	890 m^3	Surface	WBM
16 1/2”	4054	1,245	13 5/8”	195	1215 m^3	Surface	WBM
12 1/4"	4979	926	9 5/8”	60	10.5 m^3 [c]	Surface	SBM
8 1/2”	5370 [b]	390	N/A	13	3 m^3 [c]	Surface	SBM

[a] total volume of seawater with viscous sweeps released during riserless drilling is in the order of 2,100 m^3 assuming 100 bbls of sweeps is added approximately every 15 m whilst drilling riserless and an additional 150 % hole volume is pumped after reaching the target depth of the 42” and 26” sections.

[b] The additional volume associated with another 145 m of drilling (geological uncertainty) would be ~5m^3 in a 8 1/2" hole, which may take in the order of 15 hours of additional drilling. Based on extensive modelling studies the judgement of RPS is that the potential additional drill cuttings volume resulting from drilling to a deeper depth will not materially increase the footprint on the seabed.

[c] Estimated fluid discharge is based upon amount of SBM discharged to the environment as residual oil-on-cuttings. At the end of drilling, all the recovered SBM will be returned to the vendor for reuse i.e. no planned discharge of whole SBM.

2.3.4 Contingency Drilling Activities

Contingent drilling activities such as re-spudding the well or side-tracking may be required if surface casing strings do not reach their planned setting depth. This could be a result of bore hole instability, where the borehole does not maintain its size and shape which can result in structural integrity issues. Contingent drilling activities may also include the use of lost circulation materials in the event of downhole fluid losses to the formation. Lost circulation occurs when the drill bit encounters natural fissures in the rock formations, and drilling fluids flow into these spaces rather than circulate back to the rig. In both cases, these contigent drilling activities are undertaken to maintain well control.

The Ironbark drilling team estimates the probability of having to respud 1 in 10, based on a review of the offset wells on either side of the Ironbark prospect.

Some contingent drilling activities may generate additional volumes of drilling fluids and cuttings to be discharged (Table 2-4).

Table 2-4 Contingent Drilling Activities

Abnormal Condition	Contingent Drilling Activity	Process	Additional Discharges
Operational or technical issues when drilling the 42" or 26" sections	Well re-spud	Move the MODU and begin to drill a new well in a suitable, safe location within the immediate area of the original well. Well construction issues resulting in a re-spud generally occur during riser-less operations when response or remediation options are more limited.	Increase in the volume of fluids and cuttings discharged i.e. maximum additional discharge equal to double the estimate of fluids and cuttings discharged during the 42" and 26" sections.
Operational or technical issues when drilling 17 1/2"x22", 16 1/2", 12 1/4" or contingency 8 1/2" sections.	Side track	Drilling a secondary well-bore away from an original well-bore, typically having isolated the original motherbore.	Increase in the volume of fluids and cuttings discharged i.e. maximum additional discharge equal to doubling the estimate of fluids and cuttings discharged for the relevant hole sections.
Lost circulation. **When drilling fluid preferentially flows into exposed geological formations instead of returning up the annulus.**	Use of lost circulation materials (LCM)	Use of insoluable or fibrous fluid additives, bridging agents such as ground calcium carbonate, or in extreme cases cement.	Potential for additional cement discharges. Quantities will be dependent on the scenario encountered. For example, when using cement to respond to severe lost circulation it may be possible to continue drilling ahead by drilling out the cement in the wellbore, however in other scenarios it may be necessary to side-track. During a lost circulation event it is expected that the volume of drilling fluid and cuttings discharged from surface would remain consistent with normal drilling operations.

2.3.5 Blow-Out Preventer Installation and Function Testing

A blow-out preventer (BOP) is used for parts of the drilling program to provide additional well control and prevent unplanned release of fluids from the wellbore. BOPs consist of a series of hydraulically-operated valves and sealing mechanisms, such as ram preventers and annular preventers, that can be quickly closed to isolate the well if required. Whilst the configuration and size of the BOP vary between MODUs and well requirements, the BOP system will comprise 'rams' including annular rams designed to seal around the tubular components in the well; as well as blind-shear rams that have the capability to sever the drill pipe and in some cases casing strings. To ensure redundancy within the system, valves can be operated remotely from either the MODU, or via intervention using remotely operated vehicles (ROV).

The BOP is pressure tested frequently (at least every 21 days) and function tested (at least once every 7 days or as operations allow), as per API Standard 53, to ensure that it is in good operating condition during use. During these function and pressure tests, a small volume of water-based control fluids (such as Castrol Transaqua HT2 and Stack Magic Eco F) is released to the environment. Indicatively, 3.1 m^3 of diluted control fluid (at a concentration of 3-5%) is released per function test and 1.5 m^3 per pressure test is released to the environment.

2.3.6 Cementing Operations

After a string of casing or a liner has been positioned in the well, spacer fluid is pumped to flush drilling fluids and remove filter cake to allow a good cement bond to be formed between the steel casing and the formation. Following the spacer fluid, a cement slurry is pumped down the inside of the casing (or liner). Drilling fluid is typically then pumped into the casing with a wiper plug to displace the cement out of the bottom of the casing and up into the annular space between the casing and the borehole wall. Once the cement has cured, the casing and sealing elements are pressure tested.

When cementing top-hole sections (without a riser in place), the spacer fluid is displaced by the cement slurry and discharged directly to the seabed at the mudline: resulting in a release of approximately 8 m^3 of spacer fluid. Once the riser is installed, approximately 8 m^3 of spacer fluid is anticipated to be discharged from the surface after each cement activity.

Upon completion of each cementing activity, the cementing head and blending tanks are cleaned which results in a release of cement-contaminated water to the ocean: approximately 3 m^3 (20 bbls) per cement activity, depending on the volume left over within the cement unit pipework. Flushing and cleaning of the cement mixing equipment and lines is a necessary operation to prevent plugging of the equipment by cement.

In the event that the cement slurry is mixed incorrectly, it may not be possible or appropriate to use the slurry as a well barrier. This would result in the cement being discharged to sea. In the worst case, the entire volume discharged would be in the order of 90 m^3 (550 bbls).

The bulk dry cement may be transported in dry bulk storage tanks to the MODU via project support vessels. During transfer the holding tanks are vented, which may result in small volumes of dry cement being discharged. Additionally, prior to commencement of cementing operations, the cementing unit may be tested and result in a discharge of a volume up to 16 m^3 of cement slurry to the sea.

The bulk cement inventory is managed and only shipped prior to planned cement jobs, to minimise the risk of cement degradation during storage. Unused excess bulk dry cement will be utilised by the subsequent operator on the MODU if possible. Alternatively, excess bulk dry cement will be mixed with water and discharged below the water line at the well location.

The potential volume of cement slurry resulting from the disposal of excess bulk dry cement is assumed to be within the worst-case cement slurry discharge volume of 90 m^3 (in the event cement slurry is mixed incorrectly and requires disposal).

2.3.7 Formation Evaluation - VSP

A standard data acquisition program is planned for the evaluation of the Ironbark well. During the drilling phase there will be both mudlogging (surface cuttings and gas) and logging while drilling (LWD - down hole petrophysical logs such as GR-Res-Sonic Neutron Density) data sets collected for the entire well. In a success case, additional wireline logs will be run at Target Depth (TD - where hydrocarbon reservoirs are predicted to be located) to further evaluate formation and fluids. These wireline logs may include Nuclear Magnetic Resonance (NMR), Elemental Capture Spectroscopy sonde (ECS), images, downhole pressures and fluids, rotary sidewall cores and vertical seismic profiling (VSP). Of these activities, only VSP is associated with additional emissions. VSP is a routine activity conducted as part of exploration drilling activities to provide detailed information regarding geological structures and stratigraphy in the vicinity of the well. VSP operations involve deploying an acoustic sound source from the MODU or support vessel, while a number of receivers are positioned at different levels within the drilled hole to measure the travel time.

For this drilling program, VSP sound sources are anticipated to have a volume of 512 cubic inches and expected sound pressure level of 227 dB re 1 uPa @ 1 m RMS. Sound sources are generally positioned at 5 to 10 m water depth. VSP operations are typically of short duration. Specific details of the VSP program will depend on the geological target and the objectives of the VSP operation. VSP operations are generally undertaken over a period of 24 hours.

2.3.8 Well Plugging and Abandonment

After completing the drilling activity and gathering the required logging data, BP will plug and permanently abandon the Ironbark-1 exploration well. A summary of the abandonment methodology is included in the following subsections.

2.3.8.1 Isolation of identified permeable zones

Once sufficient information has been gathered to evaluate the target formation, a permanent reservoir barrier will be installed and verified adjacent to identified natural geological seals, meeting the requirements of Oil and Gas United Kingdom (OGUK) Well Decommissioning Guidelines (OGUK, 2018). If required, annular cement will first be verified and/or remediated prior to isolating the wellbore. Cement will then be placed in the wellbore adjacent to the verified annulus cement and identified geological seals to form a lateral barrier. Once the cement has hardened, the barrier will be verified using weight and/or pressure tests. The SBM volume recovered will be shipped back to shore for re-use. Any contaminated SBM will be segregated and shipped to shore for reconditioning or disposal.

Any additional over-pressured, permeable zones that have been identified during well construction will also be isolated during the well abandonment process.

After installing and verifying all the well barriers for permanent abandonment the well will be displaced to seawater.

2.3.8.2 *Casing removal*

To facilitate removing the wellhead a shallow portion of the 13 5/8” casing is first required to be removed. This casing cutting operation is expected to result in the generation of approximately 30 kg of metal shavings. These will be returned to the MODU via the riser and recovered for disposal through the cuttings treatment equipment.

2.3.8.3 *Removal of BOP stack*

Once all of the permanent abandonment barriers have been installed and successfully tested, the marine riser with the attached BOP is disconnected and both are recovered back to the MODU. Prior to disconnecting the marine riser and BOP from the wellhead, the riser and BOP will be flushed and displaced to seawater.

2.3.8.4 *Removal of surface casing and wellhead*

A wellhead cutting tool is then landed onto the wellhead to sever the casing just below the seabed (~1.5m below the seabed). This requires cutting the 22” casing and the 36” conductor strings. Metal shavings (approximately 420 kg) generated during cutting will remain within the wellbore below seabed, although it is anticipated that some material will disperse to the seabed in close proximity to the well location. Based upon previous wellhead removal, the typical time to cut wellhead is in the order of three to seven hours.

2.3.8.5 *Recovery of wellhead*

The wellhead will be recovered to the MODU immediately following wellhead severance.

If the wellhead cannot be removed whilst the MODU is on location, BP will submit a proposed revision to the EP to remove the wellhead at a later date.

2.3.9 Post Operation ROV survey

Once the wellhead is removed, an ROV is deployed from the MODU to conduct a post operation survey that involves a 70 m radius visual check from the wellhead location. This survey records the condition of the seabed at the completion of the program to ensure that no dropped objects or subsea equipment intended for removal remain on the seabed.

2.3.10 Summary of Drilling Discharges

A summary of the drilling and well abandonment discharges estimated for the Ironbark-1 exploration well is provided in Table 2-5.

Table 2-5: Summary of Drilling Emissions and Discharges

Type	Estimated Volume [a]	Discharge location	Activity	Description
Drill cuttings and high-viscosity gel sweeps	635 m^3 cuttings 2100 m^3 fluid	Subsurface	Riserless drilling	During the initial well construction stage, prior to a conduit (riser) being in place to transport cuttings back to the MODU, the cuttings are deposited around the well location. Fluids used during these sections are generally, inert and water-based with low toxicity
Drill cuttings and water-based	625 m^3 cuttings	Surface	Drilling	Water based drilling fluids are fluids in which water or saltwater is the major

Type	Estimated Volume [a]	Discharge location	Activity	Description
drilling fluid (WBM)	2105 m^3 fluid			liquid phase. General categories of water-base muds are fresh water, seawater, brine.
Drill cuttings and non-aqueous drilling fluid (SBM)	73 m^3 cuttings 13.5 m^3 fluid	Surface	Drilling	Non-aqueous drilling fluids are fluids in which synthetic fluids are in continuous liquid phase. No non-aqueous drilling fluid discharges are planned however it is recognised that some fluid will be entrained on dried drilled cuttings which are planned to be discharged. It is estimated that up to 13.5 m^3 of non-aqueous drilling fluid may be discharged as fluid entrained on discharged cuttings.
Cementing spacer fluid	8 m^3 per cement activity	Subsurface (riserless cementing operations) Surface (cementing post-riser installation)	Cementing operations	Drilling fluids are often incompatible with cement slurries, so a spacer fluid, which is compatible with both systems, is used to separate the two.
Cement contaminated water	3 m^3 per cement activity	Surface	Cementing operations	Cleaning of the surface cementing equipment and blending tanks after each cement job results in a release of water containing traces of cement
BOP fluid	3.1 m^3 diluted control fluid per function test; and 1.5 m^3 pressure test fluid - per pressure test	Subsurface	BOP Installation and Function Testing	Operating the BOP results in small volumes of water-based control fluids being released to the environment.
Metal shavings	420 kg metal shavings	Subsurface	Well Plug and Abandonment	The wellhead protrudes above the seabed and once cemented in place enables the BOP to be connected to the well. Removal of the wellhead (or severing of the wellhead) requires a mechanical cutting tool to be run into the well. Cutting through the 22” and 36” casing strings to remove the wellhead results in the generation of metal shavings. The majority of these shavings are expected to remain inside the wellbore beneath the seabed.
Atmospheric emissions	Emissions based on usage of 30,000 m^3 MDO by MODU	Surface	Power generation	The energy needed on offshore drilling rigs is usually supplied by diesel engines. Typically these engines use 20–30 m^3 diesel fuel per day, depending on the operations performed (IPIECA 2013).

[a] Volumes listed do not include an allowance for contingency operations.

2.4 Support Operations

The MODU will be supported by two or three dynamically positioned (DP) vessels, including anchor handling, tow and support (AHTS) vessels. The vessels will be fuelled with marine diesel oil (MDO) and be either stationary or operating at slow speeds while undertaking activities within the Operational Area including:

- Towing the MODU to/from well location;
- Supporting mooring and BOP running operations;
- Providing standby for the MODU (one vessel on location at all times performing a number of duties such as vessel interaction sentry and standby during helicopter take-off / landing);
- Transfer provisions (food, bulk materials*, fuel), equipment and wastes to and from the MODU and shore base; and
- Facilitate site and equipment inspections / surveys before and after MODU arrival.

* Different materials required for the drilling program will be transferred from support vessels to the MODU in dry or liquid bulk.

Cement, barite and bentonite are transported as dry bulk to the MODU by support vessels and pneumatically blown to the MODU storage tanks using compressed air. The dry bulk storage tanks on the MODU vent excess compressed air to atmosphere. This venting process carries small amounts of solids, which is discharged below the MODU. Based upon previous programs it is estimated that during each transfer a loss in the order of 0.1% is expected to be recorded. In volume terms that equates to a conservative estimate of approximately 1mT for the drilling program.

Liquid bulk SBM will be transferred from support vessels onto the MODU via hoses. It is expected that the transfer of approximately 635 m^3 of SBM may require 1-2 vessels depending on capacity – where number of hose transfers will be dependent on the available pit space/vessel capacity and weather conditions. Base oil will also be transferred to allow dilution treatments of the whole mud.

The MODU is serviced by helicopters, with an expected flight frequency of 10 times per week (on average). Helicopters will primarily be used for passenger transfers/crew changes and minor supplies and may also be used in the event of an emergency evacuation.

ROVs will also be used to support drilling activities. This may include during equipment deployment, monitoring and retrieval and during BOP activation under emergency conditions. Hydraulic systems on the ROVs are closed systems and not designed to release hydraulic fluid. These ROVs are intended to be parked on the deck of the vessels and/or MODU and are unlikely to be temporarily parked on the seabed during operations.

3 Description of the Environment

3.1 Regulatory Context

OPGGS(E)R define 'environment' as the ecosystems and their constituent parts; natural and physical resources; qualities and characteristics of areas; the heritage value of places; and includes the social, economic and cultural features of those matters. In accordance with the OPGGS(E)R, the EP describes the ecological (Sections 3.2 and 3.3) and social (Section 3.4) components of the environment relevant to the activity.

A greater level of detail is provided for those particular values and sensitivities as defined by Regulation 13(3) of the OPGGS(E)R which include:

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.

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

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

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

Under the OPGGS(E)R, the EP must describe the Environment that May Be Affected (EMBA), including details of the particular values and sensitivities (if any) within that environment. Identified values and sensitivities must include, but are not necessarily limited to, the matters protected under Part 3 of the EPBC Act. A protected matters search report for the EMBA is provided in Appendix A.

3.2 Environment that May Be Affected

3.2.1 Definition

The Ironbark Exploration Drilling Program is planned in Permit WA-359-P, located in Commonwealth waters approx. 170 km offshore from Karratha. The planned exploration well is located within the IMCRA Northwest Transition bioregion (Section 3.2.8.1).

The EMBA for the Ironbark Exploration Drilling Program has been defined as an area where a change to ambient environmental conditions may potentially occur as a result of planned activities or unplanned events. It is noted that a change does not always imply that an adverse impact will occur; for example, only in the event a change to ambient environmental conditions is sustained over a particular exposure value or over a consistent period of time, a subsequent impact may occur. The EMBA for the Ironbark Exploration Drilling Program extends between the Western Australian (WA) - Northern Territory (NT) border and the south-west corner of WA to the south-western edge of the Economic Exclusion Zone (EEZ) surrounding the external Territory of Cocos (Keeling) Islands (Section 3.2.6).

For the purposes of the EP, the EMBA associated with the Ironbark Exploration Drilling Program has been further split into sub-areas that are used to support the impact and risk evaluations, as presented in in Table 3-1.

Table 3-1: Description of Ironbark Exploration Drilling Program EMBA Sub-Areas

Ironbark Exploration Drilling EMBA Sub-Areas	Description
EMBA	The extent of the EMBA for the Ironbark Exploration Drilling Program is based on the results of stochastic oil spill modelling of a highly conservative LOWC scenario (refer to Section 6.4.5). This represents the largest spatial extent of potential changes to ambient environment conditions from an aspect resulting from the proposed activity. The EMBA encompasses the cumulative extent of a total of 300 seasonal spill simulations using 'low' exposure values for each of the modelled oil components (1 g/m^2 floating, 10 ppb dissolved and entrained, 10 g/m^2 shoreline) and includes all probabilities of exposure. This modelled area of exposure was then smoothed and simplified (i.e. additional areas were incorporated, including all coastal areas, irrespective of modelling results) to define the outer boundary of the EMBA. The EMBA does not represent the reach of an individual spill event.
Operational Area	This area has been defined to include the extent of all planned activities and is the area relevant to the impact and risk assessments for all planned activites and unplanned events, with the exception of accidental hydrocarbon releases. The Operational Area has been defined as a 10.5 km area extending around the indicative well location.
Hydrocarbon Exposure Area	This area has been defined to include the worst-case extent of predicted hydrocarbon exposure resulting from planned activities, and the area relevant to the risk assessment for unplanned hydrocarbon releases. The Hydrocarbon Exposure Area has been defined based on the outcomes of stochastic modelling (i.e. it is the cumulative extent of a total of 300 seasonal model simulations) using moderate/high exposure values for each of the modelled oil components (10 g/m^2 floating, 50 ppb dissolved, 100 ppb entrained, 10 g/m^2 shoreline) and includes all probabilities of exposure[1].

Descriptions of the ecological, social, economic and cultural environments, their associated values and sensitivities, and their presence in each of the above areas, are described in the following sections. Threatened species recovery plans, threat abatement plans and species conservation advices relevant to the receptors identified in this section are detailed in Table 1-5.

[1] The identification of values and sensitivities (including an EPBC protected matters search) has been completed using the outer extent of modelled exposures at the moderate and high exposure thresholds as defined by NOPSEMA (2019).

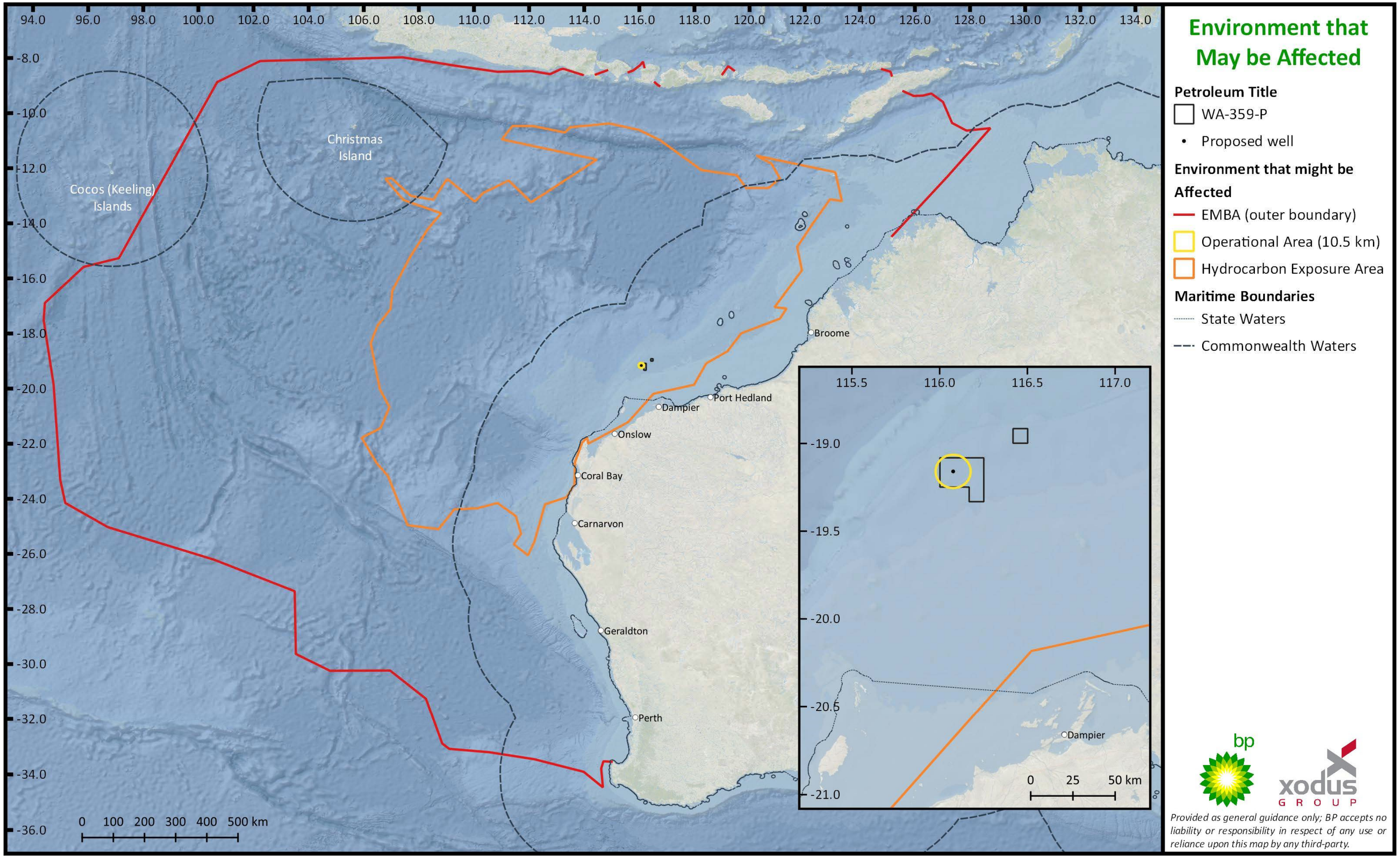


Figure 3-1: Environment that May Be Affected

3.2.2 Regional Context

Regional descriptions relevant to the EMBA sub-areas as shown in Table 3-2 are provided in the sections below.

Table 3-2: Relevant regions to the Ironbark Exploration Drilling Program EMBA Sub-areas

Marine region	EMBA	Operational Area	Hydrocarbon Exposure Area
North marine region	x	-	**x**
South-west marine region	x	-	x
Christmas Island Territory	x	-	x
Cocos (Keeling) Island Territory	x	-	-
Outside Australian EEZ	x	-	x
North-west marine region	x	x	x
Northwest Transition	x	x	x
Northwest Shelf Province	x	-	x
Northwest Province	x	-	x
Central Western Shelf Transition	x	-	x
Central Western Transition	x	-	x
Timor Province	x	-	x

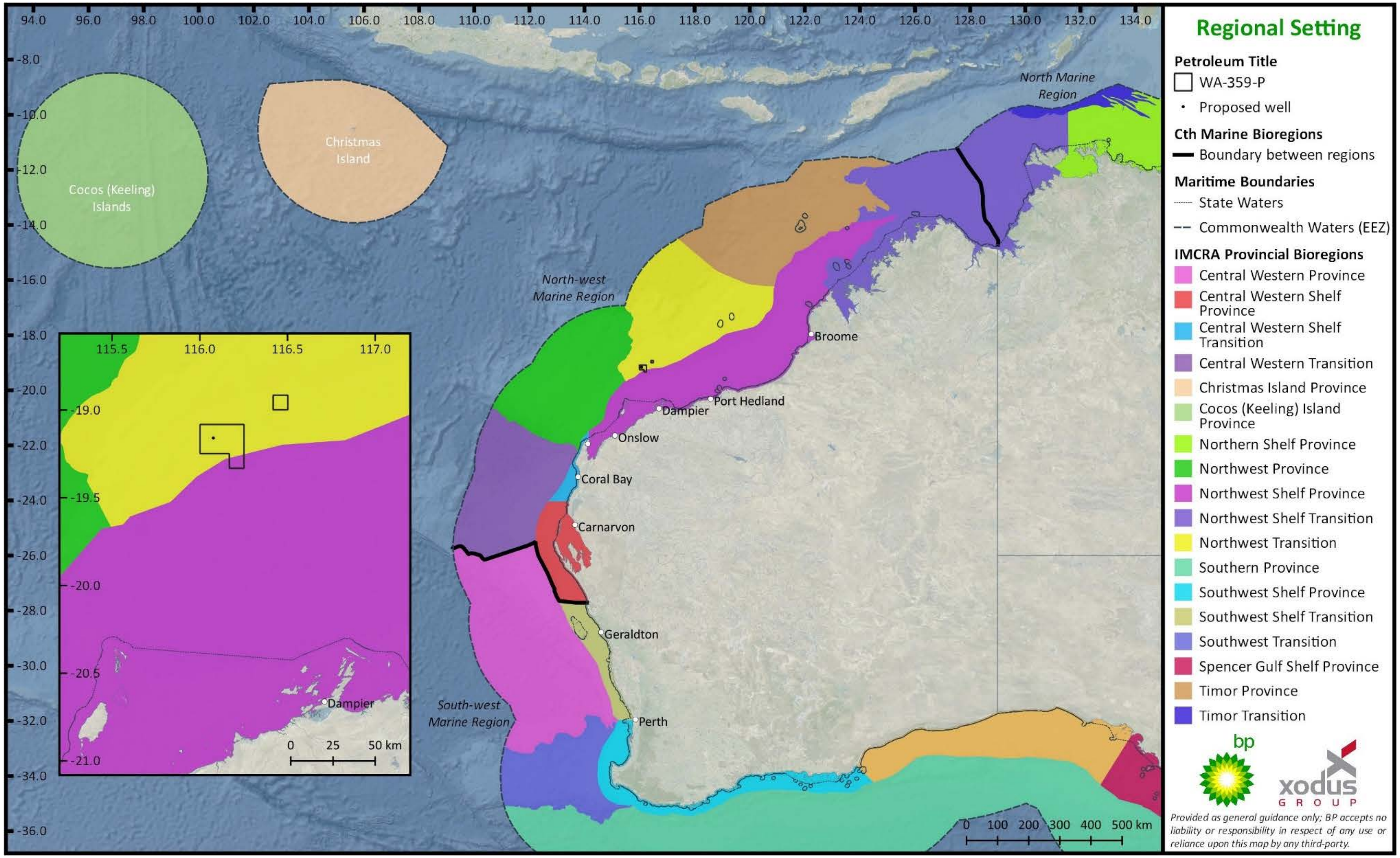


Figure 3-2: IMCRA Provincial Bioregions

3.2.3 North Marine Region

The North Marine Region comprises Commonwealth waters from west Cape York Peninsula to the Northern Territory–Western Australia border. The region covers approximately 625,689 km^2 of tropical waters in the Gulf of Carpentaria and Arafura and Timor seas, and abuts the coastal waters of Queensland and the Northern Territory.

The Region is characterised by a wide continental shelf with water depths generally less than 70 m, although water depths range from approximately 10 metres to a maximum known depth of 357 m. The Van Diemen Rise, characterised by complex geomorphology with features including shelves, shoals, banks, terraces and valleys like the Malita Shelf Valley, provides a significant connection between the Joseph Bonaparte Gulf and the Timor Trough. Other geomorphological features include: a series of shallow canyons approximately 80–100 m deep and 20 km wide that lead into the Arafura Depression; numerous limestone pinnacles up to tens of kilometres in length and width; the Arafura Shelf, an area of continental shelf up to 350 km wide and mostly 50–80 m deep that is characterised by sea-floor features such as canyons, terraces; submerged patch and barrier reefs that form a broken margin around the perimeter of the Gulf of Carpentaria and provide complex habitats in an otherwise largely featureless basin; and the Gulf of Carpentaria coastal zone—waters up to 20 m deep that are characterised by comparatively high levels of productivity and biodiversity driven by nutrient inflow from rivers and the Gulf of Carpentaria Gyre.

The Region has currents driven largely by strong winds and tides, with only minor influences from oceanographic currents such as the Indonesian Throughflow and the South Equatorial Current, and a complex weather cycles and a tropical monsoonal climate, with high temperatures, heavy seasonal yet variable rainfall and cyclones, alternated with extended rain-free periods.

By global standards, the marine environment of the North Marine Region is known for its high diversity of tropical species but relatively low endemism (i.e. species that are found nowhere else in the world) in contrast with the relatively isolated southern Australian marine fauna, which has high species endemism. Regions particularly rich in biodiversity include the Gulf of Carpentaria coastal zone, plateaux and saddle north-west of the Wellesley Islands, and the submerged coral reefs of the Gulf of Carpentaria.

3.2.4 South-west Marine Region

The South-west Marine Region comprises Commonwealth waters from the eastern end of Kangaroo Island in South Australia to Shark Bay in Western Australia. The region spans approximately 1.3 million km^2 of temperate and subtropical waters and abuts the coastal waters of South Australia and Western Australia.

The main physical features of the region include a narrow continental shelf on the west coast from the subtropics to temperate waters off south-west Western Australia, with a wide continental shelf dominated by sandy carbonate sediments of marine origin (i.e. crushed shells from snails and other small animals and calcareous algae) in the Great Australian Bight. There is high wave energy on the continental shelf around the whole region.

Depths vary throughout the Region, with islands and reefs in both subtropical (Houtman Abrolhos Islands) and temperate waters (e.g. Recherche Archipelago), and a steep, muddy continental slope which include many canyons; the most significant being the Perth Canyon, the Albany canyon group and the canyons near Kangaroo Island. Deeper waters can be found, including large tracts of poorly understood abyssal plains at depths greater than 4,000 m, the Diamantina Fracture Zone, a rugged area of steep mountains and troughs off south-west Australia at depths greater than 4,000 m, and the Naturaliste Plateau, an extension of Australia's continental mass that provides deep-water habitat at depths of 2,000–5,000 m.

By global standards, the marine environment of the South-west Marine Region has high biodiversity and large numbers of species native to the region (known as endemism). Particular hotspots for biodiversity are the Houtman Abrolhos Islands, the overlap between tropical and temperate fauna along the west coast, the Recherche Archipelago and the soft sediment ecosystems in the Great Australian Bight.

3.2.5 Christmas Island Territory

Christmas Island an external territory located in the Indian Ocean, part of the Indian Ocean Territories (IOT). The Island has an area of 137.4 km^2 and includes the Christmas Island National Park (135 km^2).

The Island's 80 km coastline is an almost continuous sea cliff reaching heights of up to 20 m. The Island is surrounded by a coral reef. There is virtually no coastal shelf and with depths reaching about 500 metres within 200 metres of the shore. The climate is tropical and temperatures range from 21 °C to 32 °C. Humidity is around 80–90 percent and south-east trade winds provide pleasant weather for most of the year. However, during the wet season between November and April, it is common for some storm activity to occur producing a swell in seas around the Island. The average rainfall is approximately 2000 mm per annum.

The Island's close proximity to South-East Asia and the equator has resulted in a diverse range of flora and fauna. There are 411 recorded plant species on Christmas Island and approximately 18 of these are native. The land crabs and sea birds are the most noticeable animals on the island. The island is a focal point for seabirds of various species, with eight species or subspecies of seabirds nesting on the island. The endemic Christmas Island Frigatebird (listed as endangered) has three well-defined nesting areas.

3.2.6 Cocos (Keeling) Islands Territory

The Cocos (Keeling) Islands is an external territory located in the Indian Ocean, part of the Indian Ocean Territories (IOT). There are 27 coral islands in the group with a total land area of approximately 15.6 square kilometres. Apart from North Keeling Island, which is 30 kilometres from the main group, the Islands form a horseshoe-shaped atoll surrounding a lagoon. North Keeling Island was declared a National Park in 1995.

The Cocos (Keeling) Islands' atolls are horseshoe shaped coral atolls, affected by prevailing winds and oceans. Coral sand beaches are to the seaward and mudflats can be found on the lagoon side. The northern atoll consists of North Keeling Island, where the island and the marine area extending 1.5km around the Island form the Pulu Keeling National Park. It is an important example of an atoll in its natural state and supports an internationally significant seabird rookery. It is also home to land crabs, turtles, and a range of flora.

The climate is tropical with high humidity. Temperatures range from 23 °C to 30 °C. The average rainfall is 2000 mm per annum falling mainly from January to August. The south-east trade winds blow most of the year producing pleasant weather conditions.

The marine environment supports a wide range of corals, fish, molluscs, crustaceans and other species. Turtles, manta rays, reef sharks and common dolphins are regularly sighted.

3.2.7 Outside of Australia's Exclusive Economic Zone

The section of Australia's Exclusive Economic Zone (EEZ) located offshore Western Australia extends to 200 nautical miles from the territorial sea limit along the mainland and Australia's Indian Ocean Territories. Australia's EEZ shares boundaries with:

- International waters, to the west and south of the WA section of the EEZ. International waters are managed under the United Nations Law of the Sea Convention (UNCLOS), administered by the International Maritime Organisation (IMO).
- the Joint Petroleum Development Area (JPDA) in the Timor Sea, along the northern edge of the EEZ. The JPDA is regulated by the National Petroleum Authority (Autoridade Nacional do Petróleo) of Timor-Leste on behalf of the Government of Australia and the Government of Timor-Leste.
- Indonesia to the north west. This boundary is defined in accordance with the Perth Treaty negotiated with the Republic of Indonesia.

Indonesia has the second longest coastline in the world at 95,181 km and has the greatest coral reef area of any country in the world totalling 51,020 km^2.

Central and eastern Indonesia lies within the Coral Triangle, an area of significant marine biodiversity. Over 70% of all reef-building coral species are found in Indonesia. Among the threats to Indonesia's reefs are direct human impacts such as overfishing and destructive fishing practices, such as blasting and poisoning, as well as indirect threats from coastal development and pollution from land-based sources.

To manage environmental sensitivities within its waters, Indonesia has established a large network of marine protected areas (MPA). MPAs relevant to the Ironbark Exploration Drilling Program are listed in Table 3-3.

Table 3-3 Indonesian Marine Protected Areas relevant to the Ironbark Exploration Drilling Program

Name	Protection Category / Listing	EMBA	Hydrocarbon Exposure Area	Operational Area
Lombok Tengah District Marine Conservation Area	IUCN Category VI	x	-	-
KKPD Kabupaten Lombok Barat Marine Recreation Park	IUCN Category VI	x	-	-
Nusa Penida Marine Recreation Park / District Marine Conservation Area	IUCN Category VI	x	-	-
Bangko-bangko Nature Recreation Park	IUCN Category V	x	-	-
Teluk Maumere Nature Recreation Park	IUCN Category V	x	-	-
KKPD Selat Pantar Dan Perairan Sekitarnya Kabupaten Alor Marine Nature Reserve	IUCN Category IV	x	-	-
KKPD Kabupaten Gunung Kidul Marine Nature Reserve	IUCN Category IV	x	-	-
KKPD Kabupaten Flores Timur Marine Nature Reserve	IUCN Category IV	x	-	-
Pulau Rambut Wildlife Reserve	IUCN Category IV	x	-	-

Name	Protection Category / Listing	EMBA	Hydrocarbon Exposure Area	Operational Area
Pulau Lembata Marine Protected Areas	IUCN category not reported	x	-	-
Pulau Sempu Nature Reserve	IUCN Category III	x	-	-
Pulau Nusa Barung Wildlife Reserve	IUCN Category III	x	-	-
KKPN Laut Sawu Marine National Park	IUCN Category II	x	-	-
Meru Betiri National Park	IUCN Category II	x	-	-
Komodo National Park	IUCN Category II World Heritage Site UNESCO-MAB Biosphere Reserve	x	-	-

x = Present in area; - = not present in area

3.2.8 North-west Marine Region

The North-west Marine Region (NWMR) comprises Commonwealth waters from the Western Australian – Northern Territory border to Kalbarri, south of Shark Bay. It covers some 1.07 million km^2 of tropical and sub-tropical waters.

Those parts of the Region adjacent to the Kimberley and Pilbara include thousands of square kilometres of shallow continental shelf (about 30 percent of the total Region), although Australia's narrowest shelf margin is also to be found within the Region at Ningaloo Reef. Over 60 percent of the seafloor in the Region is continental slope, of which extensive terraces and plateaux make up a large proportion. Those parts of the Argo and Cuvier abyssal plains that are included within the Region comprise about 10 percent of the Region's total area. Overall, the Region is relatively shallow with more than 50 percent of the Region having water depths of less than 500 m. The deepest parts of the Argo and Cuvier abyssal plains within the Region, however, reach water depths of almost 6000 m.

The Region is characterised by shallow-water tropical marine ecosystems. While in general endemism is not particularly high by Australian standards, the Region is home to significant populations of internationally threatened species.

3.2.8.1 North-west Transition

The North-west Transition covers an area of 184,424 km^2 and encompass a range of water depths, from the shelf break (200 m depth) over the continental slope, to depths of more than 1,000 m. The majority of the NWT Province occurs on the continental slope, with smaller areas in the north-west of the bioregion located on the Argo Abyssal Plain and continental rise (DEWHA, 2008a).

The vast majority of the North-west Transition is located on the continental shelf with water depths generally in the range 10–100 m. The provincial bioregion has a complex seafloor topography with a diversity of features including submerged terraces, carbonate banks, pinnacles, reefs and sand banks. The carbonate banks and pinnacles of the Joseph Bonaparte Gulf are distinctly different in morphology and character to other parts of the Region, and are believed to support a high diversity of marine species.

The biological communities are typical of Indo-west Pacific tropical flora and fauna, and occur across a range of soft-bottom and harder substrate habitats. The inshore waters off the Kimberley are where the Western Australian population of humpback whales mate and give birth. The Northwest Shelf Transition is important for commercial fisheries, defence, and the petroleum industry.

3.2.8.2 North-west Shelf Province

The North-west Shelf Province covers an area of 238,759 km^2 and is located primarily on the continental shelf between North West Cape and Cape Bougainville. As such, about half the bioregion has water depths of only 50-100 m, with maximum depths reaching only 200 m. The bioregion varies in width from approximately 50 km at Exmouth Gulf to more than 250 km off Cape Leveque.

The bioregion is a dynamic oceanographic environment, influenced by strong tides, cyclonic storms, long-period swells and internal tides. Its waters derive from the Indonesian Throughflow, are warm and oligotrophic, and circulate throughout the bioregion via branches of the South Equatorial and Eastern Gyral Currents.

Fish communities are diverse, with both benthic and pelagic fish communities represented. Humpback whales migrate through the bioregion and Exmouth Gulf is an important resting area, particularly for mothers and calves on their southern migration. Several important seabird breeding sites are located in the region (outside of Commonwealth waters), including Eighty Mile Beach, the Lacepede Islands, and Montebello and Barrow islands. The bioregion is important for the petroleum industry, commercial fishing operations, and shipping, with nationally significant ports of Dampier and Port Hedland present.

3.2.8.3 Northwest Province

The Northwest Province covers an area of 178,651 km^2 offshore between Exmouth and Port Headland. It consists entirely of continental slope, with water depths ranging from 1,000-3,000m.

The dominant geomorphic feature is the Exmouth Plateau, while the Montebello Trough and Swan Canyon are also important features. It contains the steepest shelf break in the Marine Region along the Cape Range Peninsula near Ningaloo Reef. Circulation and recirculation (via the South Equatorial Current) of Indonesian Throughflow waters comprise the dominant surface flow. The predominantly southward moving surface waters consolidate along the narrow shelf break adjacent to Cape Range Peninsula to form the Leeuwin Current, a significant feature of this bioregion and those further south.

The canyons in this bioregion probably channel currents onto the Exmouth Plateau and certainly onto the shelf along Ningaloo Reef, resulting in enhanced localised biological production. The Northwest Province represents the beginning of a transition between tropical and temperate marine species. High endemism in demersal fish communities on the slope is also evident in this provincial bioregion. Commercial fishing and petroleum are important industries in some parts of the bioregion.

3.2.8.4 Central Western Shelf Transition

The Central Western Shelf Transition is the smallest provincial bioregion in the North-west Marine Region, covering an area of 9698 km^2, and is located entirely on the continental shelf between North West Cape and Coral Bay. The maximum water depth in the bioregion is 100 m.

Although both the Leeuwin Current and the Leeuwin Undercurrent occur on the adjacent slope, this bioregion is strongly influenced by the interactions between these currents and the nearshore, northward flowing Ningaloo Current.

The bioregion is located within a significant biogeographic transition between tropical and temperate species. A large proportion of the bioregion is covered by the Ningaloo Marine Park, and Ningaloo Reef is an area of high biodiversity with over 200 species of coral and more than 460 species of reef fish. Marine turtles, dugongs and dolphins frequently visit the reef lagoon and whale sharks and manta rays visit the outer reef. Commercial fishing and petroleum are the major industries in the bioregion.

3.2.8.5 Central Western Transition

The Central Western Transition Province covers an area of 162,891 km^2 of the continental slope and abyss between Shark Bay and North West Cape. The major geomorphic features of the bioregion are the Wallaby Saddle, Carnarvon Terrace, the Cuvier Abyssal Plain and the Cloates and Cape Range Canyons. Almost half the bioregion has water depths of more than 4000 m, with the maximum water depth in the bioregion recorded at 5330m, and the proximity of deep ocean areas to the continental slope and shelf may have resulted in distinctive biological communities.

The Leeuwin Current, flowing south along the slope, is the dominant oceanographic feature. Interactions between the Leeuwin Current, Leeuwin Undercurrent and the nearshore Ningaloo Current facilitate vertical mixing of water layers and are believed to be associated with sporadic bursts in productivity (particularly during summer). The level of endemism within demersal fish communities on the slope is less than in the bioregions further north. This bioregion is also within the biogeographic transition between tropical and temperate marine species. The major industries in the bioregion are commercial fishing and petroleum.

3.2.8.6 Timor Province

The Timor Province covers almost 15 percent of the North-west Marine Region, predominantly covering the continental slope and abyss between Broome and Cape Bougainville. Water depth ranges from about 200 m near the shelf break to 5,920 m over the Argo Abyssal Plain. In addition to the Argo Abyssal Plain, the major geomorphic features are the Scott Plateau, the Ashmore Terrace, part of the Rowley Terrace and the Bowers Canyon. Ashmore Reef, Cartier Island, Seringapatam Reef and Scott Reef are important features of the provincial bioregion.

The bioregion is dominated by the warm, oligotrophic waters of the Indonesian Throughflow. The thermocline in the water column in this bioregion is particularly pronounced and is associated with the generation of internal tides, an important oceanographic feature of this bioregion. The variety of geomorphic features in the Timor Province, together with the variation in bathymetry, results in several distinct habitats and biological communities, many of which are in close proximity to each other. The reefs and islands of the bioregion are regarded as particular hotspots for biodiversity. A high level of endemicity exists in demersal fish communities of the continental slope in the Timor Province and two distinct communities have been identified; one associated with the upper slope, the other with the mid slope. The bioregion is important for the petroleum industry, and commercial fisheries operate within it.

3.3 Detailed Receptor Descriptions

3.3.1 Plankton

Phytoplankton are dependent on oceanographic processes (e.g. currents and vertical mixing), that supply nutrients needed for photosynthesis. Thus, phytoplankton biomass is typically variable (spatially and temporally), but greatest in areas of upwelling, or in shallow waters where nutrient levels are high. Offshore phytoplankton communities in the region are characterised by smaller taxa (e.g. cyanobacteria), while shelf waters are dominated by larger taxa such as diatoms (Hanson et al. 2007).

Phytoplankton species rapidly multiply in response to bursts in nutrient availability and are subsequently consumed by zooplankton, that are in turn consumed by small pelagic fish. Higher order tertiary consumers, including squid, mackerel and seabirds, feed on small pelagic fish. Scavengers such as crabs, shrimps and demersal sharks, and fish species such as queenfish, mackerel, king salmon and barramundi may also be common (Brewer et al. 2007).

Primary productivity of the North-west Marine Region is generally low and appears to be largely driven by offshore influences (Brewer et al. 2007), with periodic upwelling events and cyclonic influences driving coastal productivity with nutrient recycling and advection. Within the region, peak primary productivity along the shelf edge occurs in late summer/early autumn. Variation in productivity can also be linked to higher biologically productive period in the area (e.g. mass coral spawning events).

Zooplankton is the faunal component of plankton, comprised of small protozoa, crustaceans (e.g. krill) and the eggs and larvae from larger animals. Zooplankton includes species that drift with the currents and also those that are motile. The inshore ichthyoplankton assemblages are characterised by shallow reef fishes such as blennies (family Blenniidae), damselfish (family Pomacentridae) and north-west snappers (family Lethrinidae), while offshore assemblages are dominated by deepwater and pelagic taxa such as tuna (family Scombridae) and lanternfish (family Myctophidae) (Beckley, Muhling, & Gaughan, 2009). Some of these taxa are commercially and recreationally important species in the region.

3.3.2 Benthic Habitats and Communities

3.3.2.1 Seabed Geomorphology and Substrate

The Operational Area is located on the continental slope of the Northwest Transition bioregion, characterised by a relatively featureless seabed. Sediments on the continental slope are expected to comprise very soft sandy clay/silt with the CAMRIS Marine Benthic Substrate Database indicating sediments are comprised of mud and calcareous clay (CSIRO, 2017).

Preliminary geophysical data and photographic records from grab samples taken during site surveys in the Operational Area of the Ironbark-1 well suggest that the seabed is devoid of any features. There are some low relief furrows but no areas of hard seafloor or distinct sediment facies change. The sediment in the area comprises a mixture of sand, clay and shell gravel.

The closest distinctive seabed feature within the EMBA is the presence of several terraces and steps on the continental shelf which reflect changes in sea level that occurred over the last 100,000 years. The most prominent of these features occurs as an escarpment at a depth of 125 metres, designated as the “Ancient Coastline at 125 m Depth Contour” Key Ecological Feature (KEF) (Section 3.4.3).

The EMBA is also characterised by the presence of several other features, including offshore and nearshore reefs (e.g. Scott Reef, Ashmore Reef, Rowley Shoals, Ningaloo Reef), canyons (e.g. Cape Range, Cloates, Carnarvon, Perth), trenches (e.g. Sunda), pinnacles (e.g. Bonaparte basin) and seamounts (Vening Meinesz seamounts near Christmas Island). The majority of these features are designated as KEFs or afforded some level of protection under Commonwealth legislation (e.g Marine Park, Heritage listing), and therefore described in further detail in subsequent sections.

The Sunda trench extends approximately 3,200 km along the southwestern and southern Indonesian archipelago. Maximum depth recorded in the trench is 7,450 metres, the deepest point in the Indian Ocean. The Sunda trench is known as an active volcanic and seismic zone.

Seamounts are extinct submarine volcanoes that are conically shaped and often flat-topped. They rise abruptly from the abyssal plain to heights at least 1,000 metres above the ocean floor. The Vening Meinesz seamounts range from the Ninetyeast Ridge to the Sunda Trench, encompassing the seabed surrounding the Cocos (Keeling) Islands and Christmas Island.

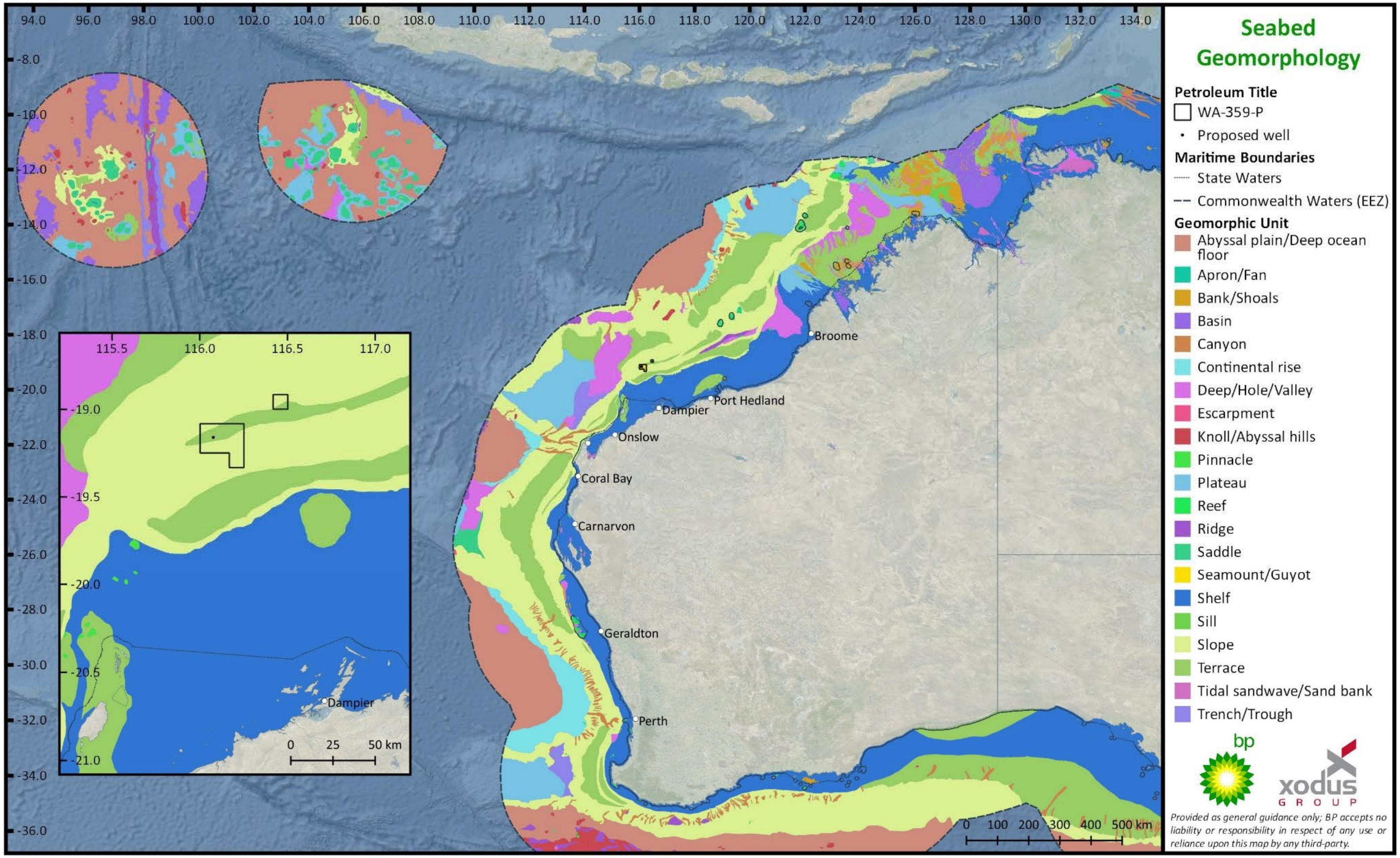


Figure 3-3: Seabed geomorphology

The EMBA overlaps areas of continental shelf, slope and abyssal plain in the Indian Ocean. The Operational Area (located in water depths of 245 - 365 m) is located on the upper slope area (water depths of 225 – 500 m) of the continental slope. Studies completed within the region indicate that benthic composition in deep water habitats is generally lower in abundance than shallow water habitats of the region (DEWHA, 2008a). Gage (1996) reported that the density of benthic fauna tends to be lower in deep water sediments (>200 m) than in shallower coastal sediments, but the diversity of communities may be similar.

3.3.2.2 Coral

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

The shallower waters within the continental shelf contain an extensive array of small barrier and fringing reefs, including important sites such as Ningaloo Reef and Dampier Archipelago. Corals are also known to occur in shallow areas around some of the Pilbara inshore islands. The region is also characterised by the presence of large offshore reef systems, including the Rowley Shoals, Scott and Seringapatam reefs and Ashmore Reef.

The Ningaloo Reef is the largest fringing coral reef in Australia and is over 300 km in length, forming a discontinuous barrier enclosing a lagoon (CALM, 2005). The Ningaloo Reef is a complex ecosystem with high species diversity (CALM, 2005). Within Ningaloo Reef there is a high diversity of hard corals with at least 217 species representing 54 genera of hermatypic (reef building) corals recorded (CALM, 2005). Corals are the most important reef building organisms, and provide food, settlement substrate and shelter for a wide variety of other marine flora and fauna. Coral communities are also important for protection of coastlines through accumulation and cementation of sediments and dissipation of wave energy.

3.3.2.3 Macrophytes

Macrophyte are aquatic plants which include both seagrass and macroalgae.

Seagrass

Seagrass are marine flowering plants, with about 30 species found in Australian waters (Huisman 2000). Seagrass generally grows in soft sediments within intertidal and shallow subtidal waters where there is sufficient light and are common in sheltered coastal areas such as bays, lees of islands and fringing coastal reefs (McClatchie et al., 2006; McLeay et al., 2003). Seagrass meadows are important in stabilising seabed sediments, and providing nursery grounds for fish and crustaceans, and a protective habitat for the juvenile fish and invertebrates species (Huisman, 2000; Kirkman, 1997). Seagrasses also provide important habitat for fish and dugongs within the Northwest Shelf Province (DEWHA, 2008a).

Western Australia has the highest diversity of seagrasses in the world, with 25 species represented. These are generally divided into temperate and tropical distributions, with Shark Bay representing the biogeographical overlap. 12 species are represented in the tropics (*Thalassia hemprichii, Thalassodendron ciliatum, Enhalus acoroides, Halophila ovalis, Halodule uninervis, Halophila minor*, *Cymodocea angustata, Syringodium isoetifolium, Cymodocea serrulata, Halophila spinulosa, Halodule pinifolia and Halophila decipiens*), one of which is endemic (*Cymodocea angustata*).

Seagrass meadows are mostly found in the sheltered bays along the southern mainland coast of the Kimberley region, as well as along the coast between Shark Bay and Augusta. Montebello and Barrow Islands contain sparse seagrass habitat (McMahon et al., 2017), however the closest known key areas of seagrass habitat to the Ironbark Exploration Drilling Program is the Ningaloo reef area.

Macroalgae

Macroalgae communities are generally found on intertidal and shallow subtidal rocky substrates. Macroalgal systems are an important source of food and shelter for many ocean species; including in their unattached drift or wrack forms (McClatchie et al., 2006). Brown algae are typically the most visually dominant and form canopy layers (McClatchie et al., 2006). The principal physical factors affecting the presence and growth of macroalgae include temperature, nutrients, water motion, light, salinity, substrate, sedimentation and pollution (Sanderson, 1997). Macroalgae habitat is known to occur within the nearshore areas surrounding some of the Pilbara inshore islands, including Muiron Islands. Glomar Shoal and Rankin Bank, which are geographically isolated from other similar features in the Pilbara region, also support macroalgal habitat (Wahab et al., 2018).

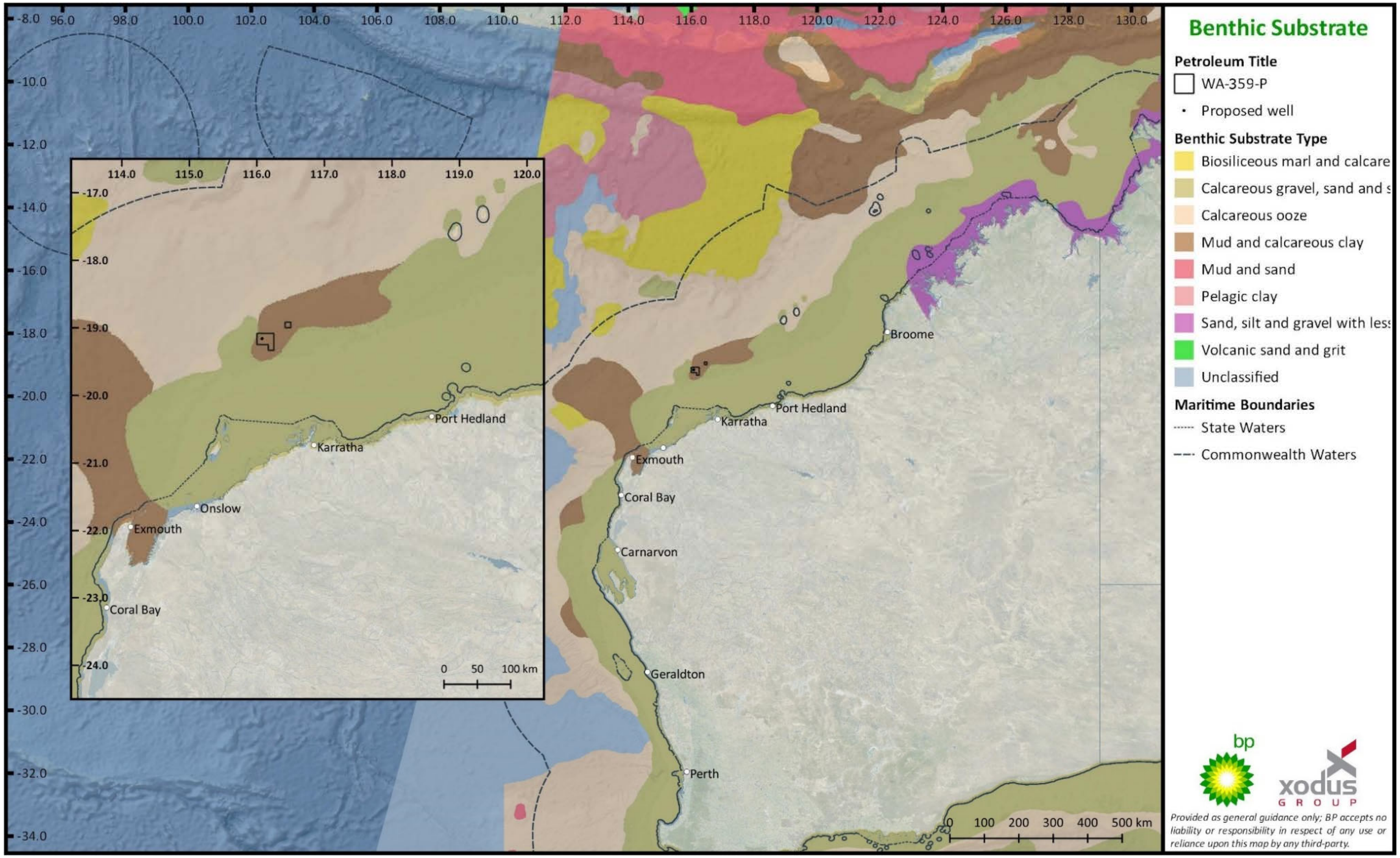


Figure 3-4: Benthic substrates

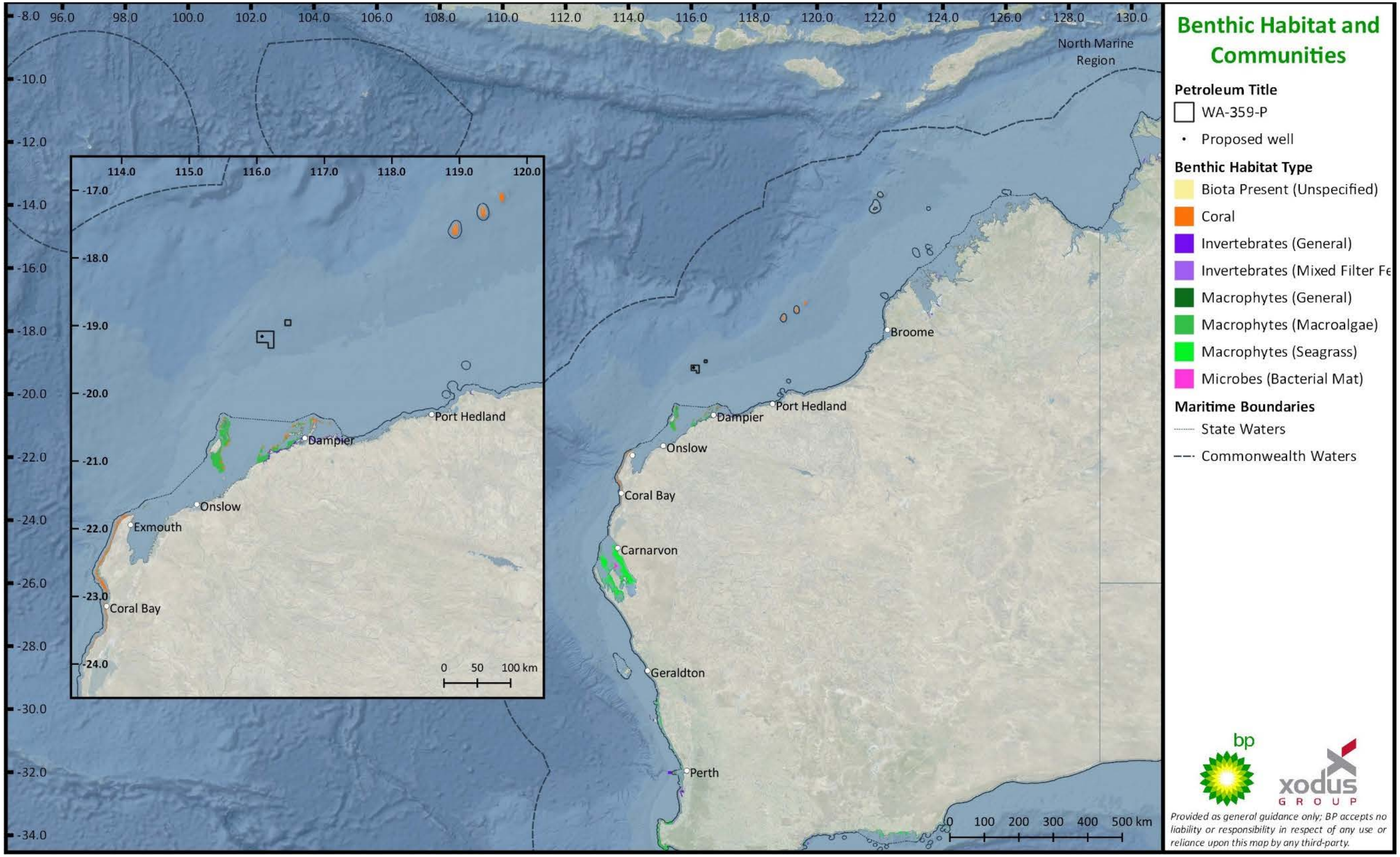


Figure 3-5: Benthic habitats and communities

3.3.3 Coastal Communities

This section describes the biological communities that live within the coastal zone; these communities include wetlands and other intertidal flora/vegetation such as saltmarsh or mangroves. A variety of fauna (e.g. birds) also form a part of these coastal communities.

3.3.3.1 Monsoon Vine Thickets

The Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula ecological communities represents certain occurrences of monsoon vine thickets in the southwest Kimberley region of Western Australia.

Dampier Monsoon Vine Thickets are considered a rainforest subset ranging from semi-deciduous vine thickets to closed semi-deciduous vine forest. The ecological community contains deciduous, semi-deciduous and evergreen perennial flora species. Patches in the higher rainfall zone (e.g. Cape Borda and Cape Leveque) tend to be the most species rich and can extend onto pindan soils, particularly in the lee of dunes. These patches tend to have a denser canopy and be characterised by co-dominant evergreen tree species in the overstorey. The ground layer is often sparse or absent. Patches of the ecological community in the lower rainfall zone, as well as those generally situated on low dunes and other exposed locations, are mostly depauperate in evergreen trees and have a more open canopy and shrubby structure (DSEWPC, 2013).

The ecological community provides an important habitat for a number of plant species. For example, the vine *Parsonsia kimberleyensis* is at the southern-most limit of its range within the ecological community along with Glycosmis sp. and the deciduous shrub *Croton habrophyllus* (Kenneally et al., 1996). The small tree, *Vitex glabrata* (bush currant) is only known to occur on the Dampier Peninsula in the ecological community (Black et al., 2010).

Compared to the adjacent open vegetation occurring over the majority of the Dampier Peninsula, the relatively dense, closed canopy of the Dampier Monsoon Vine Thickets provides a shady and humid microclimate. This relatively moist environment provides refuge for animals particularly during the dry season when fires in the landscape are more frequent (Johnstone and Burbidge, 1991; Kendrick and Rolf, 1991; Price, 2004). The abundance of fruiting plants within the ecological community also provides relatively rich food resources for many taxa. No fauna are known to be endemic to the ecological community on a national scale, but some species are endemic at a regional level and many species occur both in the ecological community and surrounding vegetation types.

3.3.3.2 Sedgelands

Sedgelands in Holocene dune swales occurs in linear damplands and occasionally sumplands, between Holocene dunes. Typical and common native species are the shrubs *Acacia rostellifera*, *Acacia saligna*, *Xanthorrhoea preissii*, the sedges *Baumea juncea*, *Ficinia nodosa*, *Lepidosperma gladiatum*, and the grass *Poa porphyroclados*. Several exotic weeds are found in this community but generally at low cover values (DEC, 2011).

Water regime is the primary abiotic determinant influencing characteristics of wetland plant communities. Depth, timing and duration of flooding and length of the dry period all affect vegetation composition and distribution (Froend et al., 2004). The sedgelands in the damplands and sumplands of the Holocene dune swales have relatively specific water regime requirements to maintain current biology, but are tolerant of seasonal and longer-term variations that reflect natural climatic patterns.

3.3.3.3 Thrombolite (Microbialite) Community of the Coastal Brackish Lake (Lake Clifton)

Microbialites are discrete organosedimentary structures formed by the activities of specific microbial communities that occur at the bottom (benthic stratum) of certain aqueous ecosystems. Here, cyanobacteria and eukaryotic microalgae photosynthesise and precipitate calcium carbonate (limestone) from the surrounding water, leading to the formation of rock-like structures (Moore et al., 1983; Moore, 1990).

The Lake Clifton thrombolite community is restricted to Lake Clifton, which occurs within the South West Natural Resource Management Region. 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 (Commander, 1988; 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 kilometres long and up to 15 metres 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.

3.3.3.4 Mangroves and Saltmarshes

Mangroves

Mangroves grow in intertidal mud and sand, with specially adapted aerial roots (pneumatophores) that provide for gas exchange during low tide (McClatchie et al., 2006). Mangrove forests can help stabilise coastal sediments, provide a nursery ground for many species of fish and crustacean, and provide shelter or nesting areas for seabirds (McClatchie et al., 2006). The mangroves along the Pilbara coast are known to provide important nursery habitat for many marine fish species and support prawn and crab (e.g. coral, blue and swimmer crab) fisheries (DEWHA, 2008a). Coastal mangrove (and associated algal mat habitat) are sites of nitrogen fixation and nutrient recycling, providing nutrients in shallower waters that are transported across the shelf via currents and tides (DEWHA, 2008a).

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

Subtropical and Temperate Coastal Saltmarsh

The Subtropical and Temperate Coastal Saltmarsh ecological community occurs within a relatively narrow margin of the Australian coastline, within the subtropical and temperate climatic zones south of the South-east Queensland IBRA bioregion boundary at 23° 37' latitude along the east coast and south of (and including) Shark Bay at 26° on the west coast (DSEWPC, 2013).

The physical environment for the ecological community is coastal areas under regular or intermittent tidal influence. In southern latitudes saltmarsh is often the main vegetation-type in the intertidal zone and commonly occurs in association with estuaries (Adam, 2002; Fairweather, 2011). It is typically restricted to the upper intertidal environment, occurring in areas within the astronomical tidal limit, often between the elevation of the mean high tide and the mean spring tide (Saintilan et al., 2009). The Coastal Saltmarsh ecological community may also include areas that have groundwater connectivity to tidal water bodies.

The Coastal Saltmarsh ecological community consists mainly of salt-tolerant vegetation (halophytes) including: grasses, herbs, sedges, rushes and shrubs. Succulent herbs, shrubs and grasses generally dominate and vegetation is generally of less than 0.5 m height (with the exception of some reeds and sedges) (Adam, 1990). Many species of non-vascular plants are also found in saltmarsh, including epiphytic algae, diatoms and cyanobacterial mats (Adam, 2002; Fotheringham and Coleman, 2008; Green et al., 2012; Millar, 2012).

The ecological community is inhabited by a wide range of infaunal and epifaunal invertebrates, and low-tide and high-tide visitors such as prawns, fish and birds (Adam, 2002; Saintilan and Rogers, 2013). It often constitutes important nursery habitat for fish and prawn species. The dominant marine residents are benthic invertebrates, including molluscs and crabs that rely on the sediments, vascular plants, and algae, as providers of food and habitat across the intertidal landscape (Ross et al., 2009).

3.3.3.5 Wetlands

Seven Wetlands of International Importance (Ramsar Wetland) and 18 wetlands of national importance have been identified within the EMBA; the closest wetlands to the Ironbark Exploration Drilling Program include Eighty Mile Beach (Ramsar & National), approximately 400 km from the indicative well location; and Leslie Saltfields (National), approximately 308 km away. None of the marine/coastal wetlands occur within either the Operational Area.

A summary description of the ecological character of the seven Ramsar wetlands is provided in Table 3-5.

Table 3-4: Wetland habitats relevant to the Ironbark Exploration Drilling Program

Wetland	EMBA	Operational Area	Hydrocarbon Exposure Area
International Importance			
Eighty-mile Beach	x	-	-
Ashmore Reef Commonwealth Marine Reserve	x	-	x
Hosnies Spring	x	-	-
Peel-Yalgorup system	x	-	-
Roebuck bay	x	-	-
The Dales, Christmas Island	x	-	-
Vasse-Wonnerup system	x	-	-
National Importance			
The Dales, Christmas Island	x	-	-
Ashmore Reef	x	-	x

Wetland	EMBA	Operational Area	Hydrocarbon Exposure Area
De Grey River	x	-	-
Eighty-mile Beach System	x	-	-
Exmouth Gulf East	x	-	-
Hamelin Pool	x	-	-
Lake MacLeod	x	-	-
Learmonth Air Weapons Range – Saline Coastal Flats	x	-	x
Leslie (Port Hedland) Saltfields System	x	-	-
Mermaid Reef	x	-	x
Murchison River (Lower Reaches)	x	-	-
Peel-Harvey Estuary	x	-	-
Prince Regent River System	x	-	-
Roebuck Bay	x	-	-
Shark Bay East	x	-	-
Swan-Canning Estuary	x	-	-
Vasse-Wonnerup Wetland System	x	-	-
Yampi Sound Training Area	x	-	-

x = present in the area; - = not present in the area

Table 3-5: Summary of the ecological character of Ramsar wetlands

Wetland
Eighty-mile Beach
Eighty-mile Beach is a large (220 km) linear sand coast. The boundary of the Ramsar site along the beach is defined by the tide, extending from Mean Low Water to 40 m above Mean High Water. The intertidal zone is comprised of a large expanse of intertidal mudflats (up to 4 km wide at the lowest tides) and a narrow strip at the landward edge of coarser quartz sands. The site is bounded by coastal dunes to the east. The discontinuous linear floodplain immediately inland of the frontal sand dunes, are predominantly outside the Ramsar boundary. The following summary of ecosystem components, processes and services has been extracted from Hale and Butcher 2009. **Ecosystem components and processes** • Climate: Semi-arid monsoonal with a prolonged dry period, >80% of rainfall in the wet season (December to March). High inter-annual variability. High occurrence of tropical cyclones. • The Beach:

Wetland
- Geomorphology: Extensive intertidal mudflats comprised of fine-grained sediments. Site is backed by steep dunes comprised of calcareous sand. - Hydrology: Macro-tidal regime. No significant surface water inflows. Groundwater interactions unknown (knowledge gap). - Primary production and nutrient cycling: Data deficient, but organic material deposited from ocean currents driving the system through bacterial or microphytobenthos driven primary production. - Invertebrates: Large numbers and diversity of invetebrates within the intertidal mudflat areas. - Fish: Data deficient, but anecdotal evidence of marine fish (including sharks and rays) using inundated mudflats. - Waterbirds: Significant site for stop-over and feeding by migratory shorebirds. Regularly supports >200,000 shorebirds during summer and >20,000 during winter. High diveristy with 97 species of waterbird recorded from the beach. Regularly supports >1% of the flyway population of 20 species. - Marine turtles: Significant breeding site for the Flatback Turtle. • Mandora Salt Marsh: - Geomorphology: Wetland formation dominated by alluvial processes. Wetlands were once a part of an ancient estuary. Freshwater springs have been dated at 7,000 years old. - Hydrology: Walyarta, East Lake and the surrounding intermittently inundated paperbark thickets are inundated by rainfall and local runoff. Extensive inundation occurs following large cyclonic events. Salt Creek and the Mound springs are groundwater fed systems through the Broome Sandstone Aquifer. - Water quality: Most wetlands are alkaline reflecting the influence of soils and groundwater. Salinity is variable, mound springs are fresh, Salt Creek hyper-saline and Walyarta variable with inundation. Nutrient concentrations in groundwater and groundwater fed systems are high. - Primary production and nutrient cycling: Data deficient. However evidence of boom and bust cycle at Walyarta with seasonal inundation. - Vegetation: Inland mangroves (*Avicennia marina*) lining Salt Creek are one of only two occurrences of inland mangroves in Australia. Paperbark thickets dominated by the saltwater paperbark (Melaleuca alsophila) extend across the site on clay soils which retain moisture longer than the surrounding landscape. Samphire (*Tecticornia spp.*) occurs around the margins of the large lakes. Freshwater aquatic vegetation occurs at Walyarta when inundated and at the mound spring sites year round. - Invertebrates: Data limited, but potentially unique species. - Waterbirds: Significant site for waterbirds and waterbird breeding, particularly during extensive inundation events. 66 waterbirds recorded. Supports >1% of the population of at least two species. Breeding recorded for at least 24 species. **Ecosystem services** • Provisioning service–Freshwater: The freshwater springs at Mandora Salt Marsh provide drinking water for livestock. • Provisioning service–Genetic resources: Plausible, but as yet no documented uses. • Regulating service– Climate regulation: Plausible, but data deficient. • Regulating service–Biological control of pests: Evidence that many of the shorebirds feed on the adjacent pastrol land and that the incidence of 2.88 million Oriental Pratincole coincided with locusts in almost plague proportions, upon which the birds fed. • Cultural Services–Recreation and tourism: The beach portion of the site is important for recreational fishing, tourism, bird watching and shell collecting. • Cultural Services–Spiritual and inspirational: Spiritually significant for the Karajarri and Nyangumarta and contain a number of specific culturally significant sites. The site has inspirational, aesthetic and existence values at regional, state and national levels. • Cultural Services–Scientific and educational: Mandora Salt Marsh and Eighty-mile Beach have been the site of a number of significant scientific investigations. In addition, Eighty-mile Beach is a significant site for migratory shorebird monitoring and is currently part of the Shorebirds 2020 program. • Supporting services: As evidenced by the listing of the Eighty-mile Beach Ramsar site as a wetland of international importance. The system provides a wide range of biodiveristy related ecological services critical for the ecological character of the site including - containing a diveristy of wetland types - supporting significant numbers of migratory shorebirds - supporting significant wetland bird breeding - supporting flatback turtle breeding.
Ashmore Reef Commonwealth Marine Reserve

Wetland

Ashmore Reef Commonwealth Marine Reserve is located in the Indian Ocean on the edge of Australia's North West Shelf, 610 km north of Broome and 840 km west of Darwin. The Reserve is in Australia's External Territory of Ashmore and Cartier Islands. It is the largest of only three emergent oceanic reefs present within the north-eastern Indian Ocean. The Reserve is comprised of numerous marine habitats and supports a regionally important and diverse range of species.

The following summary of ecosystem components, processes and services has been extracted from Hale and Butcher 2013.

Ecosystem components and processes

- Climate: Arid tropical monsoonal climate. Located outside the main belt of tropical cyclones in the Timor Sea.
- Geomprhic setting: Located in an area of high oil and gas reserves, with active hydrocarbon seeps. Geomorphic groups within the site include reef slope, reef crest, reef flat, back reef sands, lagoons and islands.
- Tides and currents: Strong seasonal influences of the Indonesian Throughflow and Holloway currents. Internal waves are a feature of the region and Ashmore Reef may act to break these resulting in increased nutrients from the bottom waters. High energy environment with spring tides over 4.5 m and large flushing on tidal cycles.
- Water quality: Seasonal variations in temperature and salinity in ocean and lagoon water. Water calrity, turbidity and other water quality parameters remain a knowledge gap.
- Vegetation: Five speces of seagrass recorded with Thalassia hemprichii dominant, comprising over 85% of total cover. Total cover of 470 ha, over 3,000 ha of macroalgae, mostly on reed slope and crest areas. Algae dominated by turf and coralline algae with fleshy macroalage comprising typically less than 10% of total algae cover.
- Marine invertebrates: Ashmore Reef has a diversity of marine invertebrates including hard and soft corals, molluscs, echinoderms and crustaceans. 275 species of hard coral, covering an area of around 700 ha. 39 taxa of soft coral, covering an area of around 300 ha. Total coral ocver was low around the time of listing following the 1998 bleaching event but recovered in recent years to baseline levels. Over 600 species of mollusc, including two endemic species. Over 180 species of echinoderm, including 18 species of sea cucumber. Sea cucumber density is highly variable, but on average exceeds 30 per hectare. 99 species of decapod crustacean.
- Fish: Over 750 species of fish, including five species of fish and three species of shark listed as threatened. Predominantly shallow water, benthic taxa that are common throughout the Indo-Pacific. Density of small reef fishes is arounf 20,000 to 40,000 per hectare. Low density of sharks (less than one per hectare).
- Seasnakes: Prior to listing there was a high diversity and population, peaking in 1998 with an estimated total population of 40,000 snakes in the site. However, by time of listing in 2002 the site was on a trajectory of decline and diversity and abundance was low.
- Turtles: Three species of marine turtle: green (*Chelonia mydas*), hawksbill (*Eretmochelyis imbricata*) and loggerhead (*Caretta caretta*) all of which are listed threatened species. Green turtles are the most abundant, with a total estimated population of around 10,000. Nesting by two species; green turtles and hawskbill turtles.
- Seabirds and shorebirds: Ashmore Reef supports an abundance and diversity of wetland birds. 72 species of wetland dependent bird recorded within the Ramsar site. 47 species listed under international migratory agreements. Average of around 48,000 seabirds and shorebirds annually. Six species are regulary recorded in numbers greater >1% of the population. Nesting of 20 species, 14 of which regulary breed in the site.
- Dugong: Small but significant population, that may breed within the site. Data deficicent.

Ecosystem services

- Provisioning services–Freshwater: Indonesian fishers use the freshwater lens at West Island.
- Cultural services–Recreation and tourism: Althought remote and access is controlled, the site is important for passive recreation such as diving and bird watching.
- Cultural services–Cultural heritage anf identity: Ashmore Reef has been regularly visted and fished by Indonesians since the early 18th century. West Island contains some archaeological artefacts and graves.
- Cultural services–Scientific and educational: The reef has high value for scientific research because it currently recieved relatively low use and is ecologically unique within the bioregion.
- Supporting services–Near-natural wetland types: Ashmore Reef supports a number of largely unmodified wetland types.
- Supporting services–Biodiversity: Ashmore Reef is a hotspot of biodiveristy within the Timor Province bioregion. Highest biodiversity of reef building corals (275 species from 56 genera). Highest diveristy of soft corals (39 taxa). More than 600 species of mollusc. Over 180 species of echinoderm, including 13 species of sea cucumber. Nearly 100 species of decapod crustacean. Over 750 species of finfish. High diversity of seasnakes.
- Supporting services–Physical habitat: The site supports large breeding colonies of seabirds.
- Supporting services–Priority wetland species: The Ramsar site supports 47 species of shorebirds listed under international migratory bird treaties.

Wetland
• Supporting services–Threatened species: Ashmore Reef supports 62 species listed as threatened at the national and/or international level.
Hosnies Spring
Christmas Island is an Australian External Territory located in the Indian Ocean approximately 2,800 km west of Darwin and 500 km south of Jakarta, Indonesia. The Island is approximately 13,500 ha in size, 63% of which is National Park, including two Ramsar wetlands: Hosnies Spring and The Dales. Christmas Island National Park is managed by Parks Australia. Hosnies Spring is a small area of shallow freshwater streams and seepages, 20-45 m above sea-level on the shore terrace of the east coast of the island. The Ramsar site consists of a stand of two species of mangroves of the usually tidal genus Bruguiera. The Ramsar site includes surrounding terrestrial areas with rainforest grading to coastal scrub and includes an area of shoreline and coral reef. The following summary of ecosystem components, processes and services has been extracted from Hale and Butcher 2010. **Ecosystem components and processes** • Climate: Warm tropical climatic zone. High rainfall (200 mm per year), warm to hot year-round. • Geomorphic setting: Site is located within the shore terrace on an area of gravel overlying phosphoric soils. Spring is situated at the base of the inland cliffs where spring water flows over a limestone flowstone. • Water quality: Limited information (two snap shot surveys only). Typical of limestone karst systems with alkaline conditions and relativelty high concentrations of calcium. Trace elements and metals are all low. Nitrogen is predominatly in the form of nitrate. High concentrations of sulphate result in a sulphurous odour. • Hydrological regime: Groundwater dominant. Source of Hosnies Spring in perched, unconfined aquifer that discharges where impermeable volcanic rocks are close to the surface. Flow rate is not known but expected ot be low. Spring is perenial. • Mangroves: Stand of mangroves from the genus Bruguiera covers the majority of the wetland. Comprises a range of size classes with evidence of active regeneration. A number of very large trees (large than typical for the species), with the largest tree measuring 82 cm diameter at breast height and exceeding 40 m. Between 300 and 600 trees in total (>2.5 cm diameter at breast height) and a density between 10 and 20 trees per 100 m2. • Land Crabs: Supports a large population of at least three species: red crabs (*Gecarcoidea natalis*); robber crabs (*Birgus latros*) and blue crabs (*Discoplax hirtipes*). **Ecosystem services** • Cultural services–Recreation and tourism: While the site is open to the public, tourism is not promoted at the site. Rather, the site is managed to provide a limited number of visitors an opportunity to visit a unique wetland that is largely undisturbed by humans. • Cultural services–Scientific and educational: The unique nature of the site and the pristine condition, provide excellent opportunities for research. • Supporting services–Supports near-nature wetland types: The spring at the Ramsar site is in near-natural condition and significant within the bioregion. It is the only area on Christmas Island that supports freshwater mangroves. • Supporting services–Biodiversity: Supports a variety of wetland species, communities and habitats including marine, terrestrial and freshwater dependent species. • Supporting services–Food webs: Interactions between land crabs and mangroves form an important food web at the site. • Supporting services–Distinct wetland species: Blue crabs are reliant on the few permanent freshwater sites on Christmas Island (including Hosnies Spring) for reproduction, and for survival in the dry season. • Supporting services–Ecological connectivity: Red crab migrate from the plateau to the ocean to breed each year.
Peel-Yalgorup system
The Peel-Yalgorup wetland system, in south-western Australia, is located approximately 80 km south of Perth within the Swan Coastal Plain bioregion. The 26,000 ha site includes shallow estuarine waters, saline, brackish and freshwater wetlands of the Peel Inlet, Harvey Estuary, several lake systems including Lake McLarty and Lake Mealup and the Yalgorup National Park.

Wetland

The following summary of ecosystem components, processes and services has been extracted from Hale and Butcher 2007.

Ecosystem components and processes

- Peel-Harvey Estuary
  - Geomorphology: Shallow bar-built estuary. Narrow connection to the Indian Ocean (Mandurah Channel). Organic sediments (black ooze).
  - Hydrology: Highly seasonal freshwater inflows from direct precipitation and rivers. Limited tidal exchange with the Indian Ocean. Limited groundwater inflows.
  - Water Quality: High concentrations of nutrients (eutrophic) from catchment. Seasonal variability in salinity. Stratification and deoxygenation of bottom waters.
  - Acid Sulfide Soils: Monosulphidic black ooze. Exposed via dredging.
  - Phytoplankton: Winter diatom blooms. Spring Nodularia blooms in the Harvey Estuary.
  - Benthic Plants: Excessive growth of green macroalgae (Cladophora and/or Chaetomorpha) in the Peel Inlet. Smotherin of seagrass.
  - Littoral Vegetation: Samphire communities around the shorelines. Paperbark communities in the Harvey River delta.
  - Invertebrates: Commercially sugnificant taxa include blue swimmer crabs and western king prawns. Diverse communities in the estuary and the intertidal zones
  - Fish: Estuarine and marine species. Migratory route for some species.
  - Birds: High diveristy and abundance of waterbirds. Regulary supports >20,000 waterbirds (maximum recorded 150,000 individuals). Breeding recorded for 12 species. Regulary supports >1% of the population of 11 species.
- Yalgorup Lakes
  - Geomorphology: Shallow depressional wetlands. No defined surface water inflow or outflow channels.
  - Hydrology: Highly seasonal freshwater infl ows predominantly from groundwater. No surface water outflows.
  - Water quality: Brackish to hypersaline conditions. Seasonal salinity cycles. Low nutrient concentrations. Some lakes exhibit stratification. Highly alkaline (calcium and bicarbonate).
  - Benthic microbial community: Thrombolites in Lake Clifton. Cyanobacterial algal mats across the sediment surface in some lakes.
  - Flora: Small buffer zones. Some areas of paperbark communities.
  - Fauna: Significant site for waterbirds. Large numbers of Shelduck and Black Swans annually. 1% of population of Banded Stilt, Red-necked Stint, Hooded Plover, Shelduck and Musk Duck. Breeding of eight species.
- Lakes McLarty and Mealup
  - Geomorphology: Shallow depressional wetlands. No defined surface water inflow or outflow channels.
  - Hydrology: Highly seasonal freshwater inflows predominantly from groundwater. No natural surface water outflows (although there are drains present).
  - Water quality: Fresh to brackish conditions. Alkaline.
  - Flora: Typha across parts of each lake. Sedges on the margins. Paperbark community at higher elevations.
  - Fauna: Important habitat for freshwater invertebrates. Provides habitat for a large diversity and number of waterbirds. Breeding recorded for 12 species of waterbird.

Ecosystem services

- Provisioning services–Wetland products: Commercial fisheries for a number of species of fish, as well as prawns and crabs.
- Regulating services–Pollution control and detoxification: Peel Inlet and Harvey Estuary act as sinks for nutrients from the catchment and a mechanism for discharges to the sea.
- Regulating services–Climate regulation: Data defi cient – plausible but not documented.
  Regulating service–Flood control: Site acts as a reciever for drainage water from the surrounding floodplain.
- Cultural services–Recreation and tourism: The Peel Inlet and Harvey Estuary are important recreational fisheries. Passive recreational activities such as bird watching occur both in the estuarine and wetland areas within the site. The Peel Inlet and Harvey Estuary are important for water based recreational activities and water sports such as boating.
- Cultural services–Spiritual and inspirational: Wetlands and estuarine areas are spiritually significant for the Nyoongar and contain a number of specific culturally significant sites. The site has inspirational, aesthetic and existence values at regional, state and national levels.

Wetland

- Cultural services–Scientific and educational: The Peel Inlet and Harvey Estuary are the sites for long-term monitoring dating back several decades. Lake Clifton represents one of very few places at which thrombolites can be studied.
- Supporting services–Biodiveristy: As evidence by the listing of the Peel-Yalgorup site as a wetland of international importance. The system provides a wide range of biodiveristy values including:
  - supporting a wide range of ecological communities
  - supporting a number of regionally, nationally and internationally threatened species
  - supporting a high diveristy of species (flora and fauna)
  - supporting a bioregionally unique community (thrombolites).
- Supporting services–Nutrient cycling: The Peel-Yalgorup system plays a large role in the recyling and discharge of nutrients from the surrounding catchment. Carbon sequestration – data defi cient but plausible.

Roebuck bay

The Roebuck Bay Ramsar site comprises 34,119 ha, mostly occupied by intertidal mudflats. Waters more than 6 m deep at low tide are excluded from the site, which stretches from Campsite (a location on the northern shore of Roebuck Bay) east of the town of Broome, to south of Sandy Point. The soft bottom intertidal mudflats of the northern and eastern shores of Roebuck Bay, and high tide roosts at Bush and Sandy Points are the most biologically significant parts of the site, which was listed for several reasons including, most notably, outstanding shorebird values.

The following summary of ecosystem components, processes and services has been extracted from Bennelongia 2009.

Ecosystem components and processes

- Climate: The climate of the Broome region is semi-arid, monsoonal with a distinct wet (October to February) and dry season (March to September). Cyclonic flooding during the summer wet season results in periodic inundation of Roebuck Plains and drainage of freshwater off the Plains and through the mangroves.
- Ocean currents: The Indonesian Flowthrough flows westwards from the Pacific to the Indian Ocean. This in turn provides a mass of warm water to the Leeuwin current off Western Australia as it sweeps south along the west coast and east along the south coast.
- Tidal variation: Tides in the vicinity of Broome have a very large range (9.5 m), thus exchange through the Bay is high, tidal velocities are relatively high and large mudflats have developed.
- Geomorphology: A megascale irregular curved embayment that contains a wide expanse of intertidal mud and sand flats indented by microscale linear tidal creeks.
- Sediment structure: Three main sediment provinces have been identified: northern sands province, eastern silt and clay province and southern sands province.
- Hydrology: The Broome Sandstone contains the most utilised (Broome water supply) and hence most threatened groundwater resource in the Canning Basin. The Broome Sandstone is generally an unconfined aquifer recharged by direct infiltration from rainfall. The Broome sandstone will be discharging groundwater to the surface or subsurface at the margins of the Roebuck plains and tidal creek systems. There will also be deep submarine groundwater discharge occurring at or below the low tide mark and within Roebuck deeps. The Broome Sandstone will be discharging groundwater to the coupled Roebuck Bay/Roebuck Plains system from all landward directions. This may create freshwater dependant ecological niches which could be threatened by regional water use or pollution. Roebuck Plains produces large amounts of sheetwash into the bay after large cyclonic events or prolonged wet season rains. This will be an important vector for nutrients, organic carbon and freshwater into the bay.
- Water quality: Water quality appears poor, with TP levels, although there is limited information available from similar marine systems for comparison. Consideration has been given to the impact of urban run-off into the marine ecosystem. Agricultural activities may influence water quality from rangeland run-off during flood events.
- Littoral vegetation: Along the sea edge there are mangrove communities. Mangrove detritus is a major source of energy for animals in the mangal and, perhaps, some mudflat species. Behind the mangal is an extensive plain of saline grassland that rises to the pindan plains typical of the western desert. Samphire occurs in the wetter zones. On beach dunes spinifex dominates.
- Plankton and diatoms: Stable isotopes of carbon and nitrogen have shown that plankton and diatoms are a major source of energy for shellfish in the Bay.
- Benthic invertebrates: Roebuck Bay has one of the most diverse arrays of benthic invertebrate infauna for any intertidal ecosystem. Species numbers are dominated by polychaetes. There is a rich assemblage of bivalves that provide an important source of accessible food for shorebirds. The average density of macrobenthic fauna is around 1287 animals per square metre.

Wetland

- Birds: The bay provides important food resources and refuge for migrating arctic shorebirds. A total of 43 species of waterbirds are recorded for the Bay including 22 species listed in migratory bird agreements.
- Fish: The mudflats and mangrove creeks are nurseries for at least 4 fish species, for commercial prawn species and for mudcrabs
- Marine fauna: Dugongs have been regular and important inhabitants of Roebuck Bay. Earlier records show evidence of Dugongs feeding on extensive seagrass beds in 1986. Loggerhead Turtles and Green Turtles regularly use the Ramsar site as a seasonal feeding area and as a transit area on migration. Flatback Turtles regularly nest in small numbers around Cape Villaret during the summer months.

Ecosystem services

- Provisioning services–Wetland products: Commercial and recreational fisheries for a number of species of fish, prawns and crabs. Aboriginal people continue to make extensive use of the Bay's natural resources.
- Regulating Services–Pollution control and detoxification: No data
- Regulating Services–Climate regulation: No data
- Cultural service–Recreation and tourism: Major tourism and bird-watching venue. Broome is an important destination for national and international tourism. Active recreational fishing and crabbing activities, boating, hovercraft.
- Cultural services–Spiritual and inspirational: Site has inspirational and aesthetic values that are both regional and nationally recognised through travel to Broome. Roebuck Bay is spiritually significant to Aboriginal people belonging to the Yawuru and Jukun groups and contains a number of specific culturally significant sites.
- Cultural services–Scientific and educational: Many scientific research programs, especially on shorebirds and mudflat invertebrates, have been based at Roebuck Bay. they have often involved Broome Bird Observatory, near Fall Point.
- Supporting Services–Biodiveristy: Key location in global flyway for migratory waders. Nursery values for prawns and fish. Seagrass beds for Dugong.

The Dales, Christmas Island

Christmas Island is an Australian External Territory located in the Indian Ocean approximately 2,800 km west of Darwin and 500 km south of Jakarta, Indonesia. The Island is approximately 13,500 ha in size and contains two Ramsar wetlands: The Dales and Hosnies Spring.

The Dales Ramsar site covers 583 ha and is located on the western coastline of Christmas Island. The western boundary of the Ramsar site extends 50 m seaward from the low water mark and incorporates part of the coast. The Dales are located within the Christmas Island National Park which is managed by Parks Australia. The Ramsar site has a near-pristine system of seven watercourses. The Dales includes permanent and perennial streams, permanent springs, and include the majority of surface water on the Island.

The following summary of ecosystem components, processes and services has been extracted from Butcher and Hale 2010.

Ecosystem components and processes

- Climate: Warm tropical climatic zone. High rainfall (2,000 mm per year); warm to hot year-round.
- Geomorphic setting: Site is located within the shore terrace on an area of gravel overlying phosphoric soils. Springs are situated at the base of the inland cliffs where spring water flows over a limestone flowstone. The island is a karstic landscape with key geomorphic features including the terrace formations, sea cliffs, and caves and other karst features such as tufa at Hugh's Dale.
- Hydrology: Karstic drainage system of groundwater and surface ephemeral stream flow post heavy rainfall events during the wet season. Spring outflow of groundwater at three of the Dales is permanent.
- Water quality: Limited site-specific data; information from one survey in 2003 for Hugh's Dale may provide baseline data for time of listing. Water quality is good, with higher concentrations of some trace metals and major ions compared to upstream reference sites, due to the presence of volcanic rocks and significant crab populations.
- Terrestrial vegetation: Limited site-specific data; descriptions of the vegetation are limited. General descriptions for vegetation associations indicate five major associations, with tall rainforest the dominant type.
- Coral reef: The coral reef is limited and dominated by abiotic habitat and hard corals of low diversity.
- Fish: Community predominantly of Indo-Pacific origin. Endemism is low, but a number of species are at the western extent of their range at Christmas Island and there is evidence of hybridisation. One endemic freshwater species recorded from the site.

Wetland
• Invertebrates (non-crabs): The site supports a low diversity of benthic marine invertebrates, but may also support anchialine fauna although no site specific data has been sourced to confirm this. • Land crabs: All 20 species of land crab occur within the boundary of the site. The Dales provide a major migration pathway for crabs to and from the ocean during spawning. The site is important for blue crabs in particular. • Water birds: Eleven waterbirds, including nine endemic species, one nationally listed vulnerable and one endangered species are found at the site. The site supports breeding seabirds including Abbott's booby and red-footed booby. **Ecosystem services** • Cultural services–Recreation and tourism: The Dales is a popular recreational area for both tourists and locals. Two timber board walks have been installed at No. 1 Dale and Hugh's Dale. The Dales is the most popular sight seeing destination on the island with the waterfall at Hugh's Dale being the greatest attraction. • Cultural services–science and education: Parks Australia undertakes and supports a range of research programs across the National Park, many of which are directly relevant to The Dales. For example, research investigations include impacts of the yellow crazy ant, land crab ecology and the Abbott's booby. • Supporting services–food webs: Crab spawning provides a rich food supply to marine biota including whale sharks. In addition the land crabs play a significant role in the energy dynamics of the forest affecting seedling recruitment and ultimately the structure of the forest. The invasion of the yellow crazy ant has significantly affected trophic relationships on Christmas Island. • Supporting services–Provides physical habitat (for breeding waterbirds): Terrestrial vegetation provides roosting and breeding sites for several species of waterbirds. • Supporting services–Biodiversity: Supports a variety of wetland species, communities and habitats including marine, terrestrial and freshwater dependent species. • Supporting services–Special ecological, physical or geomorphic features: Provides critical habitat for the blue crabs and freshwater crabs, provides examples of karst features such as tufa deposits at the Hugh's Dale waterfall, and possibly anchialine cave communities. • Supporting services–Distinct or unique wetland species: Red crabs are considered keystone species on the island. • Supporting services–Threatened wetland species, habitats and ecosystems: The Dales Ramsar site supports nesting sites for the endangered Abbott's booby. The Christmas Island frigatebird has also been recorded from the site. • Supporting services–Priority wetland services: Christmas Island supports a number of vagrant species listed under various international agreements. • Supporting services–Supports near-natural wetland types: Springs and karst systems are representative of the bioregion and considered in near natural condition at the time of listing. • Supporting services–Ecological connectivity: The streams of The Dales provide critical migration pathways for downward migration of red, blue and robber crabs and return pathways for juvenile blue crabs in particular.
Vasse-Wonnerup system
The Vasse-Wonnerup System Ramsar wetland is situated in the Perth Basin, southwestern Western Australia. It is an extensive, shallow, nutrient-enriched wetland system of highly varied salinities. Large areas of the wetland dry out in late summer. 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, with inflows of seawater managed by floodgates (weirs) since early 1900s. Water in the Vasse-Wonnerup System is fresh in winter and becomes saline in summer due to leakage past the floodgates and, since 1988, some seawater being allowed to enter. The following summary of ecosystem components, processes and services has been extracted from WRM 2007. **Ecosystem components and processes** • Geomorphology: Broad, shallow basin with large seasonal variation in area of inundation. Seasonally closed estuary. • Soil type: Sandy; poor nutrient retention; acid sulphate soils; sedimentation and erosion. • Hydrology: Significant groundwater-dependent ecosystem. Seasonal freshwater surface water inflows. The seasonal shallow and partial drying of the estuary attracts waterbirds which feed on exposed mud flats and the spatial distribution of birds will change as waters retreat and more foraging areas are made available. • Water quality: Seasonal variation in salinity (fresh to brackish during winter, becoming saline during summer). Vasse-Wonnerup is highly nutrient enriched (eutrophic) due to run-off. Hypoxic (low oxygen) or anoxic (zero oxygen) conditions are typically associated with severe algal blooms and/or high rates of microbial activity.

Wetland

- Phytoplankton and aquatic macrophytes: The lower Vasse River and estuary reaches experience frequent phytoplankton, cyanobacterial and macroalgal blooms associated with the high nutrient loads.
- Vegetation: Large areas of low samphire (*Sarcocornia blackiana*, *Halosarcia pergranulata*), fringed by taller mixed samphire, sea rush (*Juncus kraussii*) and sedges (*Lepidosperma cf. leptostachyum, Carex divisa*). Some occurrence of remnant paperbark (*Melaleuca rhaphiophylla, M. hamulos, M. cuticularis*) woodlands.
- Habitat connectivity: International and national migratory bird species. Tuart forest ecosystem or with the marine ecosystem of Geographe Bay.
- Invertebrates: No comprehensive surveys of the freshwater or estuarine invertebrate communities. Based on available information, communities of zooplankton and macroinverebrates expected to include amphipods, water boatment, aquatic snails, midges and other insects, mussels, prawns, crabs and crayfish.
- Fish: Mixture of freshwater, estuarine and marine species. All of the native freshwater species recorded are south-west regional endemics. Eight of the nine marine species that regularly occur within the Vasse-Wonnerup Site, are known to use the estuaries as nursery areas
- Waterbirds: One of the most significant coastal habitats for waterbirds in the southwest of Western Australia. At least 17 migratory species (mostly shorebirds) under international protection. The Site supports peak numbers of 25,000-35,000 waterbirds in most years, of which some 12,000 are waterfowl (ducks and swans).

Ecosystem services

- Cultural services–Recreation and tourism: Recreational fishing, bushwalking and nature observation.
- Cultural services–Spiritual and inspirational: Aesthetic values, cultural heritage (historical and archaeological), spiritual and religious (sacred sites), sense of place, educational values.
- Support services–Maintenance of hydrological stability: Flood control for protection of agricultural land and built assets.
- Support services–Sediment and nutrient retention and water purification: Sediment and nutrient deposition. Removal and dilution of wastewaters from irrigation areas and urban areas.
- Support services–Food web: Nutirent and crabon cycling; primary production.
- Support services–Ecological value (waterbirds): Supports high abundance (>20,000) and richness (>60 species) of waterbirds. Supports significant proportions (⩾1%) of the relevant Ramsar populations of Black-winged Stilt, Red-necked Avocet, Australian Shelduck and Australiasian Shoveler. Supports the largest known regular breeding colony of Black Swan in the State (50-150 pairs).

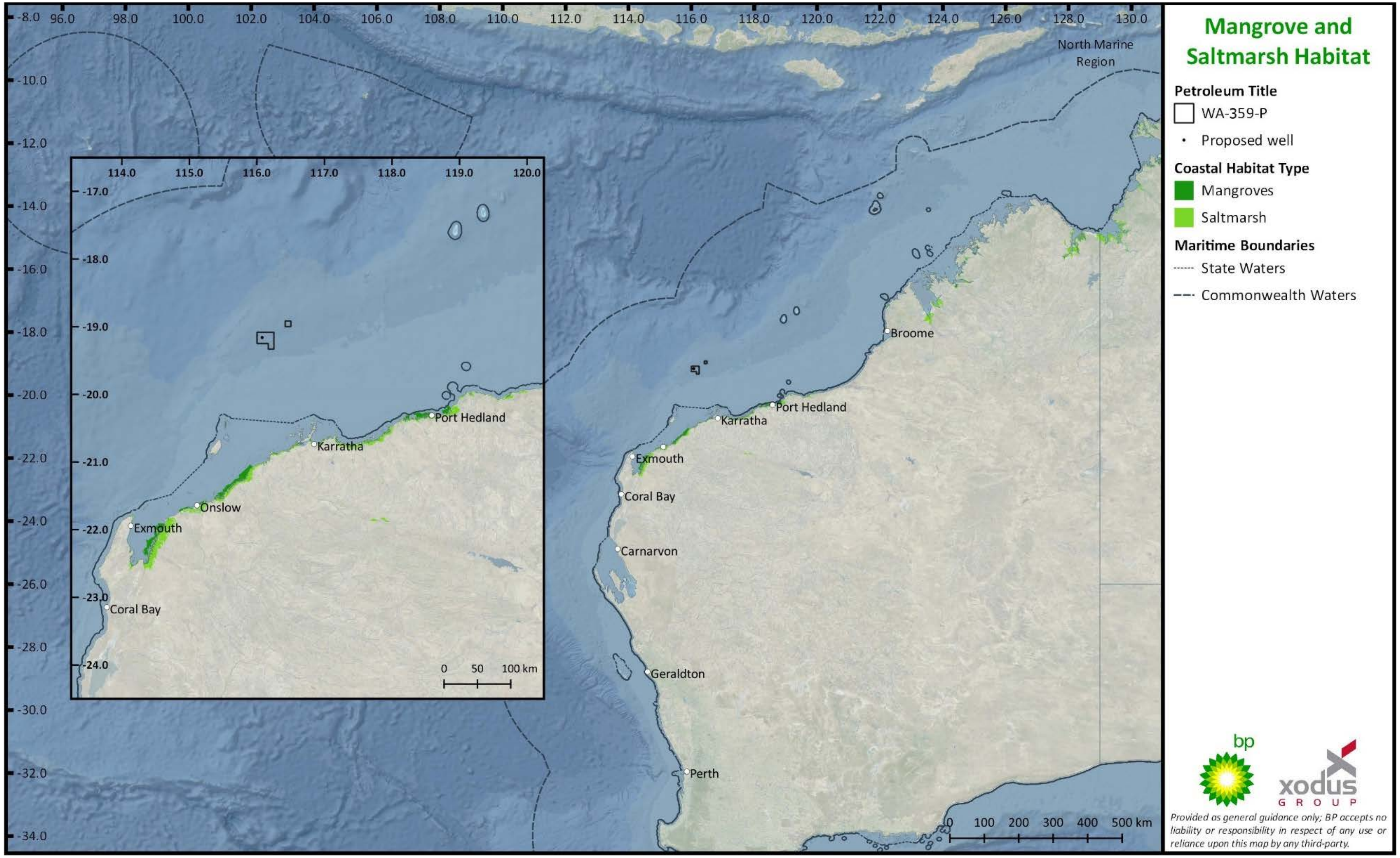


Figure 3-6: Mangrove and Saltmarsh Habitat

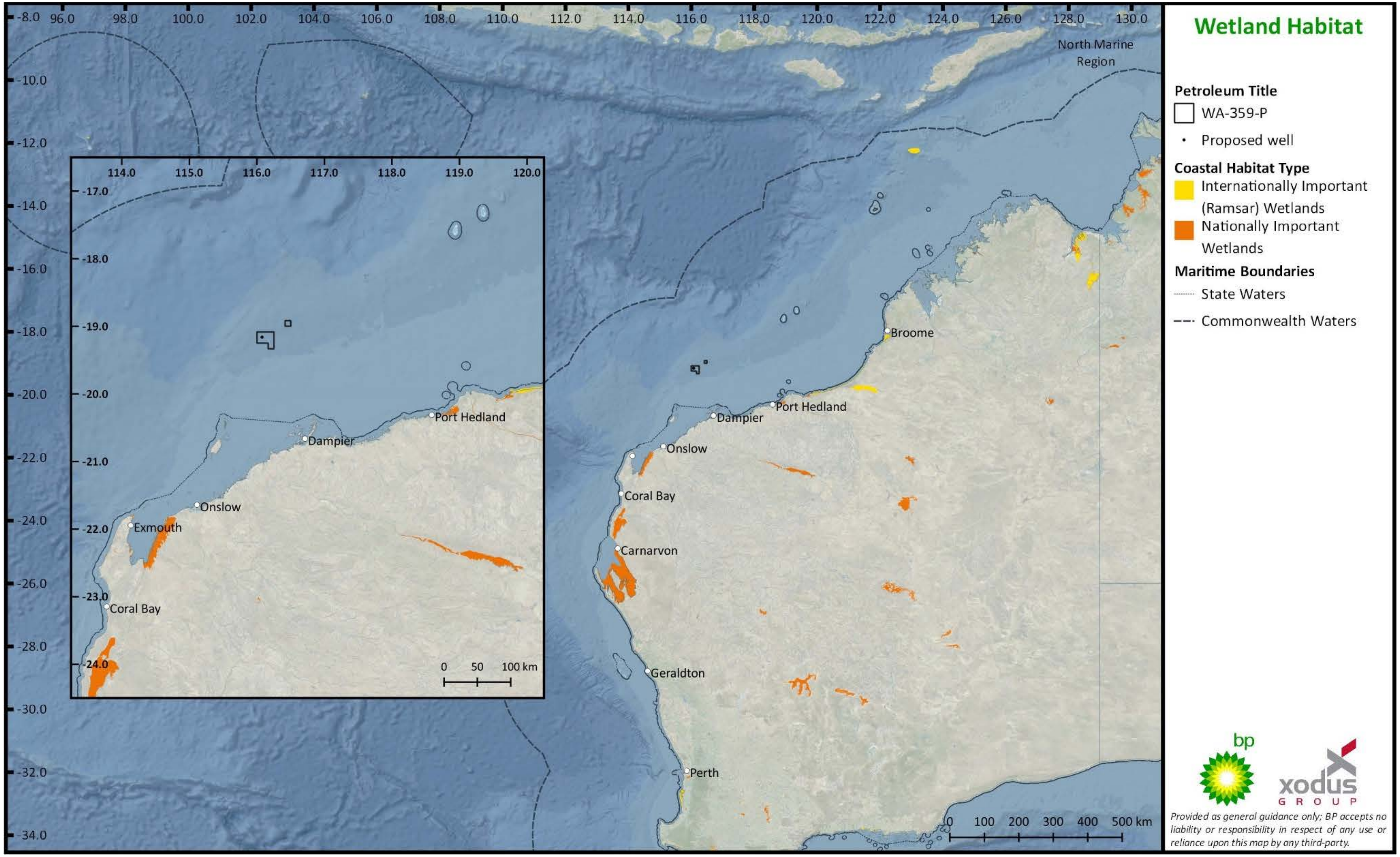


Figure 3-7: Internationally and Nationally Important Wetlands

3.3.4 Seabirds and Shorebirds

There are multiple species (or species habitat) of seabirds and shorebirds that may occur within the EMBA. The presence of most species, particularly within the Operational Area, are expected to be of a transitory nature only due to the absence of Biologically important areas[2] (BIAs). However, some species within the EMBA were identified as displaying important behaviour (e.g. breeding, roosting, foraging), some recognised as BIAs. Those closest seabird and shorebird BIA to the Ironbark Exploration Drilling Program is the breeding BIA for the wedge-tailed shearwater, approximately 50 km away.

The northwestern coastline of WA and islands provide important refuge for several seabird and shorebird species. For migratory shorebirds, the rocky shores, sandy beaches, saltmarshes, intertidal flats and mangroves are important feeding and resting habitat during spring and summer (DBCA, 2017). Migratory seabirds, including terns and shearwaters, use the islands for nesting (DBCA, 2017). Island habitats are important for seabirds as they provide relatively undisturbed roosting and nesting habitats close to oceanic foraging grounds. Oystercatchers, red-capped plovers and beach stone-curlews are among the species that have resident populations; these shorebirds are present throughout the year and nest along the coast and on offshore islands (DBCA, 2017).

The wedge-tailed shearwater is a migratory visitor to WA; estimates indicate more than one million shearwaters migrate to the Pilbara islands each year (DBCA, 2017). The wedge-tailed shearwater will excavate burrows on vegetated islands for nesting. Known breeding locations in the North-west Marine Region include Forestier Island (Sable Island), Bedout Island, Dampier Archipelago, Passage Island, Lowendal Island, islands off Barrow Island (Mushroom, Double and Boodie Islands), islands in the Onslow area (including Airlie, Bessieres, Serrurier, North and South Muiron and Locker Islands), islands in Freycinet Estuary, and south Shark Bay (Slope, Friday, Lefebre, Charlie, Freycinet, Double and Baudin Islands) (DEWHA, 2008a).

The fairy, lesser crested and roseate terns may have both a resident sub-population and a migratory population present in the Pilbara (DBCA, 2017). These tern species nest in open areas, typically sand scrapes/depressions on the sandy beaches of offshore islands. The tern species are known to nest within the region of the Ningaloo Marine Park, Muiron and Sunday islands (CALM, 2005). The Montebello Islands support the largest breeding population of roseate terns in WA (DEWHA, 2008a).

Caspian terns, little terns, and ospreys have also been known to breed on Serrurier Island and neighbouring inshore islands (DEWHA, 2008a).

Bedout Island (offshore from Port Hedland) supports one of the largest colonies of brown booby in WA; the masked booby, lesser frigatebird, roseate tern and common noddy also breed in the area (DEWHA, 2008a).

Tropicbird species spend most of their lives at sea, typically found in tropical and subtropical seas around northern Australia. A small sand cay at Bedwell Island, within Clerke Reef in Rowley Shoals Marine Park, is one of very few breeding areas in Western Australia for the Red-tailed tropicbird.

[2] Biologically important areas 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.

Table 3-6: Seabird and shorebird species or species habitat relevant the Ironbark Exploration Drilling Program

Scientific Name	Common Name	EPBC Status			Species Presence		
		Threatened Species	Migratory Species	Listed Marine Species	EMBA	Operational Area	Hydrocarbon Exposure Area
Acrocephalus orientalis	Oriental Reed-Warbler		x(W)	x	KO	-	KO
Actitis hypoleucos	Common Sandpiper		x(W)	x	KO	MO	KO
Anous minutus	Black Noddy			x	KO	-	BKO
Anous stolidus	Common Noddy		x(M)	x	BKO	MO	BKO
Anous tenuirostris melanops	Australian Lesser Noddy	V		x	BKO	-	BKO
Anseranas semipalmata	Magpie Goose			x	MO	-	-
Apus pacificus	Fork-tailed Swift		x(M)	x	LO	-	LO
Ardea alba	Great Egret			x	BKO	-	KO
Ardea ibis	Cattle Egret			x	MO	-	MO
Ardenna carneipes	Flesh-footed Shearwater		x(M)	x	FLO	-	FLO
Ardenna pacifica	Wedge-tailed Shearwater		x(M)	x	BKO	-	BKO
Arenaria interpres	Ruddy Turnstone		x(W)	x	RKO	-	-
Botaurus poiciloptilus	Australasian Bittern	E			KO	-	-
Calidris acuminata	Sharp-tailed Sandpiper		x(W)	x	RKO	MO	KO
Calidris alba	Sanderling		x(W)	x	RKO	-	-
Calidris canutus	Red Knot	E	x(W)	x	KO	MO	KO
Calidris ferruginea	Curlew Sandpiper	CE	x(W)	x	KO	-	KO
Calidris melanotos	Pectoral Sandpiper		x(W)	x	KO	MO	MO
Calidris ruficollis	Red-necked Stint		x(W)	x	RKO	-	-
Calidris subminuta	Long-toed Stint		x(W)	x	RKO	-	-
Calidris tenuirostris	Great Knot	CE	x(W)	x	RKO	-	-
Calonectris leucomelas	Streaked Shearwater		x(M)	x	KO	LO	KO
Catharacta skua	Great Skua			x	MO	-	MO

Scientific Name	Common Name	EPBC Status: Threatened Species	EPBC Status: Migratory Species	EPBC Status: Listed Marine Species	Species Presence: EMBA	Species Presence: Operational Area	Species Presence: Hydrocarbon Exposure Area
Charadrius bicinctus	Double-banded Plover		x(W)	x	RKO	-	-
Charadrius dubius	Little Ringed Plover		x(W)	x	RKO	-	-
Charadrius leschenaultii	Greater Sand Plover	V	x(W)	x	RKO	-	-
Charadrius mongolus	Lesser Sand Plover	E	x(W)	x	RKO	-	-
Charadrius ruficapillus	Red-capped Plover			x	RKO	-	-
Charadrius veredus	Oriental Plover		x(W)	x	RKO	-	MO
Chrysococcyx osculans	Black-eared Cuckoo			x	KO	-	KO
Diomedea amsterdamensis	Amsterdam Albatross	E	x(M)	x	LO	-	MO
Diomedea dabbenena	Tristan Albatross	E	x(M)	x	LO	-	-
Diomedea epomophora	Southern Royal Albatross	V	x(M)	x	FLO	-	
Diomedea exulans	Wandering Albatross	V	x(M)	x	FLO	-	MO
Diomedea sanfordi	Northern Royal Albatross	E	x(M)	x	FLO	-	-
Eudyptula minor	Little Penguin			x	BKO	-	-
Fregata ariel	Lesser Frigatebird		x(M)	x	BKO	LO	BKO
Fregata andrewsi	Christmas Island Frigatebird	E	x(M)	x	BKO		FKO
Fregata minor	Great Frigatebird		x(M)	x	BKO	MO	BKO
Gallinago megala	Swinhoe's Snipe		x(W)	x	RLO	-	-
Gallinago stenura	Pin-tailed Snipe		x(W)	x	RLO	-	-
Glareola maldivarum	Oriental Pratincole		x(W)	x	RKO	-	MO
Haliaeetus leucogaster	White-bellied Sea-Eagle			x	BKO	-	KO
Halobaena caerulea	Blue Petrel	V		x	MO	-	-
Heteroscelus brevipes	Grey-tailed Tattler			x	RKO	-	-
Himantopus himantopus	Pied Stilt			x	RKO	-	-
Hirundo daurica	Red-rumped Swallow			x	KO	-	MO

Scientific Name	Common Name	EPBC Status: Threatened Species	EPBC Status: Migratory Species	EPBC Status: Listed Marine Species	Species Presence: EMBA	Species Presence: Operational Area	Species Presence: Hydrocarbon Exposure Area
Hirundo rustica	Barn Swallow		x(T)	x	KO	-	KO
Hydroprogne caspia	Caspian Tern		x(M)	x	BKO	-	BKO
Larus novaehollandiae	Silver Gull			x	BKO	-	BKO
Larus pacificus	Pacific Gull			x	BKO	-	BKO
Limicola falcinellus	Broad-billed Sandpiper		x(W)	x	RKO	-	-
Limnodromus semipalmatus	Asian Dowitcher		x(W)	x	RKO	-	-
Limosa lapponica	Bar-tailed Godwit		x(W)	x	KO	-	KO
Limosa lapponica baueri	Bar-tailed Godwit (baueri)	V		x	KO	-	MO
Limosa lapponica menzbieri	Northern Siberian Bar-tailed Godwit	CE		x	KO	-	MO
Limosa limosa	Black-tailed Godwit		x(W)	x	RKO	-	-
Macronectes giganteus	Southern Giant Petrel	E	x(M)	x	MO	-	MO
Macronectes halli	Northern Giant Petrel	V	x(M)	x	MO	-	MO
Malurus leucopterus edouardi	White-winged Fairy-wren (Barrow Island)	V			LO	-	LO
Malurus leucopterus leucopterus	White-winged Fairy-wren (Dirk Hartog Island)				LO	-	-
Merops ornatus	Rainbow Bee-eater			x	MO	-	MO
Motacilla cinerea	Grey Wagtail		x(T)	x	KO	-	KO
Motacilla flava	Yellow Wagtail		x(T)	x	KO	-	KO
Numenius madagascariensis	Eastern Curlew	CE	x(W)	x	KO	MO	KO
Numenius minutus	Little Curlew		x(W)	x	RKO	-	-
Numenius phaeopus	Whimbrel		x(W)	x	RKO	-	-
Onychoprion anaethetus	Bridled Tern		x(M)	x	BKO	-	BKO
Pachyptila turtur subantarctica	Fairy Prion	V		x	KO	-	-
Pandion haliaetus	Osprey		x(W)	x	BKO	-	BKO

Scientific Name	Common Name	EPBC Status: Threatened Species	EPBC Status: Migratory Species	EPBC Status: Listed Marine Species	Species Presence: EMBA	Species Presence: Operational Area	Species Presence: Hydrocarbon Exposure Area
Papasula abbotti	Abbott's Booby	E		x	KO	-	LO
Pelagodroma marina	White-faced Storm-Petrel			x	BKO	-	-
Phaethon lepturus	White-tailed Tropicbird		x(M)	x	BKO	-	BKO
Phaethon lepturus fulvus	Christmas Island White-tailed Tropicbird	E		x	BLO	-	-
Phaethon rubricauda	Red-tailed Tropicbird		x(M)	x	BKO	-	BKO
Phalacrocorax fuscescens	Black-faced Cormorant			x	BLO	-	-
Phalaropus lobatus	Red-necked Phalarope		x(W)	x	RKO	-	-
Philomachus pugnax	Ruff		x(W)	x	RKO	-	-
Phoebetria fusca	Sooty Albatross	V	x(M)	x	MO	-	-
Pluvialis fulva	Pacific Golden Plover		x(W)	x	RKO	-	-
Pluvialis squatarola	Grey Plover		x(W)	x	RKO	-	-
Pterodroma arminjoniana	Round Island Petrel, Trinidade Petrel	CE		x	MO	-	-
Pterodroma macroptera	Great-winged Petrel			x	FKO	-	-
Pterodroma mollis	Soft-plumaged Petrel	V		x	FKO	-	FLO
Puffinus assimilis	Little Shearwater			x	BKO	-	-
Puffinus carneipes	Flesh-footed Shearwater			x	FLO	-	FLO
Puffinus huttoni	Hutton's Shearwater			x	FKO	-	-
Recurvirostra novaehollandiae	Red-necked Avocet			x	RKO	-	-
Rhipidura rufifrons	Rufous Fantail			x	KO	-	-
Rostratula australis	Australian Painted Snipe	E		x	KO	-	LO
Rostratula benghalensis (sensu lato)	Painted Snipe	E		x	KO	-	LO
Sterna albifrons	Little Tern		x(M)	x	BKO	-	CKO
Sterna bengalensis	Lesser Crested Tern			x	BKO	-	BKO
Sterna bergii	Crested Tern		x(W)	x	BKO	-	BKO

Scientific Name	Common Name	EPBC Status			Species Presence		
		Threatened Species	Migratory Species	Listed Marine Species	EMBA	Operational Area	Hydrocarbon Exposure Area
Sterna dougallii	Roseate Tern		x(M)	x	BKO	-	BKO
Sterna fuscata	Sooty Tern			x	BKO	-	BKO
Sterna nereis	Fairy Tern			x	BKO	-	BKO
Sternula nereis nereis	Australian Fairy Tern	V		x	BKO	-	BKO
Stiltia isabella	Australian Pratincole			x	RKO	-	-
Sula dactylatra	Masked Booby		x(M)	x	BKO	-	BKO
Sula leucogaster	Brown Booby		x(M)	x	BKO	-	BKO
Sula sula	Red-footed Booby		x(M)	x	BKO	-	BKO
Thalassarche carteri	Indian Yellow-nosed Albatross	V	x(M)	x	FMO	-	FMO
Thalassarche cauta	Tasmanian Shy Albatross	V	x(M)	x	FLO	-	MO
Thalassarche cauta cauta	Shy Albatross	V	x(M)	x	FLO	-	-
Thalassarche cauta steadi	White-capped Albatross	V		x	FLO	-	LO
Thalassarche impavida	Campbell Albatross	V	x(M)	x	MO	-	MO
Thalassarche melanophris	Black-browed Albatross	V	x(M)	x	MO	-	MO
Thalassarche steadi	White-capped Albatross		x(M)	x	FLO	-	LO
Thinornis rubricollis	Hooded Plover			x	BKO	-	KO
Tringa brevipes	Grey-tailed Tattler		x(W)	x	RKO	-	-
Tringa glareola	Wood Sandpiper		x(W)	x	RKO	-	-
Tringa nebularia	Common Greenshank		x(W)	x	KO	-	LO
Tringa stagnatilis	Marsh Sandpiper		x(W)	x	RKO	-	-
Tringa totanus	Common Redshank		x(W)	x	RKO	-	-
Xenus cinereus	Terek Sandpiper		X (W)	x	RKO	-	-

Scientific Name	Common Name	EPBC Status: Threatened Species	EPBC Status: Migratory Species	EPBC Status: Listed Marine Species	Species Presence: EMBA	Species Presence: Operational Area	Species Presence: Hydrocarbon Exposure Area

Threatened Species:	*Type of Presence:*
V ***Vulnerable***	*MO* *Species of species habitat may occur within area*
E ***Endangered***	*LO* *Species or species habitat likely to occur within area*
CE ***Critically Endangered***	*KO* *Species or species habitat known to occur within area*
	FMO *Foraging, feeding or related behaviour may occur within area*
Migratory Species:	*FLO* *Foraging, feeding or related behaviour likely to occur within area*
M ***Marine***	*FKO* *Foraging, feeding or related behaviour known to occur within area*
W ***Wetland***	*BLO* *Breeding likely to occur within area*
T ***Terrestrial***	*BKO* *Breeding known to occur within area*
	RLO *Roosting likely to occur within area*
	RKO *Roosting known to occur within area*

Table 3-7: Biologically Important Areas for seabird and shorebird species relevant to the Ironbark Exploration Drilling Program

Scientific Name	Common Name	BIA Presence: EMBA	BIA Presence: Operational Area	BIA Presence: Hydrocarbon Exposure Area	Summary Description of BIA
Anous stolidus	Common Noddy	f	-	-	Foraging grounds around islands used for breeding (e.g. Abrolhos). Presence likely around Abrolhos mid-August to late-April.
Anous tenuirostris melanops	Australian Lesser Noddy	f	-	-	Foraging grounds around islands used for breeding (e.g. Abrolhos). Presence may occur throughout the year.
Ardenna carneipes	Flesh-footed Shearwater	a	-	-	Foraging from Cape Naturaliste to Eyre, early September to late May. Pre-departure aggregation from Rottnest Island to Bunbury late April to late June and late August to early November. Breeding season late September to early May off south-western Western Australia.

Scientific Name	Common Name	BIA Presence EMBA	BIA Presence Operational Area	BIA Presence Hydrocarbon Exposure Area	Summary Description of BIA
Ardenna pacifica	Wedge-tailed Shearwater	b,f	b	b	Breeding grounds and buffer area around offshore islands (including Dampier Archipelago, Bedout Island, Forestier Islands, Montebello and Lowendal Islands). Breeding presence may occur between mid-August to April (Pilbara) or to mid-May (Shark Bay).
Eudyptula minor	Little Penguin	f	-	-	Foraging grounds (generally inshore waters) from Perth to Bunbury. Adults may be present near breeding grounds throughout the year.
Fregata ariel	Lesser Frigatebird	b	-	-	Breeding grounds and buffer area around offshore islands in Pilbara and Kimberley (including Bedout Island). Breeding season March to September.
Larus pacificus	Pacific Gull	f	-	f	Foraging grounds (generally inshore waters) along west coast and around Abrolhos Islands.
Phaethon lepturus	White-tailed Tropicbird	b	-	-	Breeding grounds and buffer area around offshore islands in Pilbara and Kimberley (including Rowley Shoals). Breeding recorded between May and October.
Pterodroma macroptera macroptera	Great-winged petrel	f	-	-	Foraging (provisioning young) offshore south of Shark Bay, extending around south-west corner of WA.
Pterodroma mollis	Soft-plumaged Petrel	f	-	f	Oceanic foraging grounds on continental shelf waters (not observed inshore). Presence may occur March to late-September.
Puffinus assimilis	Little Shearwater	f	-	f	Oceanic foraging grounds (4–200 km off coast) between Kalbarri and Eucla, with high usage around Abrolhos Islands. Presence mainly occurs April to November.
Sterna anaethetus	Bridled Tern	f	-	f	Oceanic foraging grounds. Presences is generally driven by breeding season, late-September to late-February/early-May.
Sterna caspia	Caspian Tern	f	-	f	Oceanic foraging grounds.
Sterna dougallii	Roseate Tern	b,f,r	-	b,f	Breeding grounds and buffer area around offshore islands in Gascoyne, Pilbara and Kimberley. Breeding presence may occur mid-March to July.

Scientific Name	Common Name	BIA Presence: EMBA	BIA Presence: Operational Area	BIA Presence: Hydrocarbon Exposure Area	Summary Description of BIA
Sterna fuscata	Sooty Tern	f	-	f	Oceanic foraging grounds on west coast and round Abrolhos Islands. Resting area located northern end of Eighty Mile Beach.
Sterna nereis	Fairy Tern	b,f	-	b,f	Oceanic foraging grounds; common in Abrolhos area but in small numbers. Presence associated with breeding season from late-August to early-May.
Sternula albifrons	Little Tern	b,r	-	-	Breeding grounds and buffer area around offshore islands in Gascoyne and Pilbara. Breeding may occur late-July to September.
Sula leucogaster	Brown Booby	b	-	-	Oceanic foraging grounds on west coast and round Abrolhos Islands.
Sula sula	Red-footed booby	b	-	-	Breeding in North west Kimberley and Ashmore reef, May-June.
Thalasseus bengalensis	Lesser Crested Tern	b	-	b	Breeding grounds and buffer area and resting areas, around offshore islands in Pilbara and Kimberley. Breeding has been recorded June to October.

Type of BIA Presence:

a ***aggregation grounds***
b ***breeding grounds***
f ***feeding grounds***
r ***resting grounds***

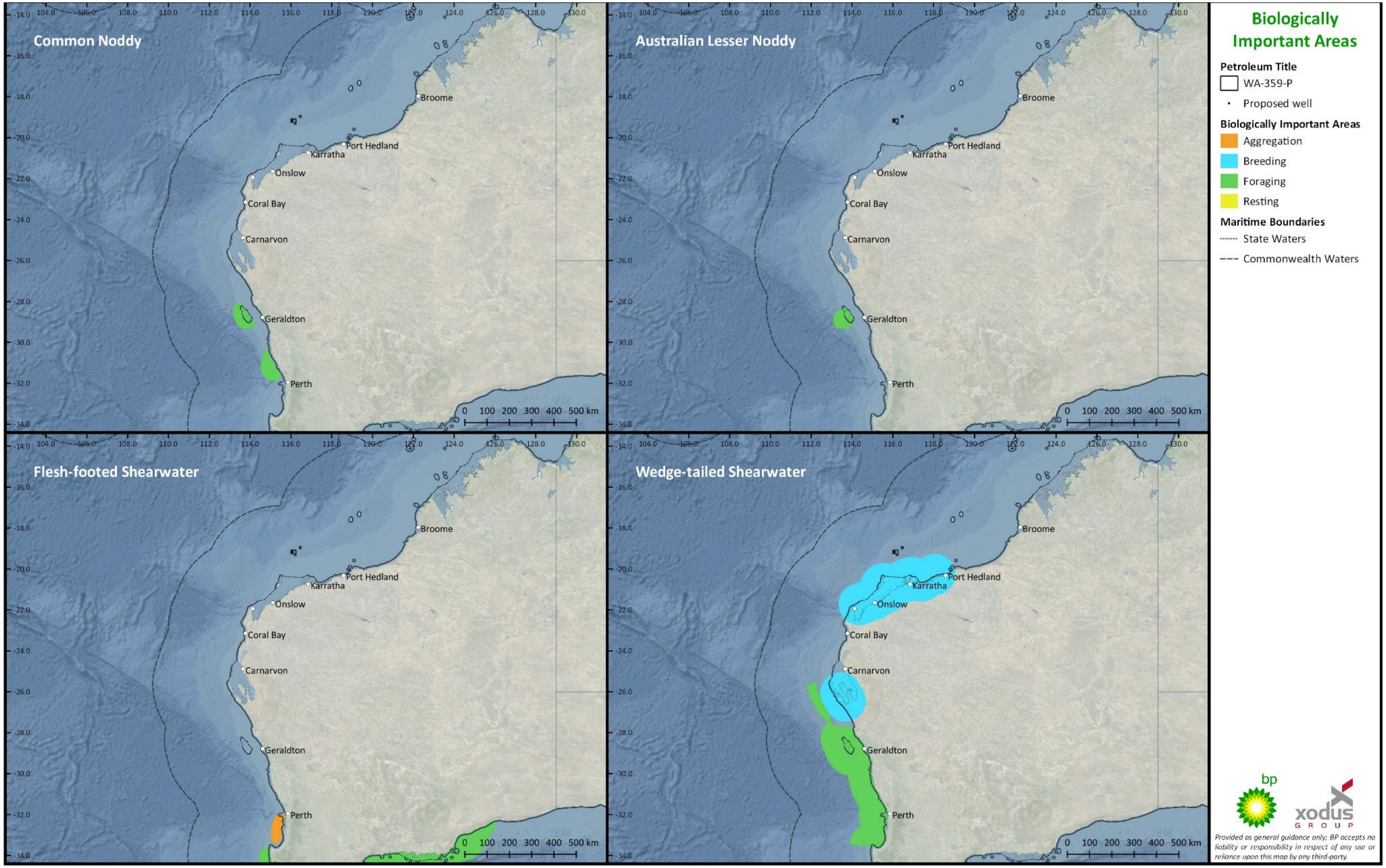


Figure 3-8: Biologically important areas for the Common noddy, Australian lesser noddy, Flesh-footed shearwater and Wedge tailed-shearwater species

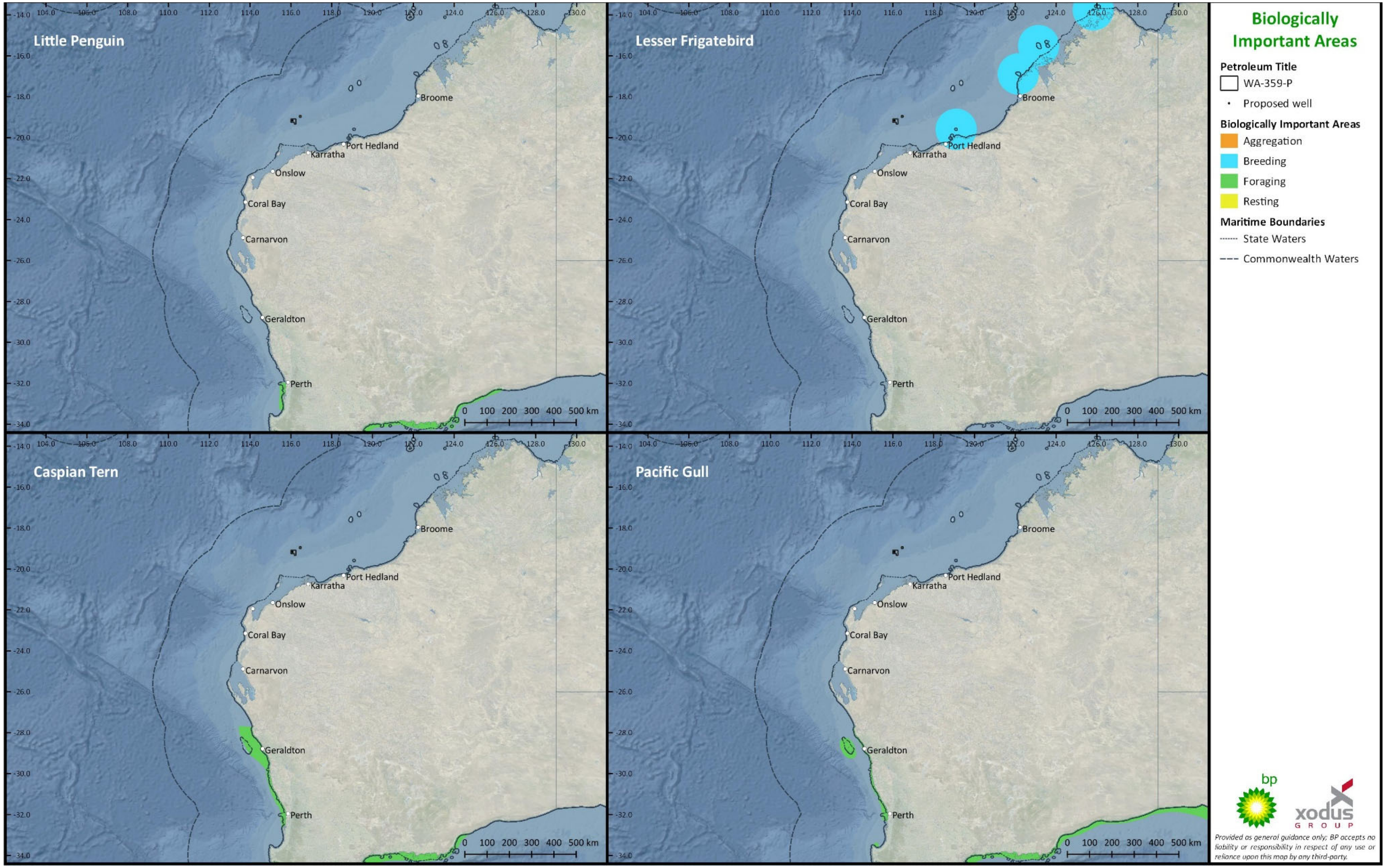


Figure 3-9: Biologically important areas for Little penguin, Lesser frigatebird, Caspian tern and Pacific gull species

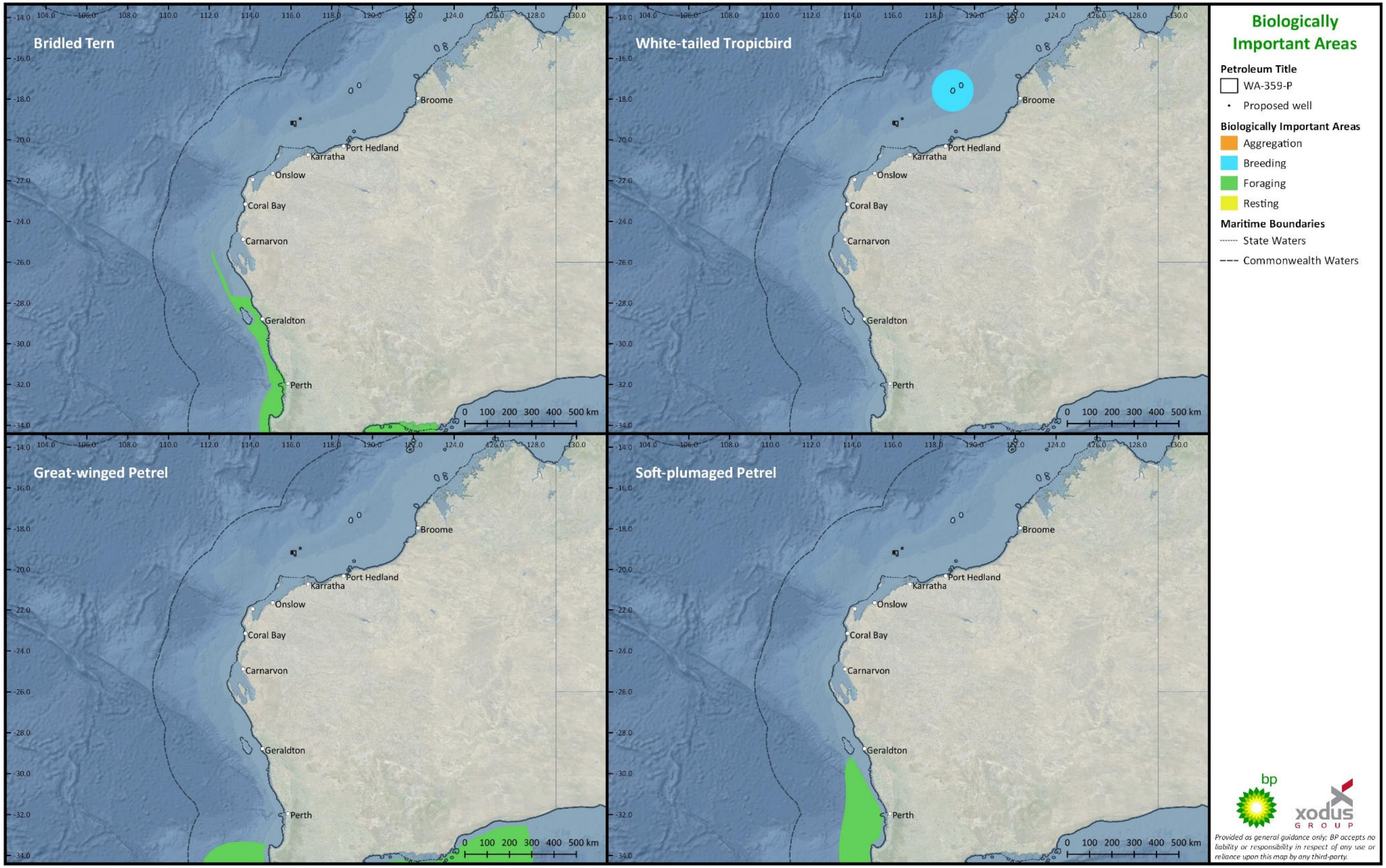


Figure 3-10: Biologically important areas for Bridled tern, white-tailed tropicbird, great-winged petrel and soft-plumaged petrel species

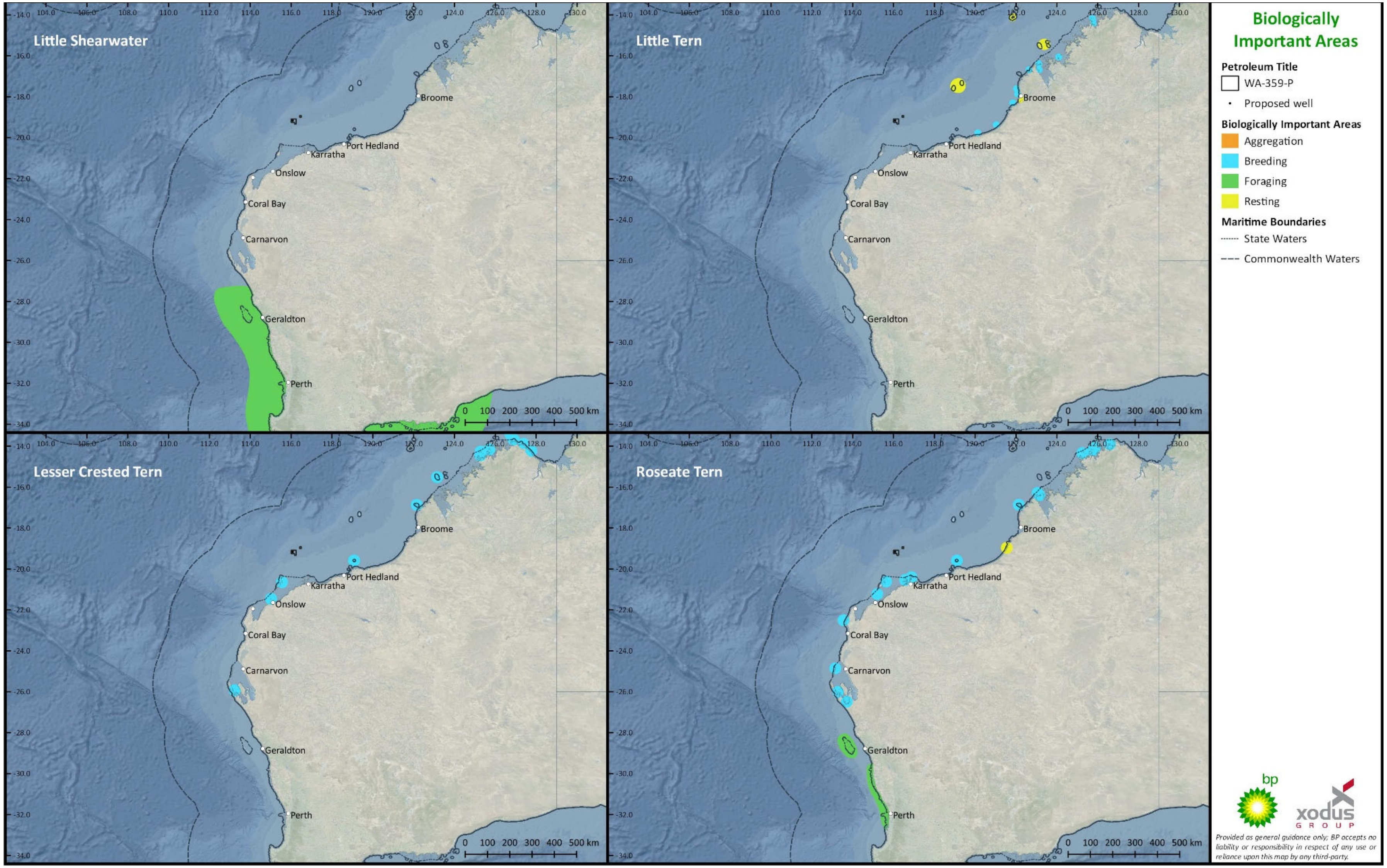


Figure 3-11: Biologically important areas for the Little shearwater, Little tern, Lesser crested tern and Roseate tern species

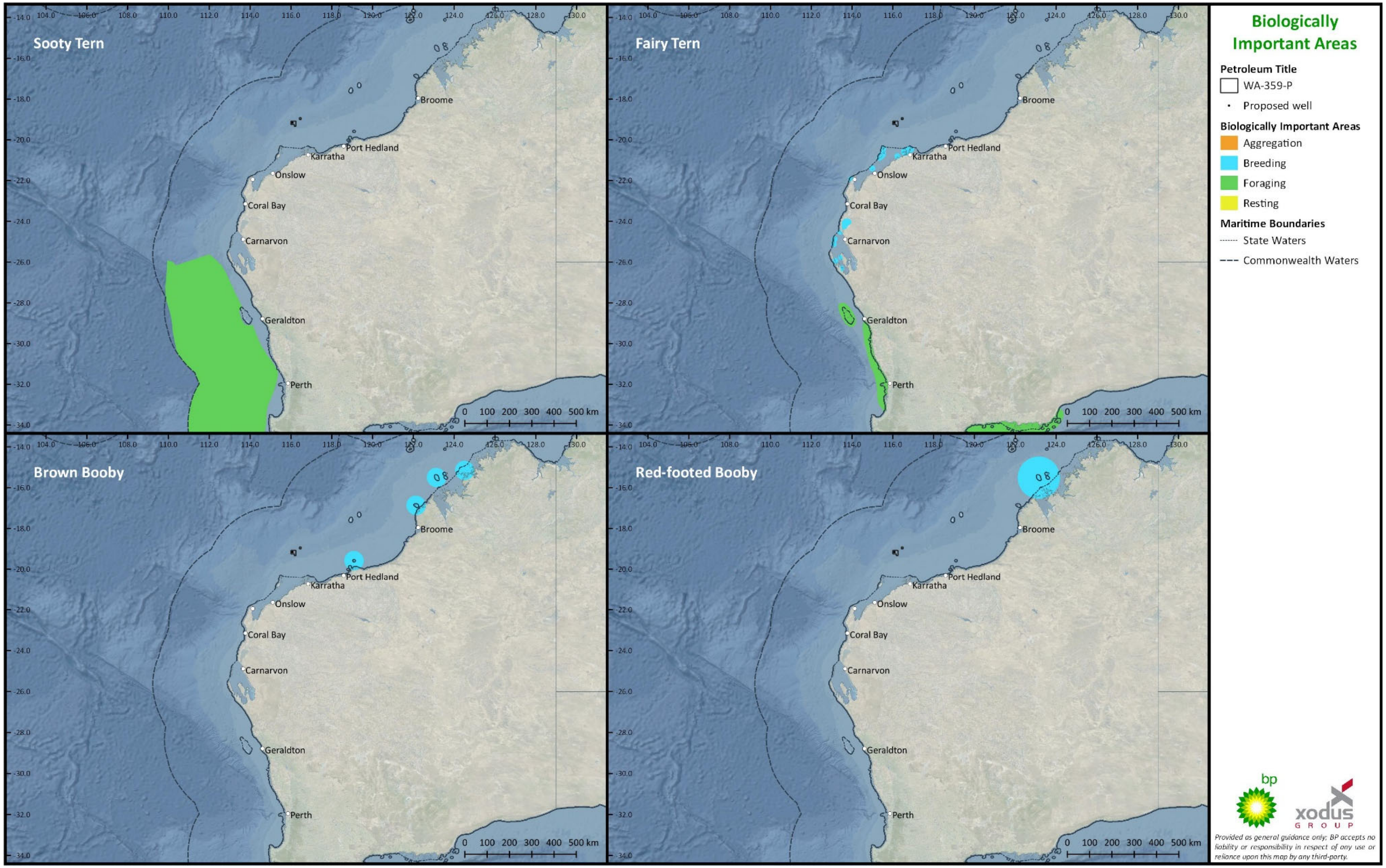


Figure 3-12: Biologically important areas for the Sooty tern, Fairy tern, Brown booby and Red-footed booby species

3.3.5 Fish and Sharks

There are multiple species (or species habitats) of fish that may occur within the EMBA. The presence of most species within the Operational Area is expected to be of a transitory nature only due to the absence of BIAs, with only a small number of species having an important behaviour (e.g. foraging) identified.

BIAs have also been identified for some species within the EMBA. The closest BIA to the Ironbark Exploration Drilling Program is the foraging BIA for the whale shark which is approximately 15 km to the south. BIAs for other species identified within the EMBA occur outside of the Operational or Hydrocarbon Exposure Area, namely:

- Whale shark (Foraging and Foraging (high density prey))
- White shark (Foraging)
- Dwarf sawfish (Foraging, Juvenile, Nursing, Pupping)
- Freshwater sawfish (Foraging, Juvenile, Nursing, Pupping)
- Green sawfish (Foraging, Juvenile, Pupping)

The whale shark is widely distributed in Australian waters; but Ningaloo Reef is the main known aggregation area (DEWHA, 2008a). Whale sharks aggregate at Ningaloo between March and June each year to feed. The whale shark is a suction filter feeder, with a diet consisting of planktonic and nektonic prey, and feeds at or close to the water's surface by swimming forward with mouth agape, sucking in prey (DotEE, 2017). While the species is generally encountered close to or at the surface, it will regularly dive and move through the water column.

Much of the seabed in the immediate vicinity of the Operational Area is expected to be flat and unvegetated soft sediment as confirmed by the preliminary results of the site survey (Section 3.3.2.1). Consequently, the demersal fish fauna abundance and diversity is likely to be lower as compared to nearshore vegetated areas or offshore areas with complex topography.

The benthic and pelagic fish communities of the Northwest Transition are strongly depth-related (Brewer et al., 2007, DEWHA, 2008a). The fish communities of the Northwest Transition, Northwest Province and Timor Province are also diverse, with high level of endemism in demersal fish communities on the slope.

Fish species commonly found on the inner shelf include lizardfish, goatfish, trevally, anglefish and tuskfish; and fish species commonly found in slightly deeper (100–200 m) shelf water include deep goatfish, deep lizardfish, ponyfish, deep threadfin bream, adult trevally, billfish and tuna (DEWHA, 2008a). Fish found in water depths up to 300 m include grouper and snapper species (Rome and Newman, 2010). Spanish mackerel spawn in the region between August and November. A small aggregation of the vulnerable grey nurse sharks has been identified off Exmouth during a five-year (2007–2012) study (Hosche and Whisson, 2016). Aggregation sites are important in the life cycle of the grey nurse shark for mating and pupping (Hosche and Whisson, 2016).

Table 3-8: Fish species or species habitat relevant to the Ironbark Exploration Drilling

Scientific Name	Common Name	EPBC Status			Type of Presence		
		Threatened Species	Migratory Species	Listed Marine Species	EMBA	Operational Area	Hydrocarbon Exposure Area
Sharks and rays							
Anoxypristis ***cuspidata***	Narrow Sawfish		x		KO	MO	KO
Carcharias taurus	Grey Nurse Shark	V			KO	-	KO
Carcharodon carcharias	White Shark	V	x		FKO	-	KO
Glyphis garricki	Northern River Shark	E			BLO	-	MO
Glyphis glyphis	Speartooth Shark	CE			MO	-	-
Isurus oxyrinchus	Shortfin Mako		x		LO	LO	LO
Isurus paucus	Longfin Mako		x		LO	LO	LO
Lamna nasus	Porbeagle, Mackerel Shark		x		LO	-	MO
Manta alfredi	Reef Manta Ray		x		KO	-	KO
Manta birostris	Giant Manta Ray		x		KO	MO	KO
Pristis clavata	Dwarf Sawfish	V	x		BKO	-	KO
Pristis pristis	Freshwater Sawfish	V	x		KO	-	KO
Pristis zijsron	Green Sawfish	V	x		BKO	-	KO
Rhincodon typus	Whale Shark	V	x		FKO	MO	FKO
Other fish species							
Acentronura australe	Southern Pygmy Pipehorse			x	MO	-	-
Acentronura larsonae	Helen's Pygmy Pipehorse			x	MO	-	MO
Bhanotia fasciolata	Corrugated Pipefish, Barbed Pipefish			x	MO	-	MO
Bulbonaricus brauni	Braun's Pughead Pipefish			x	MO	-	MO
Campichthys galei	Gale's Pipefish			x	MO	-	MO
Campichthys tricarinatus	Three-keel Pipefish			x	MO	-	MO
Choeroichthys brachysoma	Pacific Short-bodied Pipefish			x	MO	-	MO

Scientific Name	Common Name	EPBC Status: Threatened Species	EPBC Status: Migratory Species	EPBC Status: Listed Marine Species	Type of Presence: EMBA	Type of Presence: Operational Area	Type of Presence: Hydrocarbon Exposure Area
Choeroichthys latispinosus	Muiron Island Pipefish			x	MO	-	MO
Choeroichthys sculptus	Sculptured Pipefish			x	MO	-	-
Choeroichthys suillus	Pig-snouted Pipefish			x	MO	-	MO
Corythoichthys amplexus	Fijian Banded Pipefish			x	MO	-	MO
Corythoichthys flavofasciatus	Reticulate Pipefis			x	MO	-	MO
Corythoichthys haematopterus	Reef-top Pipefish			x	MO	-	-
Corythoichthys intestinalis	Australian Messmate Pipefish			x	MO	-	MO
Corythoichthys schultzi	Schultz's Pipefish			x	MO	-	MO
Cosmocampus banneri	Roughridge Pipefish			x	MO	-	MO
Cosmocampus maxweberi	Maxweber's Pipefish			x	MO	-	-
Doryrhamphus baldwini	Redstripe Pipefish			x	MO	-	-
Doryrhamphus dactyliophorus	Banded Pipefish			x	MO	-	MO
Doryrhamphus excisus	Bluestripe Pipefish			x	MO	-	MO
Doryrhamphus janssi	Cleaner Pipefish			x	MO	-	MO
Doryrhamphus multiannulatus	Many-banded Pipefish			x	MO	-	MO
Doryrhamphus negrosensis	Flagtail Pipefish			x	MO	-	MO
Festucalex scalaris	Ladder Pipefish			x	MO	-	MO
Filicampus tigris	Tiger Pipefish			x	MO	-	MO
Halicampus brocki	Brock's Pipefish			x	MO	-	MO
Halicampus dunckeri	Red-hair Pipefish			x	MO	-	MO
Halicampus grayi	Mud Pipefish			x	MO	-	MO
Halicampus macrorhynchus	Whiskered Pipefish, Ornate Pipefish			x	MO	-	-
Halicampus nitidus	Glittering Pipefish			x	MO	-	MO
Halicampus spinirostris	Spiny-snout Pipefish			x	MO	-	MO

Scientific Name	Common Name	EPBC Status: Threatened Species	EPBC Status: Migratory Species	EPBC Status: Listed Marine Species	Type of Presence: EMBA	Type of Presence: Operational Area	Type of Presence: Hydrocarbon Exposure Area
Haliichthys taeniophorus	Ribboned Pipehorse			x	MO	-	MO
Heraldia nocturna	Upside-down Pipefish			x	MO	-	-
Hippichthys cyanospilos	Blue-speckled Pipefish, Blue-spotted Pipefish			x	MO	-	-
Hippichthys heptagonus	Madura Pipefish, Reticulated Freshwater Pipefish			x	MO	-	-
Hippichthys penicillus	Beady Pipefish			x	MO	-	MO
Hippichthys spicifer	Belly-barred Pipefish, Banded Freshwater Pipefish			x	MO	-	-
Hippocampus angustus	Western Spiny Seahorse			x	MO	-	MO
Hippocampus breviceps	Short-head Seahorse			x	MO	-	-
Hippocampus histrix	Spiny Seahorse			x	MO	-	MO
Hippocampus kuda	Spotted Seahorse			x	MO	-	MO
Hippocampus planifrons	Flat-face Seahorse			x	MO	-	MO
Hippocampus spinosissimus	Hedgehog Seahorse			x	MO	-	MO
Hippocampus subelongatus	West Australian Seahorse			x	MO	-	-
Hippocampus trimaculatus	Three-spot Seahorse			x	MO	-	MO
Histiogamphelus cristatus	Rhino Pipefish			x	MO	-	-
Lissocampus caudalis	Australian Smooth Pipefish			x	MO	-	-
Lissocampus fatiloquus	Prophet's Pipefish			x	MO	-	MO
Lissocampus runa	Javelin Pipefish			x	MO	-	-
Maroubra perserrata	Sawtooth Pipefish			x	MO	-	-
Micrognathus brevirostris	Thorntail Pipefish, Thorn-tailed Pipefish			x	MO	-	-
Micrognathus micronotopterus	Tidepool Pipefish			x	MO	-	MO
Mitotichthys meraculus	Western Crested Pipefish			x	MO	-	-
Nannocampus subosseus	Bonyhead Pipefish			x	MO	-	MO

Scientific Name	Common Name	EPBC Status: Threatened Species	EPBC Status: Migratory Species	EPBC Status: Listed Marine Species	Type of Presence: EMBA	Type of Presence: Operational Area	Type of Presence: Hydrocarbon Exposure Area
Phoxocampus belcheri	Black Rock Pipefish			x	MO	-	MO
Phycodurus eques	Leafy Seadragon			x	MO	-	-
Phyllopteryx taeniolatus	Common Seadragon			x	MO	-	-
Pugnaso curtirostris	Pugnose Pipefish			x	MO	-	-
Solegnathus hardwickii	Pallid Pipehorse			x	MO	-	MO
Solegnathus lettiensis	Gunther's Pipehorse			x	MO	-	MO
Solenostomus cyanopterus	Robust Ghostpipefish			x	MO	-	MO
Stigmatopora argus	Spotted Pipefish			x	MO	-	MO
Stigmatopora nigra	Widebody Pipefish			x	MO	-	-
Syngnathoides biaculeatus	Double-end Pipehorse			x	MO	-	MO
Trachyrhamphus bicoarctatus	Bentstick Pipefish			x	MO	-	MO
Trachyrhamphus longirostris	Straightstick Pipefish			x	MO	-	MO
Urocampus carinirostris	Hairy Pipefish			x	MO	-	-
Vanacampus margaritifer	Mother-of-pearl Pipefish			x	MO	-	-
Vanacampus phillipi	Port Phillip Pipefish			x	MO	-	-
Vanacampus poecilolaemus	Longsnout Pipefish			x	MO	-	-

Threatened Species:
V ***Vulnerable***
E ***Endangered***
CE ***Critically Endangered***

Migratory Species:
M ***Marine***
W ***Wetland***
T ***Terrestrial***

Type of Presence:
MO *Species of species habitat may occur within area*
LO *Species or species habitat likely to occur within area*
KO *Species or species habitat known to occur within area*
FMO *Foraging, feeding or related behaviour may occur within area*
FLO *Foraging, feeding or related behaviour likely to occur within area*
FKO *Foraging, feeding or related behaviour known to occur within area*
BLO *Breeding likely to occur within area*
BKO *Breeding known to occur within area*
RLO *Roosting likely to occur within area*
RKO *Roosting known to occur within area*

Table 3-9: Biologically Important Areas for fish species relevant to the Ironbark Exploration Drilling Program

Scientific Name	Common Name	BIA Presence: EMBA	BIA Presence: Operational Area	BIA Presence: Hydrocarbon Exposure Area	Summary Description of BIA
Carcharodon carcharias	White Shark	f	-	-	Foraging grounds around Abrolhos Islands; foraging is associated with sea lion colonies along the south-west coast between Dongara and Augusta.
Rhincodon typus	Whale Shark	f	-	f	Oceanic foraging grounds: whale sharks known to travel along the 200 m depth contour. Presence may occur during spring. Ningaloo Reef foraging grounds: high density prey. Between April and June, and in Autumn.
Pristis clavata	Dwarf Sawfish	f,n	-	-	Inshore foraging, pupping and nursery area along Eighty Mile Beach. Nursery area at Fitzroy River Mouth, May and Robinson River.
Pristis pristis	Freshwater Sawfish	f,n	-	-	Inshore foraging and pupping area along Eighty Mile Beach. Foraging, pupping and nursery area at Roebuck Bay. Pupping occurs from January to May. Foraging and nursing occurs in King Sound.
Pristis zijsron	Green Sawfish	f,n	-	-	Inshore foraging and pupping area along Eighty Mile Beach. Pupping occurs at Willie Creek. Foraging and pupping area at Roebuck Bay. Pupping occurs from January to May. Foraging and nursing occurs in King Sound. Foraging occurs in Camden Sound.

<u>*Biologically Important Area*</u>
f ***Foraging***
n ***Nursing, pupping and/or juvenile***

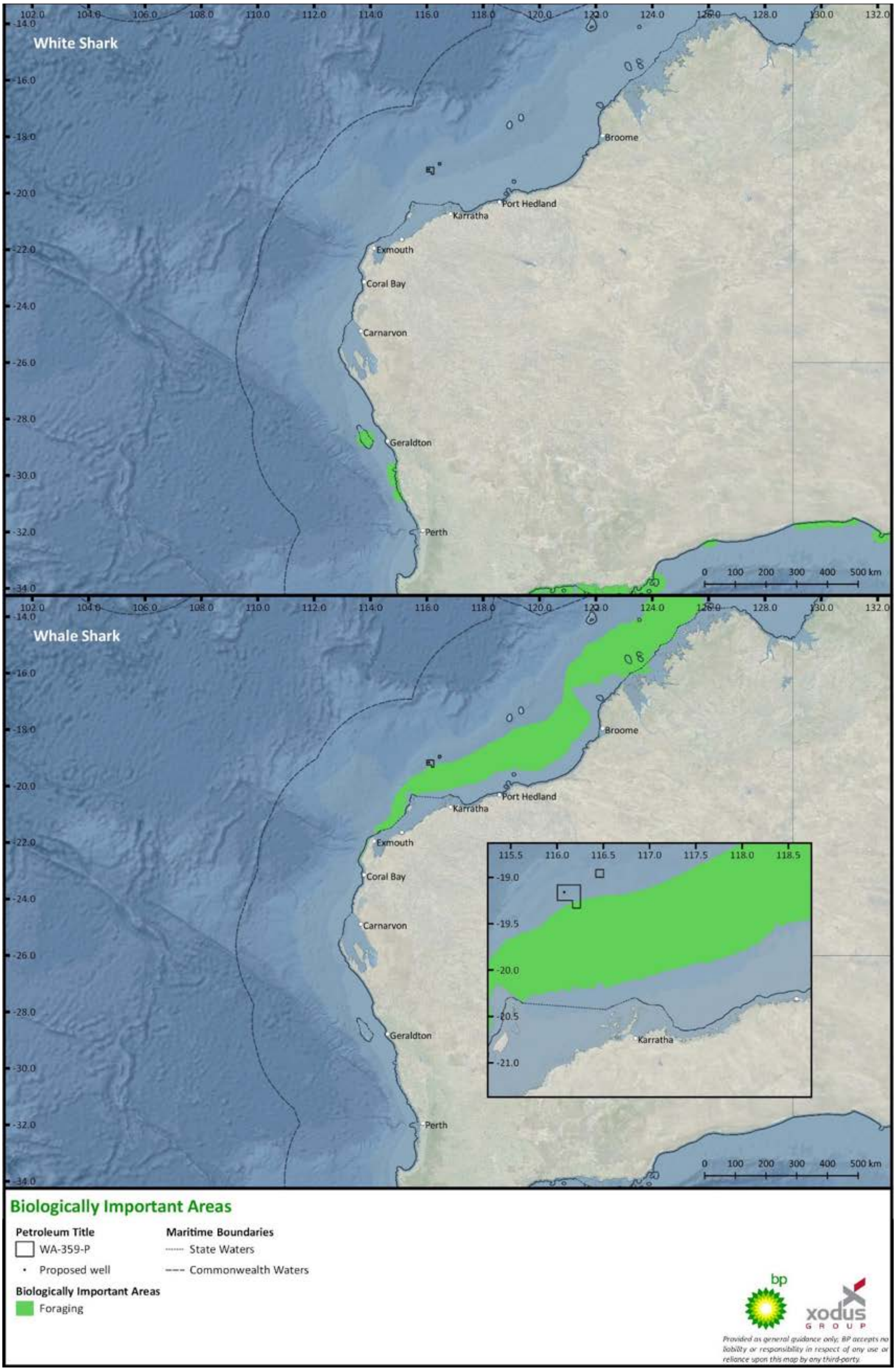


Figure 3-13: Biologically important area for shark species (Great White and Whale Shark)

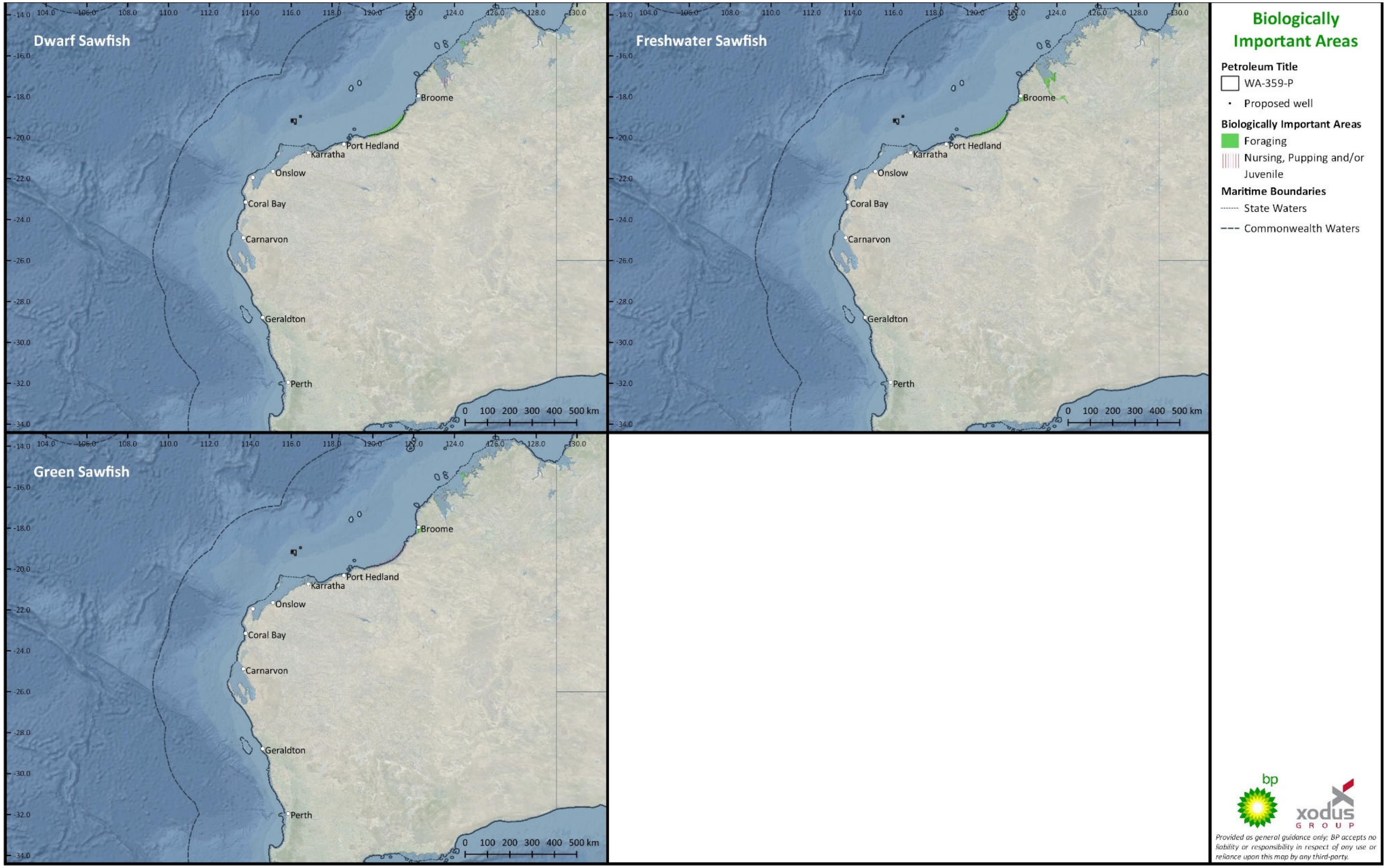


Figure 3-14: Biologically important area for sawfish species (Dwarf, Freshwater and Green Sawfish)

3.3.6 Marine Mammals

There are multiple marine mammal species (or habitat) that may occur within the EMBA. The presence of most species, within the Operational Area and wider EMBA, are expected to be of a transitory nature only, with only a small number of species having an important behaviour (e.g. foraging, breeding) identified within the EMBA.

The closest BIA to the Ironbark Exploration Drilling Program is the migration BIAs for the pygmy blue and humpback whales, and the foraging, breeding and calving/nursing BIAs for the dugong.

3.3.6.1 *Pygmy Blue Whales*

There are two subspecies of blue whales found in the southern hemisphere and known to occur in Australian waters: the Antarctic blue whale and the pygmy blue whale. Antarctic blue whales are not expected to occur within the EMBA. Pygmy blue whales are expected to occur; and seasonally important areas within WA include the Perth Canyon.

The migratory pathway of pygmy blue whales along the WA coast is reasonably well understood (McCauley and Jenner, 2010; DEWHA, 2008a) with recent information collected from satellite tags showing that the Banda and Molucca seas in Indonesia are the likely destination for the northern migration of whales that feed off the Perth Canyon (Double et al., 2012; Gales et al., 2010; Branch et al., 2004).

Pygmy blue whales migrate along the west coast of Australia: in the northern direction to their breeding grounds near the Indonesian Archipelago from mid-February to early June; and in the southern direction to the feeding grounds in the Southern Ocean from mid-November to early January (Gavrilov et al., 2018). McCauley and Jenner (2010) estimated between seven and fifteen hundred pygmy blue whales migrating southward past Exmouth in 2004.

Pygmy blue whales follow the Western Australian continental shelf edge south of North West Cape on the north and southbound migratory routes (Gavrilov et al., 2018). It was found that pygmy blue whales tended to travel southward much further away from the Western Australian coast north of North West Cape - at distances of up to 400 km from shore- than expected from data on their northbound migration (Gavrilov et al., 2018).

Satellite tagging data (2009–2012) showed that whales tagged in WA during March and April migrated northwards post tag deployment. The tagged whales travelled relatively near to the Australian coastline (100.0 ± 1.7 km) in water depths of 1,369.5 ± 47.4 m, until reaching the North West Cape, after which they travelled offshore (2,38.0 ± 13.9 km) into progressively deeper water (2,617.0 ± 143.5 m). Whales reached the northern terminus of their migration and potential breeding grounds in Indonesian waters by June (Double et al., 2014).

Although the migration BIA for this species has been historically categorised as the migration corridor centred between the 500 m and 1,000 m depth contours (DEWHA, 2008), Double et al. (2014) suggests individuals transit through deeper waters approximately 100 km from the Australian coastline during the northern migration and Gavrilov et al. (2018) suggests individuals transit in even deeper waters up to 400 km from the Australian coastline during the southern migration. This confirms that pygmy blue whales are commonly distributed in water depths over 1,000 m (Double et al., 2012). Water depths of the Operational Area are much shallower (approx. 245m to 365m), with the Operational Area located approximately 47 km from the 1,000 m isobath.

There are no known key aggregation areas (resting, breeding or feeding) located within or immediately adjacent to the Operational Area. However, the Operational Area is located on the shallow boundary edge of the pygmy blue whale migration BIA.

Although recent studies confirm that pygmy blue whales on their northbound/southbound migration are commonly distributed in water depths over 1,000 m (outside the defined migration BIA corridor) the assessment undertaken in the following sections assumes that individual whales have the potential to transit the Operational Area during the northbound, and less likely southbound, migration periods.

Owen et al. (2016) tagged a northbound pygmy blue whale, assumed to be migrating, off the southwest coast of Western Australia and determined the mean speed for a potential migrating pygmy blue whale as 2.8 ± 2.2 km/h, therefore potentially travelling a mean distance of 67 ± 53 km a day (The Operational Area has been defined as a 10.5 km area extending around the indicative well location). Diving behaviour of the tagged whale was also noted such that a total of 81.8 % of the dives were classified as migratory dives, with a mean dive duration of 5.2 min (maximum 26.7 min) (Owen et al., 2016).

McCauley and Jenner (2014) recorded 24-hour averaged counts of pygmy blue whales along the Western Australian coast and found the migratory habits of pygmy blue whales involves a short sharp pulse of southbound whales and a more protracted pulse of northbound whales. McCauley and Jenner (2014) suggests that southern migrating pygmy blue whales are swimming purposefully through the area in their desire to reach southern feeding areas. Based on this data, there is a greater probability that the passive acoustic detections of the whales migrating is not confounded by lingering individuals but whales swimming steadily past.

This highlights that individual whales that would potentially migrate along the shallowest boundary of the migration BIA, and therefore through the Operational Area, are not expected to display any sedentary behaviours, but rather travel through the area quickly.

3.3.6.2 *Humpback Whales*

Humpback whales migrate north from their Antarctic feeding grounds around May each year, and reach the waters of the North-west Marine Region in early-June (DEWHA, 2008a); however, the exact timing of the migration period can vary from year to year. From the North West Cape, northbound humpback whales travel along the edge of the continental shelf passing to the west of the Muiron, Barrow and Montebello Islands, peaking in late July (Jenner et al., 2001). Breeding and calving grounds are estimated to extend south from Camden Sound to at least North West Cape (Irvine et al. 2018); with breeding and calving occurring between August and September (DEWHA, 2008a). This also coincides with the start of the southern migration. Exmouth Gulf and Shark Bay are both important resting areas for migrating humpbacks, particularly for cow-calf pairs on the southern migration (DEWHA, 2008a). The southerly migration, from around the Lacepede Islands (north of Broome) extends parallel to the coast on approx. the 20–30 m depth contour (Jenner et al., 2001, DEWHA, 2008c). Southbound migration is more diffuse and irregular, lacking an obvious peak. An increase in southerly migrating individuals may be observed between the North West Cape and the Montebello Islands around November (Jenner et al., 2001).

3.3.6.3 *Dugongs*

A significant proportion of the world's dugong population occurs in coastal waters from Shark Bay (WA) to Moreton Bay, Queensland (DEWHA, 2008a). Shark Bay supports a significant population of dugongs, with an estimated 10,000 individuals (DEWHA, 2008a). Dugongs are also known to feed and migrate through the Northwest Shelf Province, including Exmouth Gulf, around North West Cape and offshore on the NWS. The Exmouth Gulf dugong population is considered stable and the only one not in decline (Oceanwise, 2019). Exmouth Gulf is of considered important to this species, as it has been recorded as providing significant breeding and feeding habitat (Jenner and Jenner, 2005, Oceanwise, 2019). Seagrass is the preferred food of dugongs, but they are also known to eat algae and macroinvertebrates.

Table 3-10: Marine mammal species or species habitat relevant to the Ironbark Exploration Drilling Program

Scientific Name	Common Name	EPBC Status			Type of Presence		
		Threatened Species	Migratory Species	Listed Marine Species	EMBA	Operational Area	Hydrocarbon Exposure Area
Whales							
Berardius arnuxii	Arnoux's Beaked Whale			x	MO	-	LO
Balaenoptera acutorostrata	Minke Whale			x	MO	-	MO
Balaenoptera bonaerensis	Antarctic Minke Whale		x	x	LO	-	LO
Balaenoptera borealis	Sei Whale	V	x	x	FLO	LO	FLO
Balaenoptera edeni	Bryde's Whale		x	x	LO	LO	LO
Balaenoptera musculus	Blue Whale	E	x	x	FKO	MKO	MKO
Balaenoptera physalus	Fin Whale	V	x	x	FLO	LO	FLO
Caperea marginata	Pygmy Right Whale		x	x	FLO	MO	MO
Eubalaena australis	Southern Right Whale	E	x	x	BKO	-	LO
Globicephala macrorhynchus	Short-finned Pilot Whale			x	MO	MO	MO
Globicephala melas	Long-finned Pilot Whale			x	MO	-	-
Hyperoodon planifrons	Southern Bottlenose Whale			x	MO	-	-
Kogia breviceps	Pygmy Sperm Whale			x	MO	MO	MO
Kogia simus	Dwarf Sperm Whale			x	MO	MO	MO

Scientific Name	Common Name	EPBC Status			Type of Presence		
		Threatened Species	Migratory Species	Listed Marine Species	EMBA	Operational Area	Hydrocarbon Exposure Area
Indopacetus pacificus	Longman's Beaked Whale			x	MO	-	MO
Megaptera novaeangliae	Humpback Whale	V	x	x	BKO	LO	CKO
Mesoplodon bowdoini	Andrew's Beaked Whale			x	MO	-	-
Mesoplodon densirostris	Blainville's Beaked Whale			x	MO	-	MO
Mesoplodon ginkgodens	Gingko-toothed Beaked Whale			x	MO	-	MO
Mesoplodon grayi	Gray's Beaked Whale,			x	MO	-	MO
Mesoplodon layardii	Strap-toothed Beaked Whale			x	MO	-	-
Mesoplodon mirus	True's Beaked Whale			x	MO	-	-
Peponocephala electra	Melon-headed Whale			x	MO	MO	-
Physeter macrocephalus	Sperm Whale		x	x	FKO	MO	MO
Tasmacetus shepherdi	Shepherd's Beaked Whale, Tasman Beaked Whale			x	MO	-	-
Ziphius cavirostris	Cuvier's Beaked Whale			x	MO	MO	MO
Sirenians							
Dugong dugon	Dugong		x	x	BKO	-	BKO
Dolphins							
Delphinus delphis	Common Dolphin			x	MO	MO	MO
Feresa attenuata	Pygmy Killer Whale			x	MO	-	-
Grampus griseus	Risso's Dolphin			x	MO	MO	MO
Lagenodelphis hosei	Fraser's Dolphin			x	MO	-	MO
Lagenorhynchus obscurus	Dusky Dolphin		x	x	LO	-	-
Lissodelphis peronii	Southern Right Whale Dolphin			x	MO	-	-
Orcaella brevirostris	Irrawaddy Dolphin			x	MO	-	MO
Orcaella heinsohni	Australian Snubfin Dolphin		x	x	KO	-	MO

Scientific Name	Common Name	EPBC Status			Type of Presence		
		Threatened Species	Migratory Species	Listed Marine Species	EMBA	Operational Area	Hydrocarbon Exposure Area
Orcinus orca	Killer Whale		x	x	MO	MO	MO
Peponocephala electra	Melon-headed Whale			x	MO	-	MO
Pseudorca crassidens	False Killer Whale			x	LO	LO	LO
Sousa chinensis	Indo-Pacific Humpback Dolphin		x	x	BKO	-	KO
Stenella attenuata	Spotted Dolphin			x	MO	MO	MO
Stenella coeruleoalba	Striped Dolphin			x	MO	MO	MO
Stenella longirostris	Long-snouted Spinner Dolphin			x	MO	MO	MO
Steno bredanensis	Rough-toothed Dolphin			x	MO	MO	MO
Tursiops aduncus	Spotted Bottlenose Dolphin		x	x	KO	MO	LO
Tursiops aduncus (Arafura/Timor Sea populations)	Indian Ocean Bottlenose Dolphin			x	KO	MO	KO
Tursiops truncatus s. str.	Bottlenose Dolphin			x	MO	MO	MO
Pinnipeds							
Arctocephalus forsteri	Long-nosed Fur-seal, New Zealand Fur-seal			x	LO	-	-
Neophoca cinerea	Australian Sea Lion	V		x	BKO	-	-

Threatened Species:
V ***Vulnerable***
E ***Endangered***
CE ***Critically Endangered***

Migratory Species:
M ***Marine***
W ***Wetland***
T ***Terrestrial***

Type of Presence:
MO *Species of species habitat may occur within area*
LO *Species or species habitat likely to occur within area*
KO *Species or species habitat known to occur within area*
FMO *Foraging, feeding or related behaviour may occur within area*
FLO *Foraging, feeding or related behaviour likely to occur within area*
FKO *Foraging, feeding or related behaviour known to occur within area*
BLO *Breeding likely to occur within area*
BKO *Breeding known to occur within area*
RLO *Roosting likely to occur within area*
RKO *Roosting known to occur within area*

Table 3-11: Biologically important areas for marine mammal species relevant to the Ironbark Exploration Drilling Program

Scientific Name	Common Name	BIA Presence: EMBA	BIA Presence: Operational Area	BIA Presence: Hydrocarbon Exposure Area	Summary Description of BIA
Balaenoptera musculus	Blue Whale, Pygmy Blue Whale	d,f,m	d, m	d,f,m	Offshore migration corridor, typically along shelf-edge at depths 500–1,000 m; this occurs close to the coast around Exmouth. Presence during northern migration past Exmouth area may occur April to August (whereas January to May past Perth Canyon area). Southern migration presence may occur October to late-December. Foraging along outer continental shelf from Cape Naturaliste to south of Jurien Bay (Nov-June, with peak in March-May).
Eubalaena australis	Southern Right Whale	c	-	-	Seasonal calving habitat and buffer along south-western coast, south of Perth. Presence may occur late-autumn, winter and spring.
Megaptera novaeangliae	Humpback Whale	c, m, r	-	m	Migration corridor extends out to approx. 50–100 km from the coast. Migration along the WA coast occurs between May and late November. Winter resting areas identified within Exmouth Gulf and Shark Bay. Calving ground extending from Camden Sound to North West Cape.
Physeter macrocephalus	Sperm Whale	f	-	-	Oceanic foraging grounds at western end of Perth Canyon. Presence may occur during summer.
Dugong dugon	Dugong	b,c,f	-	-	Breeding, calving, nursing and foraging grounds within the Exmouth Gulf and North West Cape regions. May be present throughout the year. Presence in Shark Bay BIAs may be more seasonal, between April and November.
Neophoca cinerea	Australian Sea Lion	f	-	-	Oceanic foraging grounds along west coast and around Abrolhos Islands for resident populations. Presence may occur throughout the year.
Orcaella heinsohni	Australian Snubfin Dolphin	b,c,f	-	-	Presence in shallow coastal waters and estuaries along the Kimberley coast. Beagle and Pender Bays on the Dampier Peninsula and tidal creeks around Yampi Sound and between Kuri Bay and Cape Londonderry are important areas

Scientific Name	Common Name	BIA Presence			Summary Description of BIA
		EMBA	Operational Area	Hydrocarbon Exposure Area	
Sousa chinensis	Indo-Pacific Humpback Dolphin	b,c,f	-	-	Breeding grounds in King Sound North, Yampi Sound and Talbot Bay Fjord area. Foraging grounds in King Sound South and Camden Sound Area - Walcott Inlet, Doubtful Bay, Deception Bay and Augustus Island (Kuri Bay), as well as Pender Bay, Carnot & Beagle bays, Maret Island, Biggee Island, Admiralty Gulf & Parry Harbour. Significant habitat reported at Vansittart Bay, Anjo Peninsula
Tursiops aduncus	Spotted Bottlenose Dolphin	b,c,f	-	-	Calving grounds in Roebuck Bay and Camden Sound Area - - Walcott Inlet, Doubtful Bay, Deception Bay and Augustus Island (Kuri Bay). Breeding grounds in King Sound, Yampi Sound and Talbot Bay Fjord area.

Biologically Important Area

b ***Breeding***
c ***Calving and/or nursing***
d ***Distribution***
f ***Foraging***
m ***Migration***

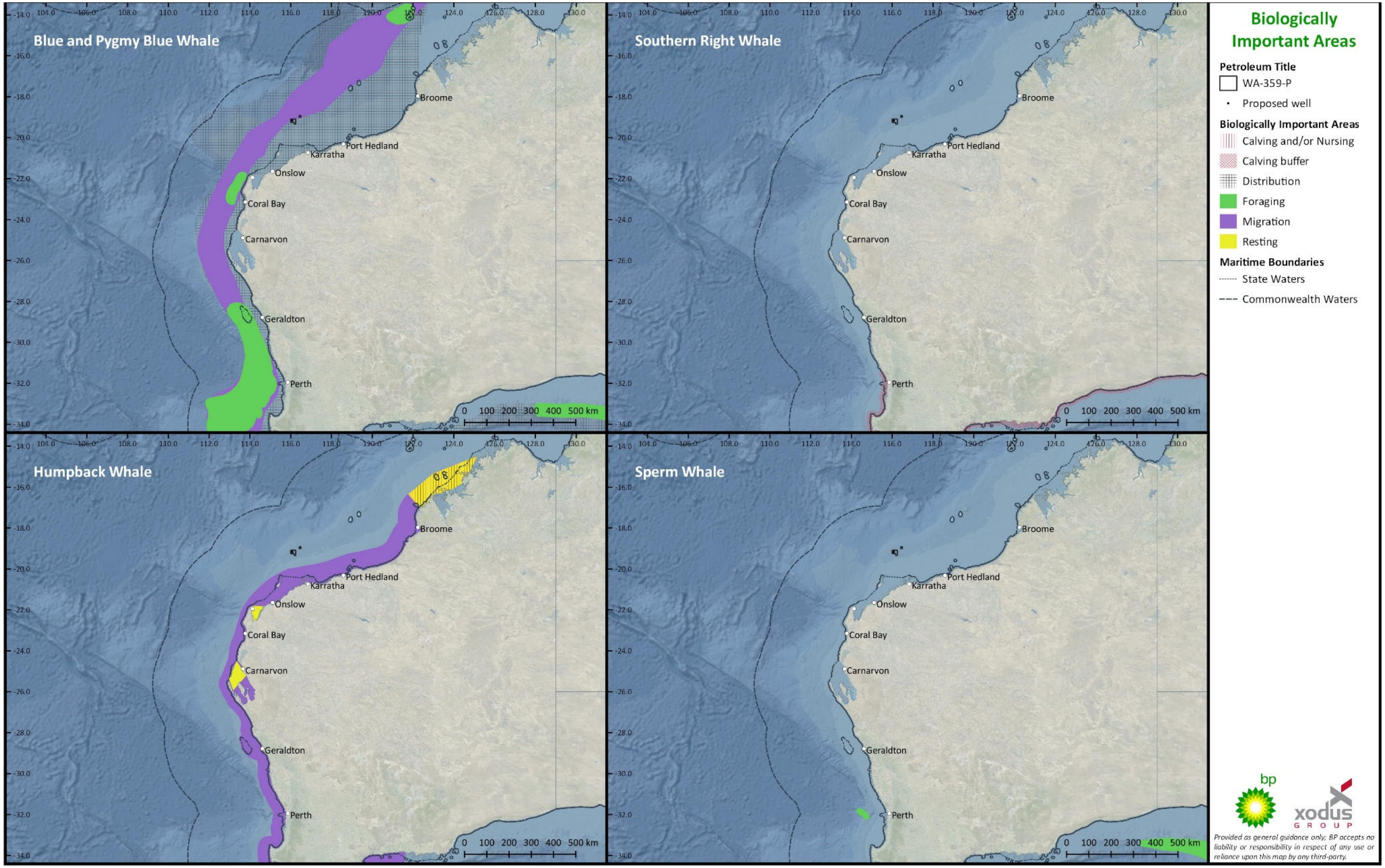


Figure 3-15: Biologically important areas for whale species (Blue, Pygmy Blue, Humpback, Sperm and Southern Right Whale)

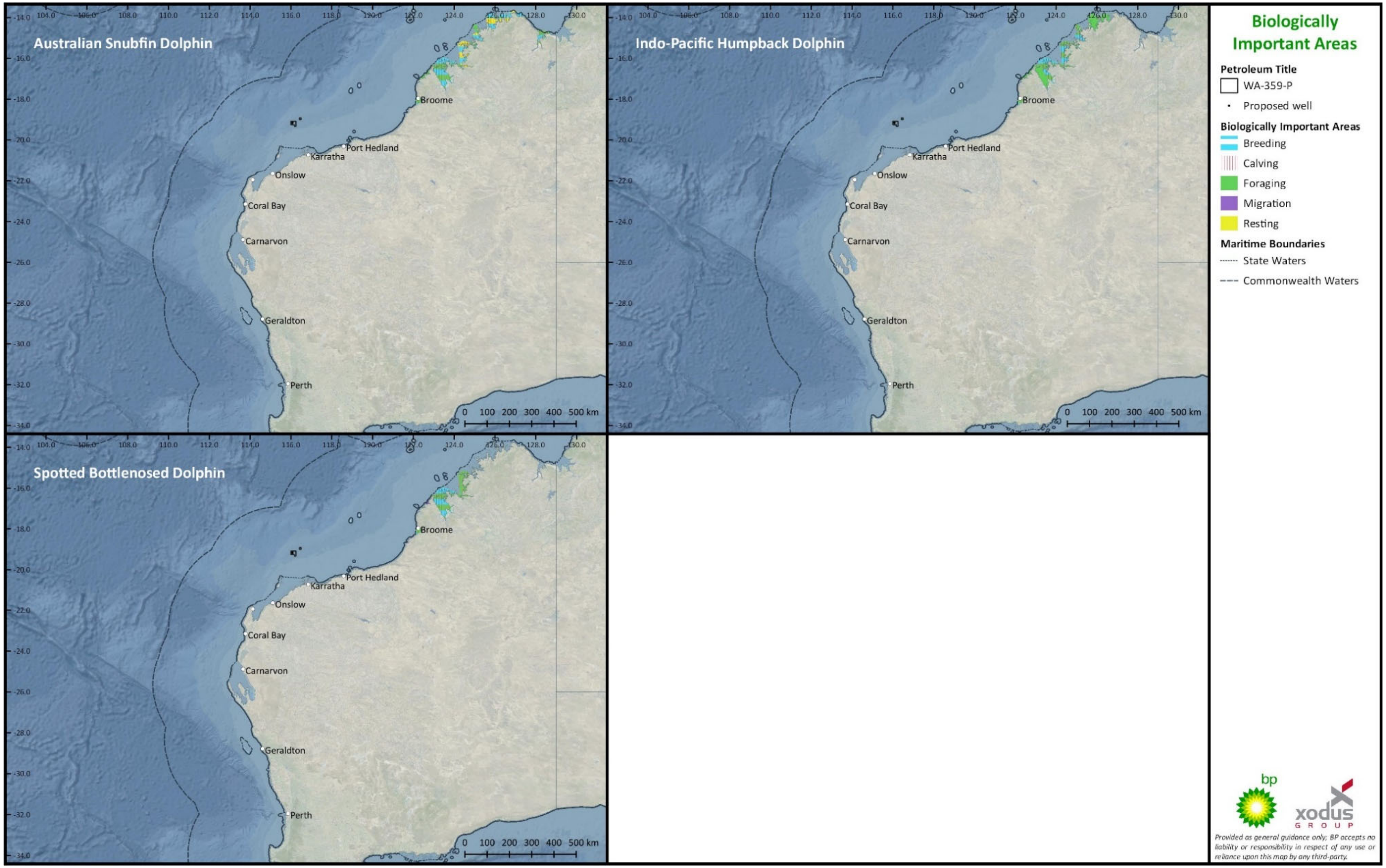


Figure 3-16: Biologically important areas for the Australian Snubfin Dolphin, Indo-Pacific Humpback Dolphin, and Spotted Bottlenose Dolphin species

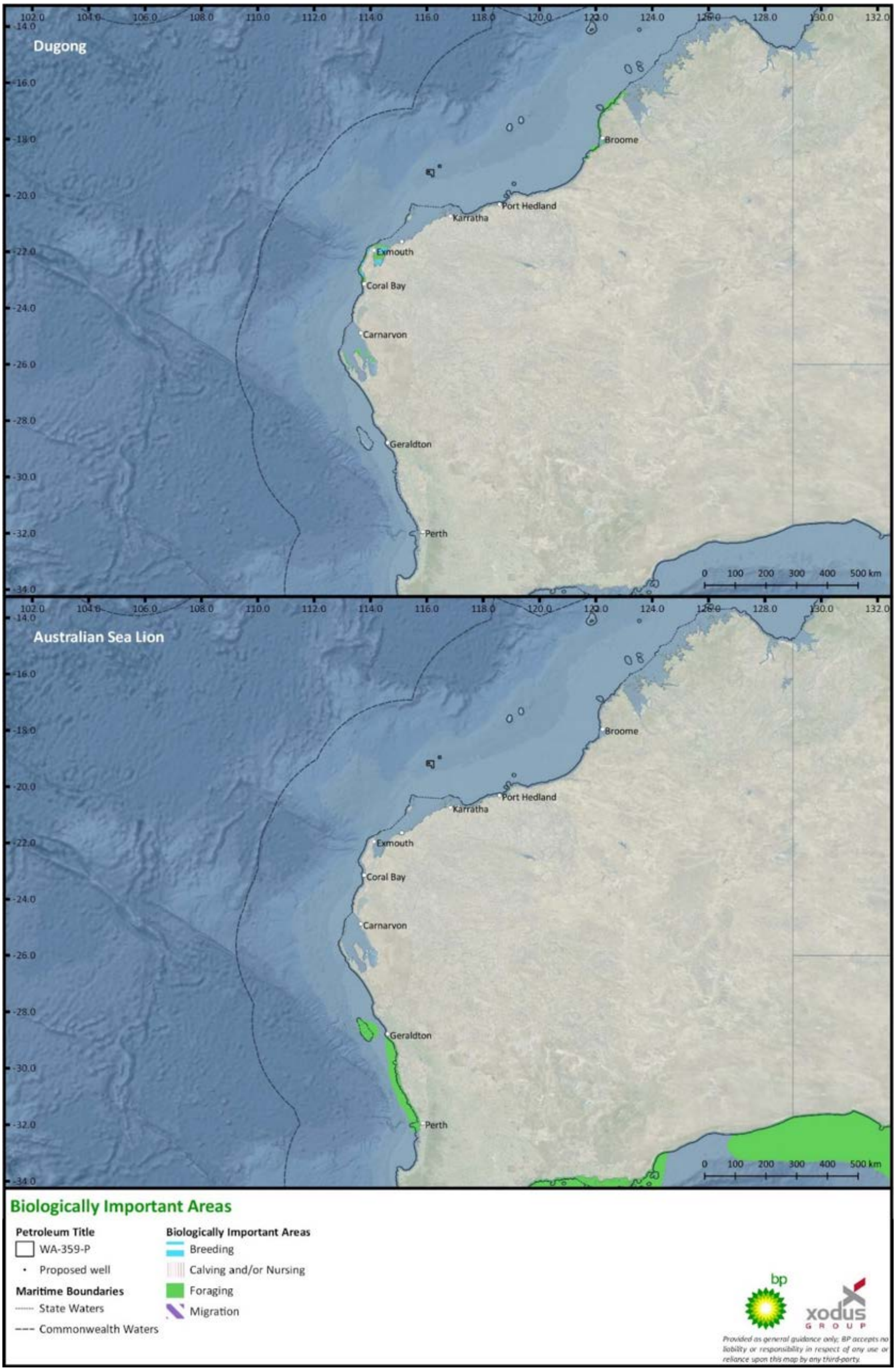


Figure 3-17: Biologically important areas for the Dugong and Australian Sea Lion

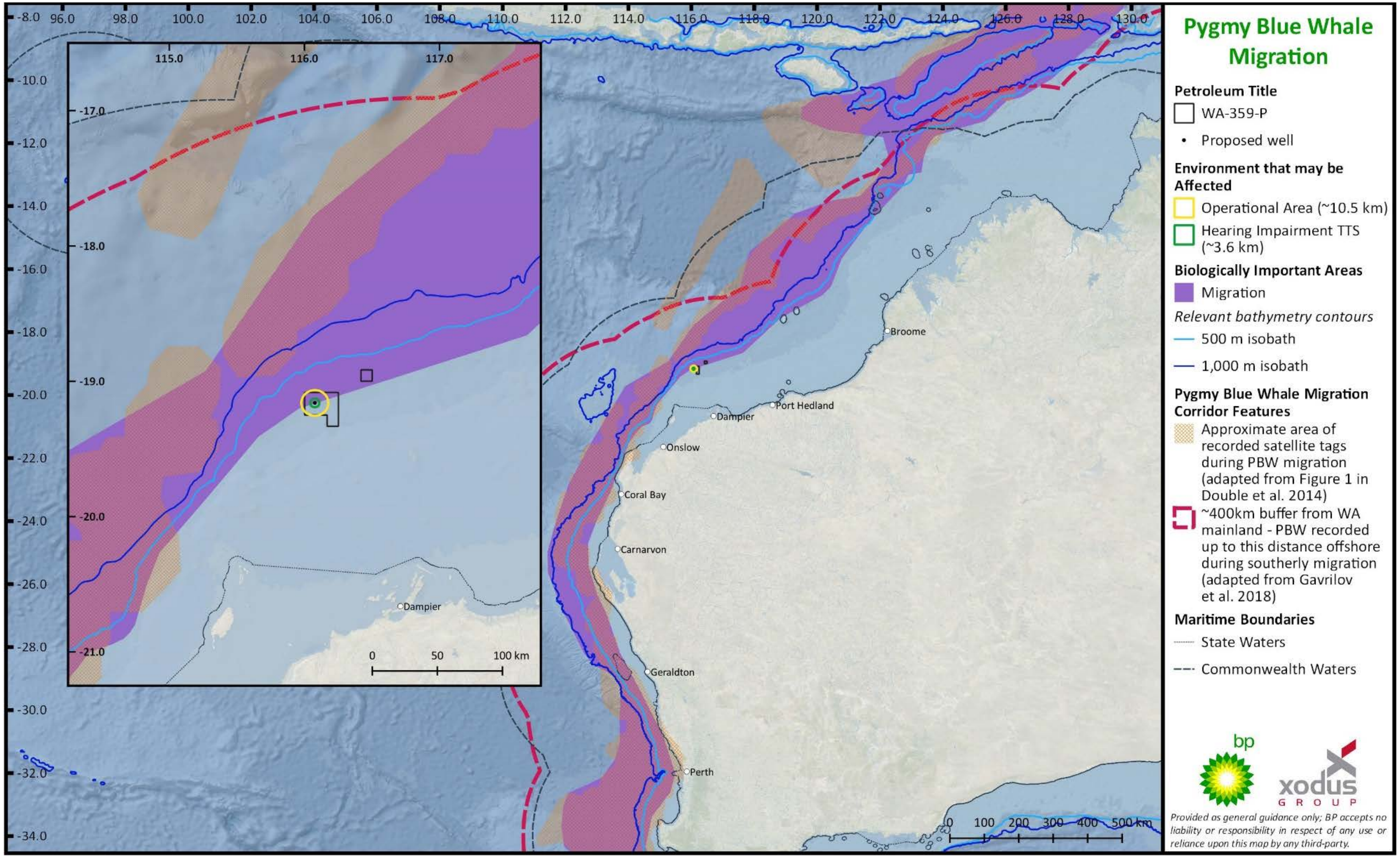


Figure 3-18: Pygmy Blue Whale BIA and Recent Distribution Data (after Double et al., 2012b, 2014; Gavrilov, 2018) In Relation to Ironbark-1 Drilling Operational Area

3.3.7 Marine Reptiles

There are multiple species (or species habitat) of marine reptile that may occur within the EMBA (Table 3-13). The presence of most species, within the Operational Area, are expected to be of a transitory nature only due to the absence of BIAs for those species. However, some species within the EMBA were identified as having important behaviours (e.g. breeding, foraging), recognised by the designation of BIAs and critical habitat for some turtle species within the EMBA. Those closest to the Ironbark Exploration Drilling Program are the nesting and internesting BIAs for the flatback, green, hawksbill and loggerhead turtle.

Marine turtles have a highly migratory life history and rely on both marine and terrestrial habitats. North-west WA, including the offshore islands is known for supporting nesting and internesting habitat for turtle species. Nesting and internesting habitat critical to the survival of a species has been identified for genetic stocks present in WA (CoA, 2017). These important nesting locations include areas inshore of the Ironbark Exploration Drilling Program at Muiron and Serrurier Islands, the North West Cape and Ningaloo coast.

Table 3-12: Habitats critical to the survival of marine turtle species

Species (Genetic Stock)	Nesting locations	Internesting buffer	Nesting season
Flatback Turtle (Pilbara)	Montebello Islands, Mundabullangana Beach, Barrow Island, Cemetery Beach, Dampier Archipelago (including Delambre Island and Huay Island), coastal islands from Cape Preston to Locker Island	60 km	October to March
Green Turtle (NWS)	Adele Island, Maret Island, Cassini Island, Lacepede Islands, Barrow Island, Montebello Islands (all with sandy beaches), Serrurier Island, Dampier Archipelago, Thevenard Island, North West Cape, Ningaloo coast	20 km	November to March
Hawksbill Turtle (WA)	Dampier Archipelago (including Rosemary Island and Delambre Island), Montebello Islands (including Ah Chong Island, South East Island and Trimouille Island), Lowendal Islands (including Varanus Island, Beacon Island and Bridled Island), Sholl Island	20 km	October to February
Loggerhead Turtle (WA)	Dirk Hartog Island, Muiron Islands, Gnaraloo Bay, Ningaloo coast	20 km	October to March
Olive Ridley Turtle	Cape Leveque, Prior Point and Llanggi, Darcy Island, Vulcan Island.	20 km	May to July

Table 3-13: Marine reptile species or species habitat that may occur within the Ironbark Exploration Drilling EMBA

Scientific Name	Common Name	EPBC Status			Type of Presence		
		Threatened Species	Migratory Species	Listed Marine Species	EMBA	Operational Area	Hydrocarbon Exposure Area
Turtles							
Caretta caretta	Loggerhead Turtle	E	x	x	BKO	LO	BKO
Chelonia mydas	Green Turtle	V	x	x	BKO	LO	BKO
Dermochelys coriacea	Leatherback Turtle	E	x	x	FKO	LO	FKO
Eretmochelys imbricate	Hawksbill Turtle	V	x	x	BKO	LO	BKO
Lepidochelys olivacea	Olive Ridley Turtle, Pacific Ridley Turtle	E	x	x	FKO	-	FLO
Natator depressus	Flatback Turtle	V	x	x	BKO	LO	BKO
Seasnakes							
Acalyptophis peronii	Horned Seasnake			x	MO	MO	MO
Aipysurus apraefrontalis	Short-nosed Seasnake	CE		x	KO	-	KO
Aipysurus foliosquama	Leaf-scaled Seasnake	CE		x	KO	-	KO
Aipysurus duboisii	Dubois' Seasnake			x	MO	MO	MO
Aipysurus eydouxii	Spine-tailed Seasnake			x	MO	MO	MO
Aipysurus fuscus	Dusky Seasnake			x	KO	-	KO
Aipysurus laevis	Olive Seasnake			x	MO	MO	MO
Aipysurus pooleorum	Shark Bay Seasnake			x	MO	-	MO
Aipysurus tenuis	Brown-lined Seasnake			x	MO	-	MO
Astrotia stokesii	Stokes' Seasnake			x	MO	MO	MO
Disteira kingii	Spectacled Seasnake			x	MO	MO	MO
Disteira major	Olive-headed Seasnake			x	MO	MO	MO
Emydocephalus annulatus	Turtle-headed Seasnake			x	MO	-	MO
Enhydrina schistosa	Beaked Seasnake			x	MO	-	-
Ephalophis greyi	North-western Mangrove Seasnake			x	MO	MO	MO

Scientific Name	Common Name	EPBC Status			Type of Presence		
		Threatened Species	Migratory Species	Listed Marine Species	EMBA	Operational Area	Hydrocarbon Exposure Area
Hydrelaps darwiniensis	Black-ringed Seasnake			x	MO	-	MO
Hydrophis atriceps	Black-headed Seasnake			x	MO	-	-
Hydrophis coggeri	Slender-necked Seasnake			x	MO	-	MO
Hydrophis czeblukovi	Fine-spined Seasnake			x	MO	MO	MO
Hydrophis elegans	Elegant Seasnake			x	MO	MO	MO
Hydrophis inornatus	Plain Seasnake			x	MO	-	-
Hydrophis mcdowelli	null			x	MO	-	MO
Hydrophis ornatus	Spotted Seasnake			x	MO	MO	MO
Lapemis hardwickii	Spine-bellied Seasnake			x	MO	-	MO
Pelamis platurus	Yellow-bellied Seasnake			x	MO	MO	MO
Other Reptiles							
Crocodylus johnstoni	Freshwater Crocodile, Johnston's Crocodile, Johnston's River Crocodile			x	MO	-	-
Crocodylus porosus	Salt-water Crocodile		x	x	LO	-	LO

Threatened Species:	*Type of Presence:*
V ***Vulnerable***	*MO* *Species of species habitat may occur within area*
E ***Endangered***	*LO* *Species or species habitat likely to occur within area*
CE ***Critically Endangered***	*KO* *Species or species habitat known to occur within area*
	FMO *Foraging, feeding or related behaviour may occur within area*
Migratory Species:	*FLO* *Foraging, feeding or related behaviour likely to occur within area*
M ***Marine***	*FKO* *Foraging, feeding or related behaviour known to occur within area*
W ***Wetland***	
T ***Terrestrial***	*BLO* *Breeding likely to occur within area*
	BKO *Breeding known to occur within area*
	RLO *Roosting likely to occur within area*
	RKO *Roosting known to occur within area*

Table 3-14: Biologically important areas for marine reptile species within the Ironbark Exploration Drilling EMBA

Scientific Name	Common Name	BIA Presence			Summary Description of BIA
		EMBA	Operational Area	Hydrocarbon Exposure Area	
Caretta caretta	Loggerhead Turtle	f,i,n	i	f,i,n	Nesting and internesting areas around rookeries, including Ningaloo Coast, Muiron, Lowendal and Montebello Islands and Dampier Archipelago. Presence may occur during spring and early summer. Oceanic foraging area between De Grey River and Bedout Island may be used throughout the year by multiple turtle species.
Chelonia mydas	Green Turtle	a,b,f,i, n,m	i	a,b,f,i, n	Nesting and internesting areas around rookeries, including North West Cape, Barrow and Montebello Islands and Dampier Archipelago. Presence may occur during summer. Oceanic foraging area around the inshore islands between Cape Preston and Onslow; and De Grey River and Bedout Island.
Eretmochelys imbricate	Hawksbill Turtle	f,i,n,m	-	f,i,n	Nesting and internesting areas around rookeries, including Ningaloo Coast, Thevenard, Barrow, Montebello and Lowendal Islands and Dampier Archipelago. Oceanic foraging area around the inshore islands between Cape Preston and Onslow; and De Grey River and Bedout Island.
Natator depressus	Flatback Turtle	a,f, i,n,m	i	a,f, i,n	Nesting and internesting areas around rookeries, including Thevenard (and other Pilbara inshore islands), Barrow and Montebello Islands and Dampier Archipelago. Presence may occur during summer. Oceanic foraging area around the inshore islands between Cape Preston and Onslow; and De Grey River and Bedout Island.
Lepidochelys olivacea	Olive Ridley Turtle, Pacific Ridley Turtle	f, i, n	-	-	Foraging grounds in Western Joseph Bonaparte Depression and Joseph Bonaparte Gulf. Nesting and interesting areas around Cape Leveque, Prior Point and Llanggi, Darcy Island, Vulcan Island.

Biologically Important Area

a ***Aggregation***
b ***Basking***
f ***Foraging***
i ***Internesting***
n ***Nesting***
m ***Migration***

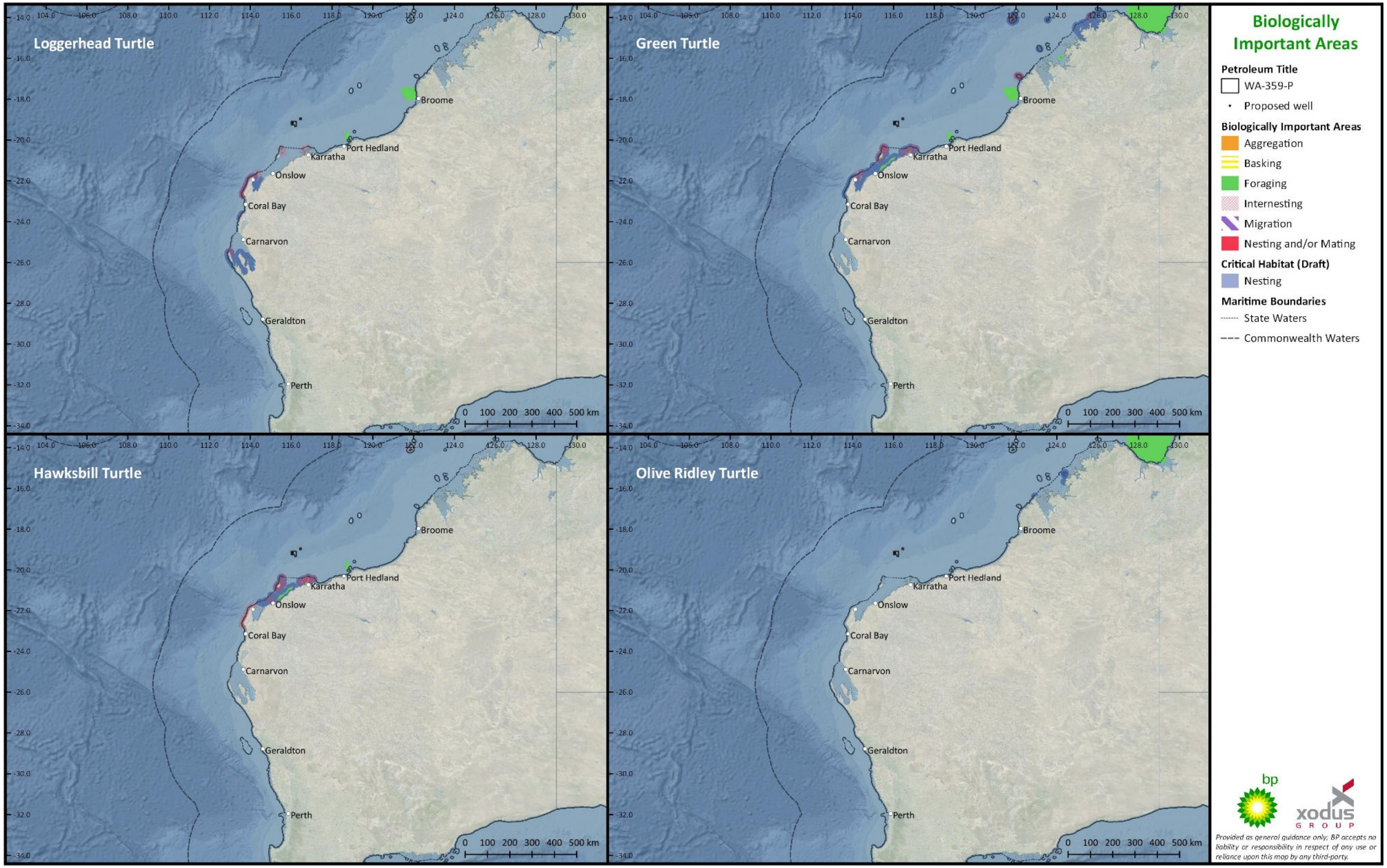


Figure 3-19: Biologically important areas and critical habitat for turtle species (Loggerhead, Green, Hawksbill and Olive Ridley Turtle)

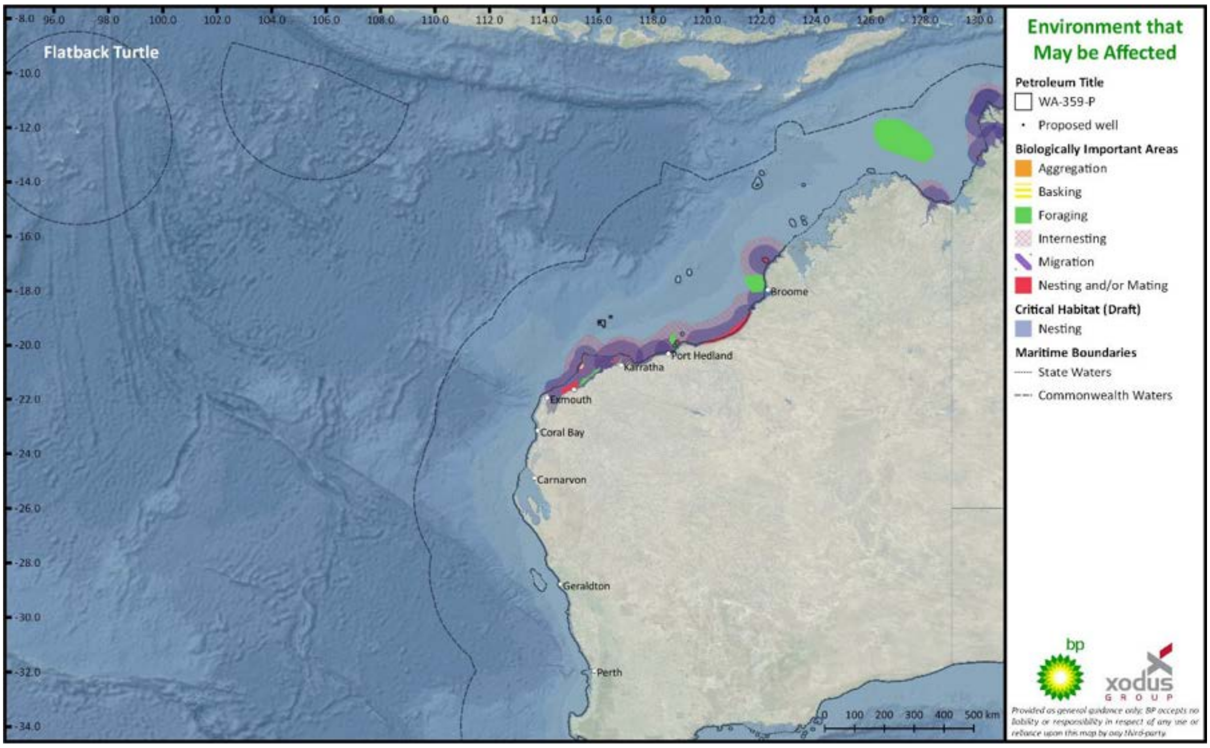


Figure 3-20: Biologically important areas and critical habitat for Flatback turtles

3.4 Social, Economic and Cultural Environment

3.4.1 Commonwealth Marine Area

The Commonwealth marine environment is a matter of national environment significance (MNES) under the EPBC Act. The EMBA for the Ironbark Exploration Drilling Program overlaps waters off Western Australia that are part of the Indian Ocean Territories (Christmas and Cocos (Keeling) islands) and three bioregions:

- North Marine Region, which comprises the Commonwealth waters and seabed from west Cape York Peninsula to the Northern Territory–Western Australia border.
- North-west Marine Region, which comprises the Commonwealth waters and seabed from the Western Australia / Northern Territory border south to Kalbarri.
- South-west Marine Region, which comprises the Commonwealth waters and seabed from Kalbarri to eastern end of Kangaroo Island (South Australia).

Conservation values of the Commonwealth marine area include:

- Protected species and/or their habitat (Sections 3.3.4, 3.3.5, 3.3.6, 3.3.7)
- Protected places including heritage places (Section 3.4.8) and Commonwealth Reserves (Section 3.4.2)
- Key ecological features (Section 3.4.3).

3.4.2 Commonwealth Reserves

National Park

The EMBA overlaps with a section of the Christmas Island National Park, which covers approximately 85 square kilometres (63 %) of Christmas Island as well as the adjacent marine environment, extending 50 metres seaward of the low water mark, incorporating fringing coral reefs. The park provides habitat for endangered, vulnerable, threatened and migratory species as well as endemic species, including seabirds and a diverse array of land crabs. Red crabs are a keystone species responsible for maintaining the structure and species composition of the island's rainforest vegetation and are internationally renowned for their annual breeding migration.

Christmas Island National Park has been designated to protect the natural features of the island including:

- Tropical rainforest habitat;
- 254 endemic taxa and 165 taxa occurring nowhere else in Australia, and 110 species listed as threatened, migratory or marine under the EPBC Act;
- Nesting colonies of seabirds;
- Land crabs;
- Fringing coral reefs and waters supporting over 600 fish species, as well as hybrid fish;
- Significant geomorphological features including terraces and cave systems; in particular anchialine cave systems, which exist at only one other location in WA;
- Scenic land and seascapes;
- The Dales and Hosnies Spring wetlands which are listed as Wetlands of International Importance under the Ramsar Convention.

Australian Marine Parks

Australian Marine Parks (AMPs) occur within Commonwealth waters and have been proclaimed as Commonwealth reserves under the EPBC Act in 2007 and 2013. Within the EMBA, 20 AMPs are present; one within the North Marine Region, 13 within the North-west Marine Region, and six within the South-west Marine Region. The closest AMP to the Ironbark Exploration Drilling Program is the Montebello Marine Park, approximately 100 km from the indicative well location.

The following types of values have been identified for each of the marine parks within the respective management plans (DNP 2018a, 2018b), and are summarised in Table 3-16:

- Natural values, as habitats, species and ecological communities, and the processes that support their connectivity, productivity and function
- Cultural values, as living and cultural heritage recognising Indigenous beliefs, practices and obligations for country, places of cultural significance and cultural heritage sites
- Heritage values, as non-Indigenous heritage that has aesthetic, historic, scientific or social significance
- Socio-economic values, as the benefits for people, businesses and/or the economy.

Table 3-15: Australian Marine Parks within the Ironbark Exploration Drilling Program EMBA

Australian Marine Park	EMBA	Operational Area	Hydrocarbon Exposure Area
North Marine Region			
Oceanic Shoals	x	-	-
North-west Marine Region			
Kimberley	x	-	-
Ashmore Reef	x	-	x

Australian Marine Park	EMBA	Operational Area	Hydrocarbon Exposure Area
Cartier Island	x	-	-
Argo-Rowley Terrace	x	-	-
Mermaid Reef	x	-	-
Eighty Mile Beach	x	-	-
Roebuck	x	-	-
Dampier	x	-	-
Montebello	x	-	x
Ningaloo	x	-	x
Gascoyne	x	-	x
Carnarvon Canyon	x	-	x
Shark Bay	x	-	x
South-west Marine Region			
Abrolhos	x	-	-
Jurien	x	-	-
Two Rocks	x	-	-
Perth Canyon	x	-	-
Geographe	x	-	-
South-west Corner	x	-	-

x = Present within area; - = not present within area

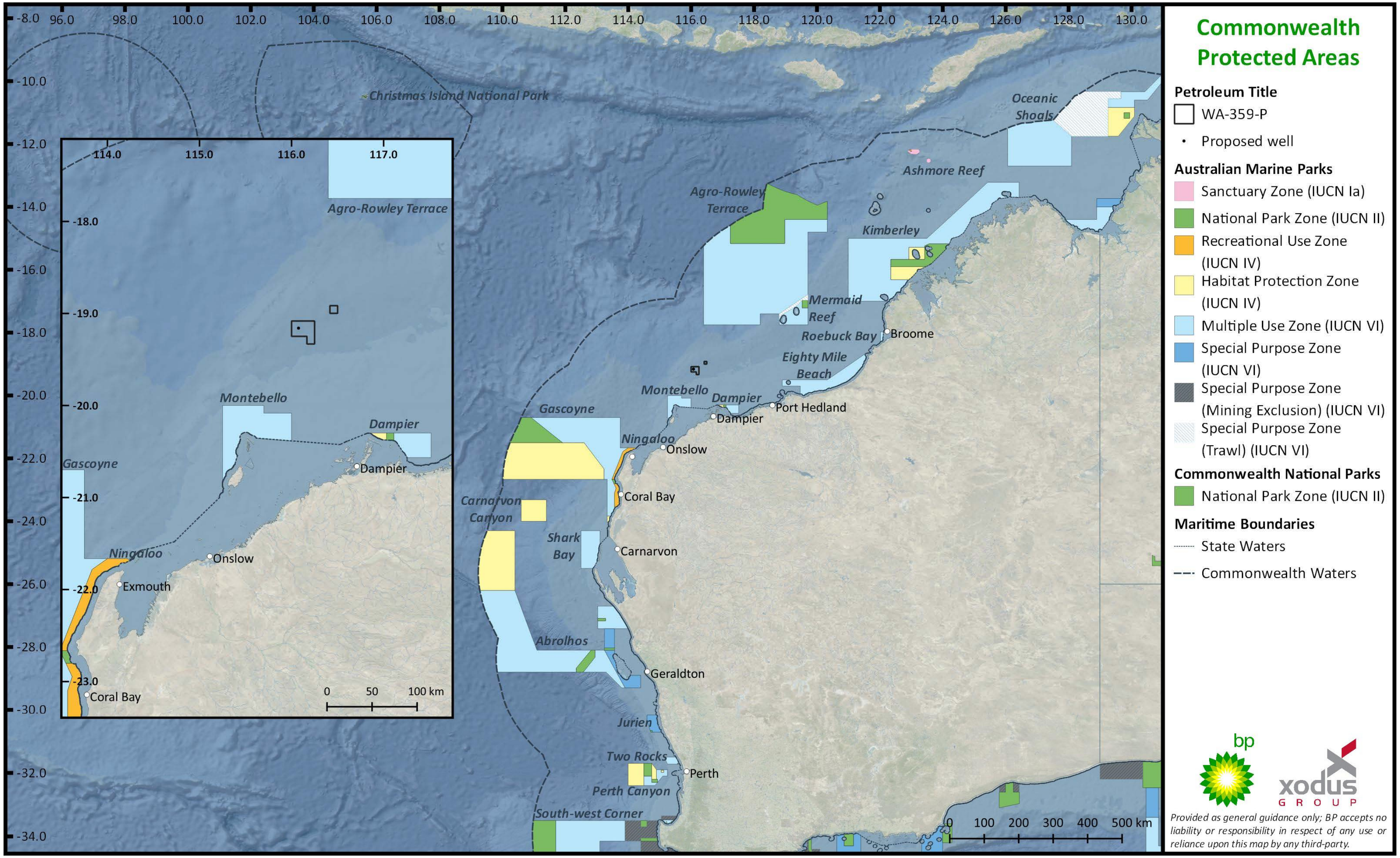


Figure 3-21: Commonwealth Protected Areas

Table 3-16: Significance and values of Australian Marine Parks

North Marine Region
Oceanic Shoals Marine Park
The Oceanic Shoals Marine Park is located west of the Tiwi Islands, approximately 155 km north-west of Darwin, Northern Territory and 305 km north of Wyndham, Western Australia. It extends to the limit of Australia's exclusive economic zone. The Marine Park covers an area of 71,743 km² and water depths from less than 15 m to 500 m. The Marine Park was proclaimed under the EPBC Act on 14 December 2013 and renamed Oceanic Shoals Marine Park on 9 October 2017. The Marine Park is assigned IUCN category VI and includes four zones assigned under this plan: National Park Zone (II), Habitat Protection Zone (IV), Multiple Use Zone (VI) and Special Purpose Zone (Trawl) (VI). Statement of significance The Oceanic Shoals Marine Park is significant because it contains habitats, species and ecological communities associated with the Northwest Shelf Transition. It contains four key ecological features: carbonate bank and terrace systems of the Van Diemen Rise; carbonate bank and terrace systems of the Sahul Shelf; pinnacles of the Bonaparte Basin; and shelf break and slope of the Arafura Shelf (all valued as unique seafloor features with ecological properties of regional significance). The Marine Park is the largest marine park in the North Network. Natural values • Examples of ecosystems representative of the Northwest Shelf Transition— a dynamic environment influenced by strong tidal currents, upwellings of nutrient-rich waters, and a range of prominent seafloor features. The pinnacles, carbonate banks and shoals are sites of enhanced biological productivity. • Key ecological features: - carbonate bank and terrace systems of the Van Diemen Rise—an area characterised by terraces, banks, channels and valleys supporting sponges, soft coral, polychaetes, ascidians, turtles, snakes and sharks; - carbonate bank and terrace system of the Sahul Shelf—an area characterised by terraces, banks, channels and valleys, supporting sponges, soft corals, sessile filter feeders, polychaetes and ascidians; - pinnacles of the Bonaparte Basin—an area that contains the largest concentration of pinnacles along the Australian margin, where local upwellings of nutrient-rich water attract aggregations of fish, seabirds and turtles; and - shelf break and slope of the Arafura Shelf—an area characterised by continental slope, patch reefs and hard substrate pinnacles that support over 280 demersal fish species. • Supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act. • Biologically important areas within the Marine Park include foraging and internesting habitat for marine turtles. Cultural values • Sea country is valued for Indigenous cultural identity, health and wellbeing. • At the commencement of this plan, there is limited information about the cultural significance of this Marine Park. • The Northern Land Council and the Kimberley Land Council are the Native Title Representative Bodies for the Northern Territory's northern region, and the Kimberley region. • The Tiwi Land Council collectively represents traditional owners of the Tiwi Islands. Heritage values • No international, Commonwealth or national heritage listings apply to the Marine Park at commencement of this plan. Social and economic values • Commercial fishing and mining are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.

North-west Marine Region
Kimberley Marine Park

The Kimberley Marine Park is located approx. 100 km north of Broome, extending from the Lacepede Islands to the Holothuria Banks offshore from Cape Bougainville. The Marine Park is adjacent to the State Lalanggarram/Camden Sound Marine Park and the North Kimberley Marine Park. The Marine Park covers an area of 74,469 km² and water depths from <15 m to 800 m. Marine Park includes three zones: National Park Zone (II), Habitat Protection Zone (IV) and Multiple Use Zone (VI).

Statement of significance

The Kimberley Marine Park is significant because it includes habitats, species and ecological communities associated with the Northwest Shelf Province, Northwest Shelf Transition and Timor Province, and includes two KEFs. The Marine Park provides connectivity between deeper offshore waters, and the inshore waters of the adjacent State North Kimberley and Lalang-garram/Camden Sound Marine Parks.

Natural values

- Examples of ecosystems representative of the:
  - Northwest Shelf Province, an area influenced by strong tides, cyclonic storms, long-period swells and internal tides. The region includes diverse benthic and pelagic fish communities, and an ancient coastline thought to be an important seafloor feature and migratory pathway for humpback whales.
  - Northwest Shelf Transition, this area straddles the North-west and North Marine Regions and includes shelf break, continental slope, and the majority of the Argo Abyssal Plain and is subject to a high incidence of cyclones. Benthic biological communities in the deeper parts of the region have not been extensively studied, although high levels of species diversity and endemism occur among demersal fish communities on the continental slope.
  - Timor Province, an area dominated by warm, nutrient-poor waters. The reefs and islands of the region are regarded as biodiversity hotspots; endemism in demersal fish communities of the continental slope is high and two distinct communities have been identified on the upper and mid slopes.
- Contains two KEFs: ancient coastline at the 125-m depth contour, and the continental slope demersal fish communities (Section 3.4.3).
- Supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- BIAs within the Marine Park include 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 foraging habitat for whale sharks.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing. The Wunambal Gaambera, Dambimangari, Mayala, Bardi Jawi and the Nyul Nyul people have responsibilities for sea country in the Marine Park.
- The Wunambal Gaambera people's country includes daagu (deep waters), with about 3,400 km^2 of their sea country located in the Marine Park.
- The national heritage listing for the West Kimberley also recognises the following key cultural heritage values:
  - cultural tradition of the Wanjina Wunggurr people incorporates many sea country cultural sites
  - log-raft maritime tradition, which involved using tides and currents to access warruru (reefs) far offshore to fish;
  - interactions with Makassan traders around sea foods over hundreds of years
  - important pearl resources that were used in traditional trade through the wunan and in contemporary commercial agreements.

Heritage values

- No international, Commonwealth or national heritage listings apply to the Marine Park.
- The Marine Park contains over 40 known historic shipwrecks (Section 3.4.8.3).

Social and economic values

- Tourism, commercial fishing, mining, recreation, including fishing, and traditional use are important activities in the Marine Park.

Ashmore Reef Marine Park

The Ashmore Reef Marine Park is located approximately 630 km north of Broome and 110 km south of the Indonesian island of Roti. The Marine Park is located in Australia's External Territory of Ashmore and Cartier Islands and is 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 583 km² and water depths from less than 15 m to 500 m. The Marine Park contains three vegetated sand cays that are permanently above water: West, Middle and East islands.

The Marine Park was originally proclaimed under the National Parks and Wildlife Conservation Act 1975 on 16 August 1983 as the Ashmore Reef National Nature Reserve, and proclaimed under the EPBC Act on 14 December 2013 and renamed Ashmore Reef Marine Park on 9 October 2017. The Marine Park is assigned IUCN category Ia and includes two zones assigned under this plan: Sanctuary Zone (Ia) and Recreational Use Zone (IV).

Statement of significance

The Ashmore Reef Marine Park is significant because it includes habitats, species and ecological communities associated with the Timor Province. It includes two key ecological features: Ashmore Reef and Cartier Island and surrounding Commonwealth waters (valued for high productivity and breeding aggregations of birds and other marine life); and continental slope demersal fish communities (valued for high levels of endemism). Ashmore Reef is the largest of three emergent oceanic reefs in the region and the only one with vegetated islands. The Marine Park is an area of enhanced biological productivity and a biodiversity hotspot, supporting a range of pelagic and benthic marine species and an important biological stepping stone facilitating the transport of biological material to the reef systems along the Western Australian coast via the south-flowing Leeuwin Current which originates in the region. The Ashmore Reef Ramsar site is located within the boundary of the Marine Park. The site was listed under the Ramsar Convention in 2002 and is a wetland of international importance under the EPBC Act. An Ecological Character Description that sets out the Ramsar listing criteria met by the site, the key threats and knowledge gaps, is available on the Department's website.

Natural values

- Examples of ecosystems representative of the
  - Timor Province—a bioregion with a depth range from about 200 m near the shelf break to 5920 m over the Argo Abyssal Plain. The reefs and islands of the bioregion are regarded as biodiversity hotspots. Ashmore Reef is an important feature of the bioregion. Endemism in demersal fish communities of the continental slope is high with two distinct communities identified: one on the upper slope, the other mid slope.
- Key ecological features:
  - Ashmore Reef and Cartier Island and surrounding Commonwealth waters—areas of enhanced productivity in an otherwise low-nutrient environment, of regional importance for feeding and breeding aggregations of birds and marine life; and
  - continental slope demersal fish communities—an area of high-diversity demersal fish assemblages. The marine environment of the Marine Park includes habitats associated with two extensive lagoons, sand flats, shifting sand cays, extensive reef flat and large areas of seagrass. The reef ecosystems are comprised of hard and soft corals, gorgonians, sponges and a range of encrusting organisms, with the highest number of coral species of any reef off the Western Australian coast.
- Supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- Biologically important areas within the Marine Park include breeding, foraging and resting habitat for seabirds, resting and foraging habitat for migratory shorebirds, foraging, mating, nesting and internesting habitat for marine turtles, foraging habitat for dugong, and a migratory pathway for pygmy blue whales.
- The Ashmore Reef Ramsar site includes the largest of the atolls in the region. West Island, Middle Island and East Island represent the only vegetated islands in the region. Ashmore Reef Ramsar site supports internationally significant populations of seabirds and shorebirds, is important for turtles (green, hawksbill and loggerhead) and dugong, and has the highest diversity of hermatypic (reef-building) corals on the West Australian coast. It is known for its abundance and diversity of sea snakes. However, since 1998 populations of sea snakes at Ashmore Reef have been in decline.

Cultural values

- Indigenous Australians Sea country is valued for Indigenous cultural identity, health and wellbeing.
- The Marine Park contains Indonesian artefacts and grave sites and Ashmore lagoon is still accessed as a rest or staging area for traditional Indonesian fishers travelling to and from fishing grounds within the MoU Box.

Heritage values

- No international or national heritage listings apply to the Marine Park at commencement of this plan.

Commonwealth heritage

- Ashmore Reef was listed on the Commonwealth Heritage List in 2004, meeting Commonwealth heritage listing criteria A, B and C.

Social and economic values

- Tourism, recreation and scientific research are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.

Cartier Island Marine Park

The Cartier Island Marine Park is located approximately 45 km south-east of Ashmore Reef Marine Park and 610 km north of Broome, Western Australia. Both Marine Parks are located in Australia's External Territory of Ashmore and Cartier Islands and are also within an area subject to a MoU between Indonesia and Australia, known as the MoU Box.

The Marine Park covers an area of 172 km² and water depths from less than 15 m to 500 m. The Marine Park was originally proclaimed under the National Parks and Wildlife Conservation Act 1975 on 21 June 2000 as the Cartier Island Marine Reserve, and proclaimed under the EPBC Act on 14 December 2013 and renamed Cartier Island Marine Park on 9 October 2017.

The Marine Park is assigned IUCN category Ia and includes one zone assigned under this plan: Sanctuary Zone (Ia).

Statement of significance

The Cartier Island Marine Park is significant because it includes habitats, species and ecological communities associated with the Timor Province. It includes two key ecological features: Ashmore Reef and Cartier Island and surrounding Commonwealth waters (valued for high productivity and breeding aggregations of birds and other marine life); and continental slope demersal fish communities (valued for high levels of endemism). Like the islands of Ashmore Reef, Cartier Island is a biodiversity hotspot and an important biological stepping stone, facilitating the transport of biological material to the reef systems along the Western Australian coast via the south-flowing Leeuwin Current which originates in the region.

Natural values

- Examples of ecosystems representative of the:
  - Timor Province—a bioregion with a depth range from about 200 m near the shelf break to 5920 m over the Argo Abyssal Plain. The reefs and islands of the bioregion are regarded as biodiversity hotspots. Endemism of demersal fish communities of the continental slope is high with two distinct communities identified, one on the upper slope, the other mid slope.
- Key ecological features:
  - Ashmore Reef and Cartier Island and surrounding Commonwealth waters—areas of enhanced productivity in an otherwise low-nutrient environment, of regional importance for feeding and breeding aggregations of birds and marine life; and
  - Continental slope demersal fish communities—an area of high diversity in demersal fish assemblages. The Marine Park includes an unvegetated sand island (Cartier Island), mature reef flat, a small, submerged pinnacle (Wave Governor Bank), and two shallow pools to the north-east of the island. It is also an area of high diversity and abundance of hard and soft corals, gorgonians (sea fans), sponges and a range of encrusting organisms. The reef crests are generally algal dominated, while the reef flats feature ridges of coral rubble and large areas of seagrass.
- The Marine Park supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- Biologically important areas within the Marine Park include breeding and foraging habitat for seabirds, internesting, nesting and foraging habitat for marine turtles and foraging habitat for whale sharks.
- Important for a range of other species and internationally significant for its abundance and diversity of sea snakes, some of which are listed species under the EPBC Act.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing.
- At the commencement of this plan, there is limited information about the cultural significance of this Marine Park.

Heritage values

- No international, Commonwealth or national listings apply to the Marine Park at commencement of this plan.

Historic shipwrecks

- The Marine Park contains one known shipwreck listed under the Historic Shipwrecks Act 1976: the Ann Millicent (wrecked in 1888).

Social and economic values

- Scientific research is an important activity in the Marine Park.

Argo-Rowley Terrace Marine Park

The Argo–Rowley Terrace Marine Park is located approx. 270 km north-west of Broome. The Marine Park is adjacent to the Mermaid Reef Marine Park and the State Rowley Shoals Marine Park. The Marine Park covers an area of 146,003 km^2 and water depths of 220–6,000 m. The Marine Park includes three zones: National Park Zone (II), Multiple Use Zone (VI) and Special Purpose Zone (Trawl) (VI).

Statement of significance

The Argo–Rowley Marine Park is significant because it contains habitats, species and ecological communities associated with the Northwest Transition and Timor Province, and includes two KEFs. The Marine Park is the largest in the North-west Network. It includes the deeper waters of the region and a range of seafloor features (e.g. canyons on the slope between the Argo Abyssal Plain, Rowley Terrace and Scott Plateau). These are believed to be up to 50 million years old and are associated with small, periodic upwellings that results in localised higher levels of biological productivity.

Natural values

- Examples of ecosystems representative of the:
  - Northwest Transition, an area of shelf break, continental slope, and the majority of the Argo Abyssal Plain. Together with Clerke Reef and Imperieuse Reef, Mermaid Reef is a biodiversity hotspot and key topographic feature of the Argo Abyssal Plain.
  - Timor Province, an area dominated by warm, nutrient-poor waters. Canyons are an important feature in this area of the Marine Park and are generally associated with high productivity and aggregations of marine life.
- Contains two KEFs: Canyons linking the Argo Abyssal Plain with the Scott Plateau, and Mermaid Reef and Commonwealth waters surrounding Rowley Shoals (Section 3.4.3).
- Supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- BIAs within the Marine Park include resting and breeding habitat for seabirds and a migratory pathway for the pygmy blue whale.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing. However, to date there is limited information about the cultural significance of this Marine Park.

Heritage values

- No international, Commonwealth or national heritage listings apply to the Marine Park.
- The Marine Park contains two known historic shipwrecks: Alfred (1908) and Pelsart (1908) (Section 3.4.8.3).

Social and economic values

- Commercial fishing and mining are important activities in the Marine Park.

Mermaid Reef Marine Park

The Mermaid Reef Marine Park is located approx. 280 km north-west of Broome, adjacent to the Argo–Rowley Terrace Marine Park and approx. 13 km from the WA Rowley Shoals Marine Park. The Marine Park covers an area of 540 km^2 and covers water depths from <15 m to 500 m. The Marine Park includes one zone: National Park Zone (II).

Statement of significance

The Marine Park is significant because it contains habitats, species and ecological communities associated with the Northwest Transition and includes one KEF. Mermaid Reef is one of three reefs forming the Rowley Shoals; the others are

Clerke Reef and Imperieuse Reef and occur to the south-west of the Marine Park. The Rowley Shoals have been described as the best geological examples of shelf atolls in Australian waters.

The reefs of the Rowley Shoals are ecologically significant in that they are considered ecological stepping-stones 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.

Natural values

- Examples of ecosystems representative of the Northwest Transition, an area of shelf break, continental slope, and the majority of the Argo Abyssal Plain. Together with Clerke Reef and Imperieuse Reef, Mermaid Reef is a biodiversity hotspot and key topographic feature of the Argo Abyssal Plain.
- Contains one KEF: Mermaid Reef and Commonwealth waters surrounding Rowley Shoals (Section 3.4.3).
- Ecosystems are associated with emergent reef flat, deep reef flat, lagoon, and submerged sand habitats.
- Supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- BIAs within the Marine Park include breeding habitat for seabirds and a migratory pathway for the pygmy blue whale.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing. However, to date there is limited information about the cultural significance of this Marine Park.

Heritage values

- No international or national heritage listings apply to the Marine Park.
- The Marine Park surrounds the Mermaid Reef – Rowley Shoals Commonwealth Heritage Place (Section 3.4.8.2).
- The Marine Park contains one known historic shipwreck: Lively (1810) (Section 3.4.8.3).

Social and economic values

- Tourism, recreation, and scientific research are important activities in the Marine Park.

Eighty Mile Beach Marine Park

The Eighty Mile Beach Marine Park is located approx. 74 km north-east of Port Hedland, adjacent to the State Eighty Mile Beach Marine Park. The Marine Park covers an area of 10,785 km² and covers water depths from <15 m to 70 m. The Marine Park includes one zone: Multiple Use Zone (VI).

Statement of significance

The Marine Park is significant because it contains habitats, species and ecological communities associated with the Northwest Shelf Province and consists of shallow shelf habitats, including terrace, banks and shoals. The Marine Park is adjacent to the Eighty Mile Beach Ramsar site, recognised as one of the most important areas for migratory shorebirds in Australia; and the State Eighty Mile Beach Marine Park, providing connectivity between offshore and inshore coastal waters of Eighty Mile Beach.

Natural values

- Examples of ecosystems representative of the Northwest Shelf Province, a dynamic environment influenced by strong tides, cyclonic storms, long-period swells and internal tides, the region includes diverse benthic and pelagic fish communities, and ancient coastline thought to be an important seafloor feature and migratory pathway for humpback whales.
- Supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- BIAs within the Marine Park include breeding, foraging and resting habitat for seabirds, internesting and nesting habitat for marine turtles, foraging, nursing and pupping habitat for sawfish and a migratory pathway for humpback whales.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing. The Nyangumarta, Karajarri and Ngarla people have responsibilities for sea country in the Marine Park.

Heritage values

- No international, Commonwealth or national heritage listings apply to the Marine Park.

- The Marine Park contains three known historic shipwrecks: Lorna Doone (1923), Nellie (1908) and Tifera (1923) (Section 3.4.8.3).

Social and economic values

- Tourism, commercial fishing, pearling and recreation are important activities in the Marine Park.

Roebuck Marine Park

The Roebuck Marine Park is located approximately 12 km offshore of Broome, and is adjacent to the Western Australian Yawuru Nagulagun/Roebuck Bay Marine Park. The Marine Park covers an area of 304 km² and a water depth range of less than 15 m to 70 m.

The Marine Park was proclaimed under the EPBC Act on 14 December 2013 and renamed Roebuck Marine Park on 9 October 2017.

The Marine Park is assigned IUCN category VI and includes one zone assigned under this plan: Multiple Use Zone (VI).

Statement of significance

The Roebuck Marine Park is significant because it contains habitats, species and ecological communities associated with the Northwest Shelf Province, and consists entirely of shallow continental shelf habitat. The Marine Park is adjacent to the Roebuck Bay Ramsar site, recognised as one of the most important areas for migratory shorebirds in Australia; and the Western Australian Yawuru Nagulagun/Roebuck Bay Marine Park, providing connectivity between offshore and inshore coastal waters of Roebuck Bay.

Natural values

- Examples of ecosystems representative of the:
  - Northwest Shelf Province—a dynamic environment influenced by strong tides, cyclonic storms, long-period swells and internal tides. The bioregion includes diverse benthic and pelagic fish communities, and ancient coastline thought to be an important seafloor feature and migratory pathway for humpback whales.
- The Marine Park supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- Biologically important areas within the Marine Park include breeding and resting habitat for seabirds, foraging and internesting habitat for marine turtles, a migratory pathway for humpback whales and foraging habitat for dugong.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing.
- Yawuru people have always recognised the waters of Roebuck Bay as nagula (Yawuru sea country), and have customary responsibilities to care for it. They have a deep spiritual connection to offshore landscapes from Bugarrigarra (creator beings), and believe that snake-like metaphysical beings inhabit the sea.
- Cultural sites in sea country are also a source of law. The Yawuru people harvest marine resources according to the six Yawuru seasons. They have harvested pearl shell for food and cultural purposes. Fish are a staple food source, and fishing a form of cultural expression, connecting people to their country, modelled on tradition and based in traditional law. Access to sea country by families is important to cultural traditions, livelihoods and future socio-economic development opportunities.
- The Yawuru Native Title Holders Aboriginal Corporation is the Prescribed Body Corporate representing traditional owners with native title over coastal areas adjacent to the Marine Park, and is the point of contact for sea country in the Marine Park. The Kimberley Land Council is the Native Title Representative Body for the Kimberley region.

Heritage values

- No international, Commonwealth or national listings apply to the Marine Park at commencement of this plan, however the Marine Park is adjacent to the West Kimberley National Heritage Place.

Social and economic values

- Tourism, commercial fishing, pearling and recreation, including fishing, are important activities that occur in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.

Dampier Marine Park

The Dampier Marine Park is located approx. 10 km north-east of Cape Lambert and 40 km from Dampier extending from the WA state water boundary. The Marine Park covers an area of 1,252 km^2 and a water depth range from <15 m to 70 m. The Marine Park includes three zones: National Park Zone (II), Habitat Protection Zone (IV) and Multiple Use Zone (VI).

Statement of significance

The Dampier Marine Park is significant because it contains habitats, species and ecological communities associated with the Northwest Shelf Province. The Marine Park provides protection for offshore shelf habitats adjacent to the Dampier Archipelago, and the area between Dampier and Port Hedland, and is a hotspot for sponge biodiversity. The Marine Park includes several submerged coral reefs and shoals including Delambre Reef and Tessa Shoals.

Natural values

- Examples of ecosystems representative of the Northwest Shelf Province, a dynamic environment influenced by strong tides, cyclonic storms, long-period swells and internal tides, the region includes diverse benthic and pelagic fish communities, and ancient coastline thought to be an important seafloor feature and migratory pathway for humpback whales.
- Supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- BIAs within the Marine Park include breeding and foraging habitat for seabirds, internesting habitat for marine turtles and a migratory pathway for humpback whales.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing. The Ngarluma, Yindjibarndi, Yaburara, and Mardudhunera people have responsibilities for sea country in the Marine Park.

Heritage values

- No international, Commonwealth or national heritage listings apply to the Marine Park.

Social and economic values

- Port activities, commercial fishing and recreation, including fishing, are important activities in the Marine Park.

Montebello Marine Park

The Montebello Marine Park is located offshore of Barrow Island and 80 km west of Dampier extending from the WA State water boundary. The Marine Park covers an area of 3,413 km^2 and water depths from <15 m to 150 m. The Marine Park includes one IUCN zone: Multiple Use Zone (IUCN VI).

Statement of significance

The Montebello Marine Park is significant because it contains habitats, species and ecological communities associated with the Northwest Shelf Province. The Marine Park includes one KEF, the ancient coastline at the 125-m depth contour (Section 3.4.3). The Marine Park provides connectivity between deeper waters of the continental shelf and slope, and the adjacent State Barrow Island and Montebello Islands Marine Parks. A prominent seafloor feature in the Marine Park is Trial Rocks consisting of two close coral reefs; these reefs are emergent at low tide.

Natural values

- Examples of ecosystems representative of the Northwest Shelf Province, a dynamic environment influenced by strong tides, cyclonic storms, long-period swells and internal tides, the region includes diverse benthic and pelagic fish communities.
- Contains one KEF: the ancient coastline at the 125-m depth contour.
- Supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- BIAs within the Marine Park 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.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing. However, to date there is limited information about the cultural significance of this Marine Park.

Heritage values

- No international, Commonwealth or national heritage listings apply to the Marine Park.
- The Marine Park contains two known historic shipwrecks: *Trial* (1622) and *Tanami* (unknown date) (Section 3.4.8.3).

Social and economic values

- Tourism, commercial fishing, mining and recreation are important activities in the Marine Park.

Ningaloo Marine Park

The Ningaloo Marine Park stretches approx. 300 km along the west coast of the Cape Range Peninsula, and is adjacent to the State Ningaloo Marine Park and Commonwealth Gascoyne Marine Park. The Marine Park covers an area of 2,435 km^2 and occurs over a water depth range of 30 m to >500 m. The Marine Park contains zones designated as National Park Zone (IUCN II) and Recreational Use Zone (IUCN IV).

Statement of significance

The Ningaloo Marine Park is significant because it contains habitats, species and ecological communities associated with the Central Western Shelf Transition, Central Western Transition, Northwest Province, and Northwest Shelf Province; and contains three KEFs.

The Marine Park provides connectivity between deeper offshore waters of the shelf break and shallower coastal waters. It includes some of the most diverse continental slope habitats in Australia, in particular the continental slope area between North West Cape and the Montebello Trough. Canyons in the Marine Park are important for their role in sustaining the nutrient conditions that support the high diversity of Ningaloo Reef. The Marine Park is located in a transition zone between tropical and temperate waters and sustains tropical and temperate flora and fauna, with many species at the limits of their distributions.

Natural values

- Examples of ecosystems representative of the:
  - Central Western Shelf Transition, an area of continental shelf of water depths up to 100 m, and a significant transition zone between tropical and temperate species
  - Central Western Transition, characterised by large areas of continental slope, a range of topographic features (e.g. terraces, rises and canyons), seasonal and sporadic upwelling, and benthic slope communities comprising tropical and temperate species
  - Northwest Province, an area of continental slope comprising diverse and endemic fish communities
  - Northwest Shelf Province, an area influenced by strong tides, cyclonic storms, long-period swells and internal tides; this region includes diverse benthic and pelagic fish communities, and ancient coastline thought to be an important seafloor feature and migratory pathway for humpback whales.
- Contains three KEFs: Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula, Commonwealth waters adjacent to Ningaloo Reef, and Continental slope demersal fish communities (Section 3.4.3).
- Ecosystems are influenced by the Leeuwin and Ningaloo currents, and the Leeuwin undercurrent.
- Supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- BIAs within the Marine Park include breeding and or foraging habitat for seabirds, internesting habitat for marine turtles, a migratory pathway for humpback whales, foraging habitat and migratory pathway for pygmy blue whales, breeding, calving, foraging and nursing habitat for dugong and foraging habitat for whale sharks.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing. The Gnulli people have responsibilities for sea country in the Marine Park.

Heritage values

- The Marine Park is within the Ningaloo Coast World Heritage Property, adjacent to the Ningaloo Coast National Heritage Place, and within the Ningaloo Marine Area (Commonwealth waters) Commonwealth Heritage Place (Section 3.4.8.2).
- The Marine Park contains over 15 known historic shipwrecks (Section 3.4.8.3).

Social and economic values

- Tourism and recreation (including fishing) are important activities in the Marine Park.

Gascoyne Marine Park

The Gascoyne Marine Park is located approx. 20 km off the west coast of the Cape Range Peninsula, adjacent to the State and Commonwealth Ningaloo Marine Parks. The Marine Park covers an area of 81,766 km^2 and over water depths between 15–6,000 m. The Marine Park contains zones designated as National Park Zone (IUCN II), Habitat Protection Zone (IUCN IV) and Multiple Use Zone (IUCN VI).

Statement of significance

The Gascoyne Marine Park is significant because it contains habitats, species and ecological communities associated with the Central Western Shelf Transition, Central Western Transition, and Northwest Province, and includes four KEFs. The Marine Park includes diverse continental slope habitats in Australia, in particular the continental slope area between North West Cape and the Montebello Trough. Canyons in the Marine Park link the Cuvier Abyssal Plain to the Cape Range Peninsula and are important for their role in sustaining the nutrient conditions that support the high diversity of Ningaloo Reef.

Natural values

- Examples of ecosystems representative of the:
  - Central Western Shelf Transition, an area of continental shelf of water depths up to 100 m, and a significant transition zone between tropical and temperate species
  - Central Western Transition, characterised by large areas of continental slope, a range of topographic features (e.g. terraces, rises and canyons), seasonal and sporadic upwelling, and benthic slope communities comprising tropical and temperate species
  - Northwest Province, an area of continental slope comprising diverse and endemic fish communities.
- Contains four KEFs: Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula, Commonwealth waters adjacent to Ningaloo Reef, Continental slope demersal fish communities, and the Exmouth Plateau (Section 3.4.3).
- Ecosystems are influenced by the Leeuwin and Ningaloo currents, and the Leeuwin undercurrent.
- Supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- BIAs within the Marine Park include breeding habitat for seabirds, internesting habitat for marine turtles, a migratory pathway for humpback whales, and foraging habitat and migratory pathway for pygmy blue whales.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing. The Gnulli people have responsibilities for sea country in the Marine Park.

Heritage values

- The Marine Park is adjacent to Ningaloo Coast World Heritage Property and National Heritage Place, and the Ningaloo Marine Area (Commonwealth waters) Commonwealth Heritage Place (Section 3.4.8.2).
- The Marine Park contains over 5 known historic shipwrecks (Section 3.4.8.3).

Social and economic values

- Commercial fishing, mining and recreation are important activities in the Marine Park.

Carnarvon Canyon Marine Park

The Carnarvon Canyon Marine Park is located approximately 300 km north-west of Carnarvon. It covers an area of 6,177 km^2 and occurs over a water depth range of 1,500–6,000 m. The Marine Park includes one IUCN zone: Habitat Protection Zone (IUCN IV).

Statement of significance

The Carnarvon Canyon Marine Park is significant because it contains habitats, species and ecological communities associated with the Central Western Transition, including deep-water ecosystems associated with the Carnarvon Canyon. The Marine Park lies within a transition zone between tropical and temperate species and is an area of high biotic productivity.

Natural values

- Examples of ecosystems representative of the Central Western Transition, which is a bioregion characterised by large areas of continental slope, a range of topographic features (e.g. terraces, rises and canyons), seasonal and sporadic upwelling, and benthic slope communities comprising tropical and temperate species.
- The Carnarvon Canyon is a single-channel canyon covering the entire depth range of the Marine Park.
- Ecosystems are influenced by tropical and temperate currents, deep-water environments and proximity to the continental slope and shelf.
- The soft-bottom environment at the base of the Carnarvon Canyon is likely to support species that are typical of the deep seafloor (e.g. holothurians, polychaetes and sea-pens).
- Supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing. However, to date there is limited information about the cultural significance of this Marine Park.

Heritage values

- No international, Commonwealth or national heritage listings apply to the Marine Park.

Social and economic values

- Commercial fishing is an important activity in the Marine Park.

Shark Bay Marine Park

The Shark Bay Marine Park is located approximately 60 km offshore of Carnarvon, adjacent to the Shark Bay world heritage property and national heritage place. The Marine Park covers an area of 7,443 km², extending from the WA state water boundary, over a water depth range of 15–220 m. The Marine Park includes one IUCN zone: Multiple Use Zone (IUCN VI).

Statement of significance

The Shark Bay Marine Park is significant because it contains habitats, species and ecological communities associated with the Central Western Shelf Province and Central Western Transition. The Marine Park provides connectivity between deeper Commonwealth waters and the inshore waters of the Shark Bay world heritage property.

Natural values

- Examples of ecosystems representative of the:
  - Central Western Shelf, which is a predominantly flat, sandy and low-nutrient area, in water depths of 50–100 m; this region is a transitional zone between tropical and temperate species
  - Central Western Transition, which is characterised by large areas of continental slope, a range of topographic features such as terraces, rises and canyons, seasonal and sporadic upwelling, and benthic slope communities comprising tropical and temperate species.
- Ecosystems are influenced by the Leeuwin, Ningaloo and Capes currents.
- Supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- BIAs within the Marine Park include breeding habitat for seabirds, internesting habitat for marine turtles, and a migratory pathway for humpback whales.
- The Marine Park and adjacent coastal areas are also important for shallow-water snapper.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing. The Gnulli and Malgana people have responsibilities for sea country in the Marine Park.

Heritage values

- No international, Commonwealth or national heritage listings apply to the Marine Park.
- The Marine Park contains approx. 20 known historic shipwrecks (Section 3.4.8.3).

Social and economic values

- Tourism, commercial fishing, mining and recreation are important activities in the Marine Park.

South-west Marine Region

Abrolhos Marine Park

The Abrolhos Marine Park is located adjacent to the Houtman Abrolhos Islands and extends from approx. 27 km south-west of Geraldton north to approx. 330 km west of Carnarvon. The Marine Park covers an area of 88,060 km² and a water depth range from <15 m to 6,000 m. The Marine Park includes four zones: National Park Zone (II), Habitat Protection Zone (IV), Multiple Use Zone (VI) and Special Purpose Zone (VI).

Statement of significance

The Abrolhos Marine Park is significant because it contains habitats, species and ecological communities associated with the Central Western Province, Central Western Shelf Province, Central Western Transition and South-west Shelf Transition regions, and includes seven KEFs. The southern shelf component of the Marine Park partially surrounds the State Houtman Abrolhos Islands Nature Reserve. The islands and surrounding reefs are renowned for their high level of biodiversity, due to the southward movement of species by the Leeuwin Current. The Marine Park contains several seafloor features including the Houtman Canyon, the second largest submarine canyon on the west coast.

Natural values

- Examples of ecosystems representative of the:
  - Central Western Province, characterised by a narrow continental slope incised by many submarine canyons and the most extensive area of continental rise in any of Australia's marine regions. A significant feature within the area are several eddies that form off the Leeuwin Current at predictable locations, including west of the Houtman Abrolhos Islands.
  - Central Western Shelf Province, a predominantly flat, sandy and low nutrient area, in water depths of 50–100 m. Significant seafloor features of this area include a deep hole and associated area of banks and shoals offshore of Kalbarri. The area is a transitional zone between tropical and temperate species.
  - Central Western Transition, a deep ocean area characterised by large areas of continental slope, a range of significant seafloor features including the Wallaby Saddle, seasonal and sporadic upwelling, and benthic slope communities comprising tropical and temperate species.
  - South-west Shelf Transition, an area of narrow continental shelf that is noted for its physical complexity. The Leeuwin Current has a significant influence on the biodiversity of this nearshore area as it pushes subtropical water southward along the area's western edge. The area contains a diversity of tropical and temperate marine life including a large number of endemic fauna species.
- Contains seven KEFs: Commonwealth marine environment surrounding the Houtman Abrolhos Islands, Demersal slope and associated fish communities of the Central Western Province, Mesoscale eddies, Perth Canyon and adjacent shelf break, and other west-coast canyons, Western rock lobster, Ancient coastline between 90 m and 120 m depth, and the Wallaby Saddle (Section 3.4.3).
- Supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- BIAs within the Marine Park include foraging and breeding habitat for seabirds, foraging habitat for Australian sea lions and white sharks, and a migratory pathway for humpback and pygmy blue whales.
- The Marine Park is adjacent to the northernmost Australian sea lion breeding colony in Australia on the Houtman Abrolhos Islands.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing. The Nanda and Naaguja people have responsibilities for sea country in the Marine Park.

Heritage values

- No international, Commonwealth or national heritage listings apply to the Marine Park.
- The Marine Park contains 11 known historic shipwrecks (Section 3.4.8.3).

Social and economic values

- Tourism, commercial fishing, mining, recreation including fishing, are important activities in the Marine Park.

Jurien Marine Park

The Jurien Marine Park is located approx. 148 km north of Perth and 155 km south of Geraldton, adjacent to the State Jurien Bay Marine Park. The Marine Park covers an area of 1,851 km² of continental shelf, and over water depths of 15–220 m. The Marine Park includes two zones: National Park Zone (II) and Special Purpose Zone (VI).

Statement of significance

The Jurien Marine Park is significant because it includes habitats, species and ecological communities associated with the South-west Shelf Transition and Central Western Province, and includes three KEFs. The Marine Park contains a mixture of tropical species carried south by the Leeuwin Current, and temperate species carried north by the Capes Current. The Marine Park's shelf habitats are defined by distinct ridges of limestone reef with extensive beds of macroalgae. Inshore lagoons are inhabited by a diverse range of invertebrates and fish. Seagrass meadows occur in more sheltered areas as well as in the inter-reef lagoons along exposed sections of the coast. The Marine Park includes habitats connecting to and complementing the adjacent State Jurien Bay Marine Park.

Natural values

- Examples of ecosystems representative of the:
  - South-west Shelf Transition, an area of narrow continental shelf that is noted for its physical complexity. The Leeuwin Current has a significant influence on the biodiversity of this nearshore area as it pushes subtropical water southward along the area's western edge. The area contains a diversity of tropical and temperate marine life including a large number of endemic fauna species.
  - Central Western Province, characterised by a narrow continental slope and influenced by the Leeuwin Current.
- Contains three KEFs: Demersal slope and associated fish communities of the Central Western Province, Western rock lobster and Ancient coastline between 90 m and 120 m depth (Section 3.4.3).
- Supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- BIAs within the Marine Park include foraging habitat for seabirds, Australian sea lions and white sharks, and a migratory pathway for humpback and pygmy blue whales.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing. The Noongar people have responsibilities for sea country in the Marine Park.

Heritage values

- No international, Commonwealth or national heritage listings apply to the Marine Park.
- The Marine Park contains two known historic shipwrecks: SS Cambewarra (1914) and Oleander (1884) (Section 3.4.8.3).

Social and economic values

- Tourism, commercial fishing, mining and recreation, including fishing, are important activities in the Marine Park.

Two Rocks Marine Park

The Two Rocks Marine Park is located approx. 25 km north-west of Perth. The Marine Park covers an area of 882 km², over a water depth range from 15–120 m. The Marine Park includes two zones: National Park Zone (II) and Multiple Use Zone (VI).

Statement of significance

The Two Rocks Marine Park is significant because it includes habitats, species and ecological communities associated with the South-west Shelf Transition and includes three KEFs. The Marine Park is shallow and provides connectivity between offshore waters and the west coast inshore lagoons, which are key areas for the recruitment of rock lobster and other commercially and recreationally important fish species.

Natural values

- Examples of ecosystems representative of the South-west Shelf Transition, an area of narrow continental shelf that is noted for its physical complexity. The Leeuwin Current has a significant influence on the biodiversity of

this nearshore area as it pushes subtropical water southward along the area's western edge. The area contains a diversity of tropical and temperate marine life including a large number of endemic fauna species.
- The inshore lagoons are thought to be important areas for benthic productivity and recruitment for a range of marine species.
- Contains three KEFs: Commonwealth marine environment within and adjacent to the west-coast inshore lagoons, Western rock lobster and Ancient coastline between 90 m and 120 m depth (Section 3.4.3).
- Supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- BIAs within the Marine Park include foraging habitat for seabirds and Australian sea lions, a migratory pathway for humpback and pygmy blue whales, and a calving buffer area for southern right whales.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing. The Swan River traditional owners have responsibilities for sea country in the Marine Park.

Heritage values

- No international, Commonwealth or national heritage listings apply to the Marine Park.

Social and economic values

- Tourism, commercial fishing, recreation, including fishing, and scientific research are important activities in the Marine Park.

Perth Canyon Marine Park

The Perth Canyon Marine Park is located approx. 52 km west of Perth and approx. 19 km west of Rottnest Island. The Marine Park covers an area of 7,409 km² and covers water depths of 120–5,000 m. The Marine Park includes three zones: National Park Zone (II), Habitat Protection Zone (IV) and Multiple Use Zone (VI).

Statement of significance

The Marine Park is significant because it includes habitats, species and ecological communities associated with the Central Western Province, South-west Shelf Province, Southwest Transition and South-west Shelf Transition; and also includes four KEFs. The Marine Park includes the majority of the Perth Canyon, Australia's largest submarine canyon, which is home to the largest feeding aggregations of blue whales in Australia. This unique feature is also of significance because it cuts into the continental shelf at approximately 150 m depth west of Rottnest Island, linking the shelf with deeper (up to 5,000 m) ecosystems. The Marine Park represents the southern end of the transition area from tropical to temperate marine environments.

Natural values

- Examples of ecosystems representative of the:
  - Central Western Province, characterised by a narrow continental slope incised by many submarine canyons (including Perth Canyon), and the most extensive area of continental rise in any of Australia's marine regions. A significant feature within the area are several eddies that form off the Leeuwin Current at predictable locations (including the Perth Canyon).
  - South-west Shelf Province, an area of diverse marine life, influenced by the warm waters of the Leeuwin Current
  - South-west Transition, characterised by the submarine canyons that incise the northern parts of the slope and the deep-water mixing that results from the dynamics of major ocean currents when these meet the seafloor (particularly in the Perth Canyon).
  - South-west Shelf Transition, an area that consists of a narrow continental shelf that is noted for its physical complexity. The Leeuwin Current has a significant influence on the biodiversity of this nearshore area as it pushes subtropical water southward along the area's western edge. The area contains a diversity of tropical and temperate marine life including a large number of endemic fauna species.
- Contains four KEFs: Perth Canyon and adjacent shelf break, and other west-coast canyons, Demersal slope and associated fish communities of the Central Western Province, Western rock lobster and Mesoscale eddies (Section 5.4.1.2).
- Supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act.

- BIAs within the Marine Park include foraging habitat for seabirds, Antarctic blue, pygmy blue and sperm whales, a migratory pathway for humpback, Antarctic blue and pygmy blue whales, and a calving buffer area for southern right whales.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing. The Swan River traditional owners have responsibilities for sea country in the Marine Park.

Heritage values

- No international, Commonwealth or national heritage listings apply to the Marine Park.

Social and economic values

- Tourism, commercial shipping, commercial fishing, recreation, including fishing, and defence training are important activities in the Marine Park.

South-west Corner Marine Park

The South-west Corner Marine Park is located adjacent to the Western Australian Ngari Capes Marine Park, covering an extensive offshore area that is closest to Western Australia state waters approximately 48 km west of Esperance, 73 km west of Albany and 68 km west of Bunbury, and extends to the edge of Australia's exclusive economic zone. The Marine Park covers an area of 271,833 km² and a water depth range from less than 15 m to 6400 m.

The Marine Park was proclaimed under the EPBC Act on 14 December 2013 and renamed South-west Corner Marine Park on 9 October 2017.

The Marine Park is assigned IUCN category VI and includes five zones assigned under this plan: National Park Zone (II), Habitat Protection Zone (IV), Multiple Use Zone (VI), Special Purpose Zone (Mining Exclusion) (VI) and Special Purpose Zone (VI).

Statement of significance

The South-west Corner Marine Park is significant because it contains habitats, species and ecological communities associated with three bioregions: Southern Province; South-west Transition; and South-west Shelf Province. It includes six key ecological features: Albany Canyon group and adjacent shelf break (valued for high productivity, aggregations of marine life and unique seafloor features with properties of regional significance); Cape Mentelle upwelling (valued for high productivity and aggregations of marine life); Diamantina Fracture Zone (valued as a unique seafloor feature with ecological properties of regional significance); Naturaliste Plateau (valued as a unique seafloor feature with ecological properties of regional significance); western rock lobster (valued as a species that plays a regionally important ecological role); and ancient coastline between 90 m and 120 m depth (valued for relatively high productivity, aggregations of marine life and high levels of biodiversity and endemism). As the largest Marine Park in the South-west Network, it contains a wide range of important ecosystems in both shallow and deep water, reaching abyssal depths including the Diamantina Fracture Zone, Naturaliste Plateau and Donnelly Banks, along with many reefs and canyons. The Marine Park contributes to a transect that extends from coastal land (Leeuwin–Naturaliste and D'entrecasteaux National Parks), to coastal waters (Ngari Capes Marine Park) and the deep ocean.

Natural values

- Examples of ecosystems representative of:
  - Southern Province—includes the deepest ocean areas of the Australian EEZ, reaching depths of around 5900 m, and is characterised by a long continental slope incised by numerous, well-developed submarine canyons and the Diamantina Fracture Zone, a rugged area of deep seafloor comprising seamounts and many ridges and troughs.
  - South-west Transition—the main features of this area are the Naturaliste Plateau, the deepest submarine plateau along Australia's continental margins. The Plateau supports rich and diverse biological communities. Deep-water mixing results from the dynamics of major ocean currents when these meet the seafloor.
  - South-west Shelf Province—marine life in this area is diverse and influenced by the warm waters of the Leeuwin Current. A small upwelling of nutrient-rich water off Cape Mentelle during summer increases productivity locally, attracting aggregations of marine life.
- Key ecological features:

- Albany Canyon group and adjacent shelf break—a feature consisting of 32 canyons cut deeply into the steep continental slope. The canyons are believed to be associated with small periodic upwellings that enhance productivity and attract aggregations of marine life;
- 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;
- Diamantina Fracture Zone—a unique seafloor feature consisting of a rugged, deep-water environment of seamounts and many closely spaced troughs and ridges. The ridges and seamounts can affect water dynamics and flow, enhancing productivity, and may act as 'stepping stones' for species dispersal and migration across the region and the wider abyssal plain;
- Naturaliste Plateau—the combination of this unique seafloor feature's structural complexity, mixed water dynamics and relative isolation indicate that it supports deep-water communities with high species diversity and endemism;
- Western rock 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; and
- Ancient coastline between 90 m and 120 m depth—high benthic biodiversity and productivity occur where the ancient coastline forms a prominent escarpment.

- Supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act.
- BIAs within the Marine Park include foraging habitat for seabirds, Australian sea lions, white sharks and sperm whales, a migratory pathway for Antarctic blue, pygmy blue and humpback whales, and a calving buffer area for southern right whales.

Cultural values

- Sea country is valued for Indigenous cultural identity, health and wellbeing.
- The Nyungar/Noongar people have responsibilities for sea country in the Marine Park. Traditional owners have maintained cultural responsibilities for sea country as passed down from elders, to keep the oceans healthy, to support spiritual wellbeing and to uphold and protect obligatory cultural responsibilities for future generations.
- The South West Aboriginal Land and Sea Council is the Native Title Service Provider for the South-west region.

Heritage values

- No international, Commonwealth or national heritage listings apply to the Marine Park at commencement of this plan.

Historic shipwrecks

- The Marine Park contains 10 known shipwrecks listed under the *Underwater Cultural Heritage Act 2018*.

Social and economic values

- Tourism, commercial fishing, commercial shipping, and recreation, including fishing, are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.

3.4.3 Key Ecological Features

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 are not MNES and have no legal status in their own right; however, they may be considered as components of the Commonwealth marine area.

Within the EMBA, 24 KEFs are present; two within the North Marine Region, 12 within the North-west Marine Region, and ten within the South-west Marine Region. The closest KEFs to the Ironbark Exploration Drilling Program are the 'ancient coastline at 125 m depth contour' and the 'Glomar Shoals', approx. 25 km and 65 km from the indicative well location.

The importance and values have been identified for each of the KEFs within the Species Profile and Threats (SPRAT) database (DotEE, 2019b) and are summarised in Table 3-18.

Table 3-17: Key Ecological Features relevant to the Ironbark Exploration Drilling Program

Key Ecological Feature	EMBA	Operational Area	Hydrocarbon Exposure Area
North Marine Region			
Carbonate bank and terrace system of the Van Diemen Rise	x	-	-
Pinnacles of the Bonaparte Basin	x	-	-
North-west Marine Region			
Carbonate bank and terrace system of the Sahul Shelf	x	-	-
Ashmore Reef and Cartier Island and surrounding Commonwealth waters	x	-	x
Ancient coastline at 125 m depth contour	x	-	x
Canyons linking the Argo Abyssal Plain with the Scott Plateau	x	-	x
Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	x	-	x
Commonwealth waters adjacent to Ningaloo Reef	x	-	x
Continental slope demersal fish communities	x	-	x
Exmouth Plateau	x	-	x
Glomar Shoals	x	-	x
Mermaid Reef and Commonwealth waters surrounding Rowley Shoals	x	-	x
Seringapatam Reef and Commonwealth waters in the Scott Reef complex	x	-	x
Wallaby Saddle	x	-	x
South-west marine region			
Ancient coastline at 90–120 m depth	x	-	x
Commonwealth marine environment surrounding the Houtman Abrolhos Islands	x	-	-
Commonwealth marine environment within&**adjacent to the west coast inshore lagoons**	x	-	-
Meso-scale eddies ^	x	-	x
Perth Canyon and adjacent shelf break, and other west coast canyons	x	-	-
Western demersal slope and associated fish communities	x	-	x
Western rock lobster	x	-	-
Commonwealth marine environment within and adjacent to Geographe Bay	x	-	-
Cape Mentelle Upwelling	x	-	-
Naturaliste Plateau	x	-	-

x = Present within area; - = not present within area / ^ = indicative points shown on Figure 3-22.

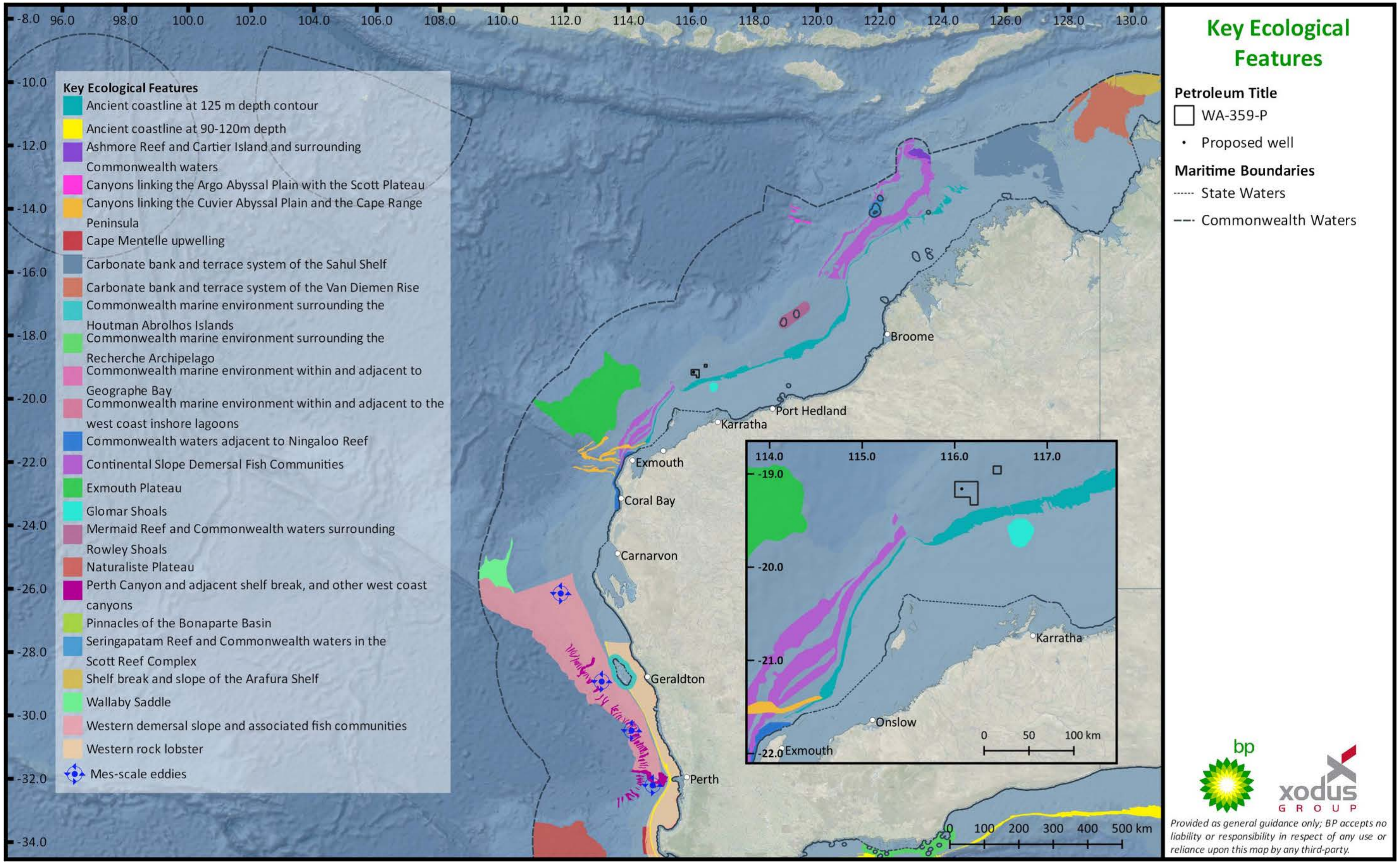


Figure 3-22: Key Ecological Features

Table 3-18: Importance and Values of Key Ecological Features

North Marine Region
Carbonate bank and terrace system of the Van Diemen Rise
National and/or regional importance The Carbonate bank and terrace system of the Van Diemen rise is defined as a key ecological feature for its role in enhancing biodiversity and local productivity relative to its surrounds and for supporting relatively high species diversity. Location The Carbonate bank and terrace system of the Van Diemen rise lies on the north-eastern side of the Joseph Bonaparte gulf, adjacent to the WA/NT border. This feature is part of a larger system associated with the Sahul banks to the north and Londonderry Rise to the west. It is characterised by terrace, banks, channels and valleys. The carbonate banks and shoals found within the Van Diemen rise make up 80 % of the banks and shoals, 79 % of the channels and valleys, and 63 % of the terrace found across the North Marine Region. Description and values The carbonate banks and valleys of the Van Diemen Rise provide habitat diversity, resulting in a higher diversity of epifauna (Przeslawski et al,. 2011). The region has been identified as a sponge biodiversity hotspot (Przeslawski et al., 2014). The banks, ridges and terraces of the Van Diemen rise are raised geomorphic features with relatively high proportions of hard substrate which support sponge and octocoral gardens. These, in turn, provide habitat to other epifauna (Przeslawski et al., 2011). The variability in water depth and substrate composition may contribute to the presence of unique ecosystems, in turn contributing to the richness of epifauna. Rich sponge gardens and octocorals have been identified on the eastern Joseph Bonaparte Gulf along the banks, ridges and some terraces (Heap et al., 2010, Przeslawski et al., 2014). Plains and deep holes/valleys are characterised by scattered epifauna and infauna that include polychaetes and ascidians. Epibenthic communities such as the sponges found in the channels support first and second-order consumers.
Pinnacles of the Bonaparte Basin
National and/or regional importance The Pinnacles of the Bonaparte Basin are defined as a KEF as a unique seafloor feature, with ecological properties of regional significance. They represent 61 % of the limestone pinnacles in the North-west Marine Region, and 40 % of all pinnacles that exist in the North Marine Region. Location The limestone pinnacles are located in the Joseph Bonaparte gulf, which intersects both the North Marine Region and the North-west Marine Bioregion. The largest concentration of pinnacles along the entire Australian margin occurs in the Northwest Shelf Transition where more than 110 pinnacles are found, covering a total area of more than 520 km² (Heap & Harris 2008). Description and values The limestone pinnacles of the Bonaparte Basin lie on the mid-outer shelf in the western Joseph Bonaparte Gulf. The surrounding area is relatively featureless soft sediments (Brewer et al., 2007). The pinnacles can be up to 50 metres high and 50–100 kilometres long (Baker et al., 2008) and are thought to be remnants of calcareous shelf and coastal features from previous low sea-level stands (Baker et al. 2008, Heyward et al. ,1997). The Pinnacles of the Bonaparte basin provide areas of hard substrate in an otherwise soft sediment environment and so are important for sessile species. Rising steeply from depths of about 80 m some pinnacles emerge to within 30 m of the water surface, allowing light dependent organisms to thrive. Communities include sessile benthic invertebrates including hard and soft corals, sponges, whips, fans, bryozoans and aggregations of demersal fish species such as snappers, emperors and groupers (Brewer et al., 2007, Nichol et al., 2013). The pinnacles are also recognised as a biodiversity hotspot for sponges as they are home to more sponge species and different communities than the surrounding seafloor (NERP MBH, 2014).

Surveys undertaken in 2012 suggest the area supports a wide range of high-order pelagic animals with 32 species observed, including 11 shark species, black marlin, barracuda, olive ridley turtle, sea snakes and orcas. Demersal fish communities were found to occur in larger and more diverse populations on the shallower, less turbid banks and pinnacles (Nichol et al., 2013). Marine turtles including flatback, loggerhead and olive ridley are known to forage around the pinnacles (Donovan et al., 2008; Whiting et al., 2007). The pinnacles are considered a general use area for sawfishes (green and freshwater).

North-west Marine Region

Carbonate bank and terrace system of the Sahul Shelf

National and/or regional importance

The carbonate banks and terrace system of the Sahul Shelf is defined as a key ecological feature for its role in enhancing biodiversity and local productivity based on its unique seafloor feature supporting relatively high species diversity.

Location

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 carbonate banks and terraces are part of a larger complex of banks and terraces that occurs on the Van Diemen Rise in the adjacent North Marine Region. The banks consist of a hard substrate and flat tops at depths of 150–300 metres. Each bank occupies an area generally less than 10 square kilometres and is separated from the next bank by narrow sinuous channels with depths up to 150 metres (Brewer et al., 2007).

Description and values

The Sahul banks are the single most extensive region of banks and shoals in the Australian exclusive economic zone forming a nearly continuous chain of complex submerged algal banks on the middle and outer shelf (Heap & Harris, 2008). The Carbonate banks and terrace system of the Sahul Shelf are regionally important because of their role in enhancing biodiversity and local productivity relative to their surrounds. The carbonate banks and terraces provide areas of hard substrate in an otherwise soft sediment environment which are important for sessile species.

Communities of sessile benthic invertebrates including hard and soft corals, sponges, whips, fans and bryozoans (Nichol et al., 2013, NERP MBH, 2014). The banks are also recognised as a biodiversity hotspot for sponges

More than 90 % of carbonate banks in the North-west Marine Region are in the Northwest Shelf Transition Bioregion and the North-west Marine Region contains up to 60 % of banks and shoals in the entire Australian exclusive economic zone. The carbonate banks and terraces of the outer Sahul shelf were built by repeated episodes of reef growth during high sea level phases of the last two million years. These features were then shaped by erosion and weathering during the low sea level of a following ice age (NERP MBH, 2014).

The banks are known to be foraging areas for loggerhead, olive ridley and flatback turtles (Donovan et al., 2008). Humpback whales, and green and freshwater sawfish are likely to occur in the area (Donovan et al., 2008).

Ashmore Reef and Cartier Island and surrounding Commonwealth waters

National and/or regional importance

Ashmore Reef and Cartier Island and surrounding Commonwealth waters are defined as a key ecological feature for their high productivity, biodiversity and aggregations of marine life, which apply to both benthic and pelagic habitats.

Location

Ashmore Reef and Cartier Island are situated on the shallow upper slope of the Sahul Shelf. They form part of a series of submerged reef platforms along the outer edge of the continental slope of the North-west Marine Region.

Ashmore contains a large reef shelf, two large lagoons, several channelled carbonate sand flats, shifting sand cays, an extensive reef flat, three vegetated islands—East, Middle and West islands—and surrounding waters. 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 Commonwealth Marine Reserve (Cartier) is located in the West Sahul region of the Indian Ocean. The island is 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 and contains one unvegetated sand cay and mature reef flat with two shallow pools to the north-east of the cay (EA, 2002).

Description and values

Ashmore Reef is the largest of only three emergent oceanic reefs in the north-eastern Indian Ocean and is the only oceanic reef in the region with vegetated islands. Ashmore Reef supports the highest number of coral species of any reef off the Western Australian coast (Veron, 1993) and provide varied habitat that attracts a diverse range of primary and secondary consumers, including a particularly diverse fish fauna. Toothed whales, dolphins and whale sharks are found in the Commonwealth waters around these reefs, as is a genetically distinct dugong population at Ashmore Reef (Whiting, 1999).

The marine habitats among the reefs are nationally and internationally significant supporting diverse and abundant marine reptile populations (Limpus, 2008). Both Ashmore and Cartier reefs support highly diverse and internationally significant sea snake populations. Ashmore Reef and Cartier Island also support a genetically distinct breeding population of green turtles and provide foraging grounds for this species as well as for loggerhead and hawksbill turtles (Limpus, 2008). The reef system is an important staging post for seabirds and migratory shorebirds and the area is home to some of the most important seabird colonies in the North-west Marine Region (Milton, 2005). The importance of Ashmore Reef for seabirds and shorebirds is reflected in its listing as a Ramsar Wetland of International Importance in 2003.

Ancient coastline at 125m depth contour

National and/or regional importance

The ancient coastline at 125 m depth contour is defined as a key ecological feature as it is a unique seafloor feature with ecological properties of regional significance.

Location

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 as an escarpment along the NWS and Sahul Shelf at a depth of 125 m. The spatial boundary of this KEF is defined by depth range 115–135 m in the Northwest Shelf Province and Northwest Shelf Transition IMCRA provincial bioregions.

Description and values

The ancient submerged coastline provides areas of hard substrate and therefore may provide sites for higher diversity and enhanced species richness relative to surrounding areas of predominantly soft sediment. Little is known about fauna associated with the hard substrate of the escarpment, but it is likely to include sponges, corals, crinoids, molluscs, echinoderms and other benthic invertebrates representative of hard substrate fauna in the NWS bioregion.

The escarpment may also facilitate increased availability of nutrients off the Pilbara by interacting with internal waves and enhancing vertical mixing of water layers. Enhanced productivity associated with the sessile communities and increased nutrient availability may attract larger marine life such as whale sharks and large pelagic fish.

Humpback whales appear to migrate along the ancient coastline, using it as a guide to move through the region.

Canyons linking the Argo Abyssal Plain with the Scott Plateau

National and/or regional importance

The Canyons linking the Argo Abyssal Plain with the Scott Plateau are defined as a KEF for their high productivity and aggregations of marine life. These values apply to both the benthic and pelagic habitats within the feature.

Location

The spatial boundary of this KEF includes the three canyons adjacent to the south-west corner of Scott Plateau. The Bowers and Oates canyons are the largest canyons connecting the Scott Plateau with the Argo Abyssal Plain; they are situated in the Timor Province (IMCRA provincial bioregion), west of Scott Reef.

Description and values

The Bowers and Oats canyons are major canyons on the slope between the Argo Abyssal Plain and Scott Plateau. The canyons cut deeply into the south-west margin of the Scott Plateau at a depth of approx. 2,000–3,000 m, and act as conduits for transport of sediments to depths of more than 5,500 m on the Argo Abyssal Plain. Benthic communities at these depths are likely to be dependent on particulate matter falling from the pelagic zone to the sea floor.

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. The ocean above the canyons may be an area of moderately enhanced productivity, attracting aggregations of fish and higher-order consumers such as large predatory fish, sharks, toothed whales and dolphins.

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. Noting that the reasons for these historical aggregations of marine life remains unclear.

Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula

National and/or regional importance

The Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula are defined as a key ecological feature as they are unique seafloor features with ecological properties of regional significance, which apply to both the benthic and pelagic habitats within the feature.

Location

The largest canyons on the slope linking the Cuvier Abyssal Plain and Cape Range Peninsula are the Cape Range Canyon and Cloates Canyon which are located along the southerly edge of Exmouth Plateau adjacent to Ningaloo Reef. The canyons are unusual because their heads are close to the coast of North West Cape.

Description and values

The canyons on the slope of the Cuvier Abyssal Plain and Cape Range Peninsula are connected to the Commonwealth waters adjacent to Ningaloo Reef, and may also have connections to Exmouth Plateau. The canyons are thought to interact with the Leeuwin Current to produce eddies inside the heads of the canyons, resulting in waters from the Antarctic intermediate water mass being drawn into shallower depths and onto the shelf; these waters are cooler and richer in nutrients and strong internal tides may also aid upwelling at the canyon heads. The narrow shelf width (approx. 10 km) near the canyons facilitates nutrient upwelling and this nutrient-rich water interacts with the Leeuwin Current at the canyon heads. Aggregations of whale sharks, manta rays, humpback whales, sea snakes, sharks, large predatory fish and seabirds are known to occur in this area and are related to productivity.

The canyons, Exmouth Plateau and Commonwealth waters adjacent to Ningaloo Reef operate as a system to create the conditions for enhanced productivity seen in this region.

Commonwealth waters adjacent to Ningaloo Reef

National and/or regional importance

The Commonwealth waters adjacent to Ningaloo Reef are defined as a KEF for their high productivity and aggregations of marine life, which apply to both the benthic and pelagic habitats.

Location

Ningaloo Reef extends >260 km along Cape Range Peninsula with a landward lagoon 0.2–6 km wide. Seaward of the reef crest, the reef drops gently to depths of 8–10 m; the waters reach 100 m depth, 5–6 km beyond the reef edge. Commonwealth waters over the narrow shelf (10 km at its narrowest) and shelf break are contiguous with Ningaloo Reef and connected via oceanographic and trophic cycling.

Description and values

Ningaloo reef is the only extensive coral reef in the world that fringes the west coast of a continent; it is also a significant easonal aggregation site for whale sharks. The Commonwealth waters adjacent to Ningaloo Reef and associated canyons and plateau are interconnected and support the high productivity and species richness of Ningaloo Reef. The Leeuwin and Ningaloo currents interact on the seaward side of the reef, leading to areas of enhanced productivity which support aggregations and migration pathways of whale sharks, manta rays, humpback whales, seasnakes, sharks, large predatory fish and seabirds. Detrital input from phytoplankton production in surface waters and from higher-trophic consumers cycles back to the deeper waters of the shelf and slope. Deepwater biodiversity includes fish, molluscs, sponges, soft corals and gorgonians. Some of these sponge and filter-feeding communities appear to be significantly different to those of the Dampier Archipelago and Abrolhos Islands, indicating that the Commonwealth waters of Ningaloo Marine Park have some areas of potentially high and unique sponge biodiversity.

The outer reef is marked by a well-developed spur and groove system of fingers of coral formations penetrating the ocean with coral sand channels in between. The spurs support coral growth, while the grooves experience strong scouring surges and tidal run-off and have little coral growth.

Continental slope demersal fish communities

National and/or regional importance

This species assemblage is recognised as a key ecological feature because of its biodiversity values, including high levels of endemism.

Location

This KEF is defined as the area of slope found in the Northwest Province and Timor Province provincial bioregions, at the depth ranges of 220-500 m and 750-1,000 m.

Description and values

The diversity of demersal fish assemblages on the continental slope in the Timor Province, the Northwest Transition and the Northwest Province is high compared to elsewhere along the Australian continental slope. The continental slope between North West Cape and the Montebello Trough has >500 fish species, 76 of which are endemic, which makes it the most diverse slope bioregion in Australia. The slope of the Timor Province and the Northwest Transition also contains >500 species of demersal fish of which 64 are considered endemic. The Timor Province and Northwest Transition bioregions are the second-richest areas for demersal fish across the entire continental slope.

The demersal fish species occupy two distinct demersal community types (biomes) associated with the upper slope (water depth of 225–500 m) and the mid-slope (750–1,000 m). Although poorly known, it is suggested that the demersal-slope communities rely on bacteria and detritus-based systems comprised of infauna and epifauna, which in turn become prey for a range of teleost fish, molluscs and crustaceans. Higher-order consumers may include carnivorous fish, deepwater sharks, large squid and toothed whales. Pelagic production is phytoplankton based, with hot spots around oceanic reefs and islands.

Bacteria and fauna present on the continental slope are the basis of the food web for demersal fish and higher-order consumers in this system. Loss of benthic habitat along the continental slope at depths known to support demersal fish communities may lead to a decline in species richness, diversity and endemism associated with this feature.

Exmouth Plateau

National and/or regional importance

The Exmouth Plateau is defined as KEF as it is a unique seafloor feature with ecological properties of regional significance, which apply to both the benthic and pelagic habitats.

Location

The Exmouth Plateau is located in the Northwest Province and covers an area of 49,310 km² in water depths of 800–4,000 m.

Description and values

Although the seascapes of this plateau are not unique, it is believed that the large size of Exmouth Plateau and its expansive surface may modify deep-water flow and be associated with the generation of internal tides; both of these features may contribute to the upwelling of deeper, nutrient-rich waters closer to the surface. The topography of the plateau (with valleys and channels), in addition to potentially constituting a range of benthic environments, may provide conduits for the movement of sediment and other material from the plateau surface through the deeper slope to the abyss.

The Exmouth Plateau is generally an area of low habitat heterogeneity; however, it is likely to be an important area of biodiversity as it provides an extended area offshore for communities adapted to depths of around 1,000 m. Sediments on the plateau suggest that biological communities include scavengers, benthic filter feeders and epifauna.

The plateau's surface is rough and undulating; the northern margin is steep and intersected by large canyons (e.g. Montebello and Swan canyons), the western margin is moderately steep and smooth and the southern margin is gently sloping and virtually free of canyons. Satellite observations suggest that productivity is enhanced along the northern and southern boundaries of the plateau and along the shelf edge, which in turn suggests that the plateau is a significant contributor to the productivity of the region.

Whaling records from the 19th century suggest that the Exmouth Plateau may have supported large populations of sperm whales.

Glomar Shoals

National and/or regional importance

The Glomar shoals are defined as a KEF for their high productivity and aggregations of marine life.

Location

The Glomar Shoals are a submerged littoral feature located approx. 150 km north of Dampier on the Rowley Shelf at depths of 33–77 m.

Description and values

While the biodiversity associated with the Glomar Shoals has not been studied, 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. These species have recorded high catch rates associated with the Glomar Shoals, indicating that the shoals are likely to be an area of high productivity.

The shoals consist of a high percentage of marine-derived sediments with high carbonate content and gravels of weathered coralline algae and shells. The area's higher concentrations of coarse material in comparison to surrounding areas are indicative of a high-energy environment subject to strong sea-floor currents. Cyclones are also frequent in this area and stimulate periodic bursts of productivity as a result of increased vertical mixing.

Mermaid Reef and Commonwealth waters surrounding Rowley Shoals

National and/or regional importance

Mermaid Reef and Commonwealth waters surrounding Rowley Shoals is defined as a KEF for its enhanced productivity and high species richness, that apply to both the benthic and pelagic habitats.

Location

The Rowley Shoals are a collection of three atoll reefs (Clerke, Imperieuse and Mermaid) which are located approx. 300 km northwest of Broome. The KEF encompasses Mermaid Reef MP as well as waters from 3–6 nm surrounding Clerke and Imperieuse reefs.

Mermaid Reef lies approx. 29 km north of Clerke and Imperieuse reefs and is totally submerged at high tide. Mermaid Reef falls under Commonwealth jurisdiction; while the Clerke and Imperieuse reefs are within the Rowley Shoals Marine Park and under State jurisdiction.

Description and values

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. The Rowley Shoals contain 214 coral species, approx. 530 species of fish, 264 species of molluscs and 82 species of echinoderms; no seasnakes are known to occur.

The reefs provide a distinctive biophysical environment in the region as there are few offshore reefs in the northwest. They have steep and distinct reef slopes and associated fish communities. Enhanced productivity is thought to be facilitated by the breaking of internal waves in the waters surrounding the reefs, causing mixing and resuspension of nutrients from water depths of 500–700 m into the photic zone. The steep changes in slope around the reef also attract a range of migratory pelagic species including dolphins, tuna, billfish and sharks.

Rowley Shoals' reefs are different from other reefs in the chain of reefs on the outer shelf of the North-west Marine Region, both in structure and genetic diversity. There is little connectivity between Rowley Shoals and other outer-shelf reefs. Both coral communities and fish assemblages of Rowley Shoals differ from similar habitats in eastern Australia. In evolutionary terms, the reefs may play a role in supplying coral and fish larvae to reefs further south via the southward flowing Indonesian Throughflow.

Seringapatam Reef and Commonwealth waters in the Scott Reef complex

National and/or regional importance

Seringapatam Reef and Commonwealth waters in the Scott Reef complex are defined as a KEF as they support diverse aggregations of marine life, have high primary productivity relative to other parts of the region, are relatively pristine and have high species richness, which apply to both the benthic and pelagic habitats.

Location

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 depth on the northwest continental slope within the Timor Province. Scott and Seringapatam reefs provide an important biophysical environment in the region as one of few offshore reefs in the northwest.

Scott Reef consists of two separate reef formations, North Reef and South Reef. The KEF encompasses the waters beyond 3 nm at South Scott Reef and the reefs and surrounding waters at North Scott and Seringapatam reefs. The total area of the KEF is approximately 2,418 km^2.

Description and values

Seringapatam Reef and Commonwealth waters in the Scott Reef complex are regionally important in supporting the diverse aggregations of marine life, high primary productivity and high species richness associated with the reefs themselves. As two of the few offshore reefs in the northwest, they provide an important biophysical environment in the region.

The coral communities at Scott and Seringapatam reefs play a key role in maintaining the species richness and subsequent aggregations of marine life. Scott Reef is a particularly biologically diverse system and includes >300 species of reef-building corals, approx. 400 mollusc species, 118 crustacean species, 117 echinoderm species and approx. 720 fish species. Corals and fish at Scott Reef have higher species diversity than the Rowley Shoals. Recent studies suggest that the capacity for coral dispersal between Scott Reef and other offshore reefs in the region may be limited

Scott and Seringapatam reefs and the waters surrounding them attract aggregations of marine life including humpback whales (on their northerly migration) and numerous other cetacean species, whale sharks and several species of seasnake. Two species of marine turtle (green and hawksbill) nest during the summer months on Sandy Islet (South Scott Reef); the turtles also internest and forage in the surrounding waters. This KEF also provides foraging areas for seabird species such as the lesser frigatebird, wedge-tailed shearwater, brown booby and roseate tern.

Aggregations of marine life, high primary productivity and species richness on the reefs and in the surrounding Commonwealth waters are likely due to the steep rise of the reef from the seabed. This causes nutrient-rich waters from below the thermocline (approx. 100 m) to mix with the warmer, relatively nutrient-poor tropical surface waters via the action of internal waves and from mixing and higher productivity in the lee of emergent reefs.

Wallaby Saddle

National and/or regional importance

Wallaby saddle is defined as a KEF for its high productivity and aggregations of marine life; these values apply to both the benthic and pelagic habitats.

Location

The Wallaby Saddle covers 7,880 km^2 of seabed and is an abyssal geomorphic feature that connects the northwest margin of the Wallaby Plateau with the margin of the Carnarvon Terrace on the upper continental slope at a depth of 4,000–4,700 m.

Description and values

The Wallaby Saddle is regionally important in that it represents almost the entire area of this type of geomorphic feature in the North-west Marine Region. The Wallaby Saddle is located 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. Little is known about the Wallaby Saddle; however, the area is considered one of enhanced productivity and low habitat diversity.

Historical sperm whale aggregations in the area of Wallaby Saddle may be attributable to higher productivity and aggregations of baitfish.

South-west Marine Region

Ancient coastline at 90–120 m depth

National and/or regional importance

The Ancient coastline between 90–120 m depth is defined as a key ecological feature for its potential high productivity and aggregations of marine life, biodiversity and endemism. Both benthic habitats and associated demersal communities are of conservation value.

Location

The continental shelf of the South-west Marine Region contains several terraces and steps. A prominent escarpment occurs close to the middle of the continental shelf at a depth of approximately 90–120 m.

Description and values

The continental shelf of the South-west Marine Region contains several terraces and steps which reflect the gradual increase in sea level across the shelf that occurred over the past 12,000 years. Some of these occur as escarpments, although their elevation and distinctness vary throughout the region. Where they are prominent, they create topographic complexity; for example, through exposure of rocky substrates that may facilitate small, localised upwellings, benthic biodiversity and enhanced biological productivity.

While the ancient coastline is present throughout the region, it is particularly evident in the Great Australian Bight, where it provides complex habitat for a number of species.

Parts of this ancient coastline may support some demersal fish species travelling across the continental shelf to the upper continental slope, thereby supporting ecological connectivity. Benthic biodiversity and productivity occur where the ancient coastline forms a prominent escarpment of exposed hard substrates.

Commonwealth marine environment surrounding the Houtman Abrolhos Islands

National and/or regional importance

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.

Location

The Houtman Abrolhos Islands are a complex of 122 islands and reefs located at the edge of the continental shelf, approx. 60 km offshore from the Mid West coast of WA.

Description and values

The Houtman Abrolhos waters and reefs are noted for their high biodiversity and mix of temperate and tropical species, resulting from the southward transport of species by the Leeuwin Current over thousands of years. The area represents the southern limit in WA of many widespread Indo-Pacific tropical fish. The islands are the largest seabird breeding station in the eastern Indian Ocean, supporting more than one million pairs of breeding seabirds, including sedentary and migratory species. Many of the islands' biodiversity features rely on the benthic and pelagic ecosystems in deeper, offshore waters; most notably, seabirds and rock lobster.

The Houtman Abrolhos Islands lie in a transitional zone between major marine biogeographic provinces: the warm, tropical water of the Leeuwin Current and colder water more typical of the islands' latitude. The Leeuwin Current allows the Houtman Abrolhos Islands to support the highest-latitude coral reefs in the Indian Ocean. The reefs are composed of 184 known species of coral that support approx. 400 species of demersal fish, 492 species of molluscs, 110 species of sponges, 172 species of echinoderms and 234 species of benthic algae. In addition, the area provides important habitat for rock lobsters (*Panulirus cygnus*). The surrounding Commonwealth marine environment is also recognised as an important resting area for migrating humpback whales. The islands are the northernmost breeding site of the Australian sea lion, although sea lions are not thought to be an important component of this ecosystem because of their low population numbers.

Commonwealth marine environment within and adjacent to the west coast inshore lagoons

National and/or regional importance

The Commonwealth marine environment within and adjacent to the west-coast inshore lagoons is defined as a KEF for its high productivity and aggregations of marine life. Both benthic and pelagic habitats within the feature are of conservation value.

Location

The spatial boundary of this KEF is based on waters <30 m depth, in Commonwealth waters, from Kalbarri to slightly south of Mandurah.

Description and values

A chain of inshore lagoons extends along the WA coast from south of Mandurah to Kalbarri. The lagoons are formed by distinct ridges of north–south oriented limestone reef with extensive beds of macroalgae (principally *Ecklonia* spp.) and extend to a depth of 30 m. Although macroalgae and seagrass appear to be the primary source of production, it is suggested that groundwater enrichment may supplement the supply of nutrients to the lagoons. Seagrass provides important habitat for many marine species, and epiphytes are the main food source in the lagoonal system.

The lagoons are associated with high biodiversity and endemism, containing a mix of tropical, subtropical and temperate flora and fauna. The area includes breeding and nursery aggregations for many temperate and tropical marine species. They are important areas for the recruitment of commercially and recreationally important fishery species; extensive schools of migratory fish visit the area annually, including herring, garfish, tailor and Australian salmon.

The mix of sheltered and exposed seabeds form a complex mosaic of habitats. The inshore lagoons are important areas for the recruitment of western rock lobster, dhufish, pink snapper, breaksea cod, baldchin and blue gropers, abalone and many other reef species.

Meso-scale eddies

National and/or regional importance

Meso-scale eddies are defined as pelagic KEF for their high productivity and aggregations of marine life.

Location

Eddies and eddy fields form at predictable locations off the western and south-western shelf break: southwest of Shark Bay; offshore of the Houtman Abrolhos Islands; southwest of Jurien Bay; Perth Canyon; southwest of Cape Leeuwin; and south of Albany, Esperance and the Eyre Peninsula.

Description and values

Driven by interactions between currents and bathymetry, persistent meso-scale eddies form regularly (three to nine eddies per year) within the meanders of the Leeuwin Current. These features range between 50–200 km in diameter and typically last more than five months.

Meso-scale eddies are important food sources, particularly for mesozooplankton, given the broader region’s nutrient-poor conditions, and they become prey hotspots for a complex range of higher trophic-level species. Meso-scale eddies and seasonal upwellings have a significant impact on the regional production patterns.

The meso-scale eddies of this region are important transporters of nutrients and plankton communities, taking them far offshore into the Indian Ocean, where they are consumed by oceanic communities. They are likely to attract a range of organisms from the higher trophic levels, such as marine mammals, seabirds, tuna and billfish. The eddies play a critical role in determining species distribution, as they influence the southerly range boundaries of tropical and subtropical species, the transport of coastal phytoplankton communities offshore and recruitment to fisheries.

Perth Canyon and adjacent shelf break, and other west coast canyons

National and/or regional importance

The Perth Canyon forms a major biogeographical boundary and it is defined as a KEF because it is an area of higher productivity that attracts feeding aggregations of deep-diving mammals and large predatory fish. It is also recognised as a unique seafloor feature with ecological properties of regional significance.

Location

The west coast system of canyons spans an extensive area (8,744 km²) of continental slope offshore from Kalbarri to south of Perth. It includes the Geographe, Busselton, Pelsaert, Geraldton, Wallaby, Houtman and Murchison canyons and, most notably, the Perth Canyon (offshore of Rottnest Island), which is Australia's largest ocean canyon.

Description and values

The Perth Canyon is prominent among the west coast canyons because of its magnitude and ecological importance; however, the sheer abundance of canyons spread over a broad latitudinal range makes this feature important.

In the Perth Canyon, interactions between the canyon topography and the Leeuwin Current induce clockwise-rotating eddies that transport nutrients upwards in the water column from greater depths. Due to the canyon's depth and the Leeuwin Current's barrier effect, this remains a subsurface upwelling (depths >400 m), which confers ecological complexity that is typically absent from canyon systems in other areas. The Perth Canyon also marks the southern boundary for numerous tropical species groups on the shelf, including sponges, corals, decapods and xanthid crabs.

The Perth Canyon marks the southern boundary of the Central Western Province. Deep ocean currents upwelling in the canyon create a nutrient-rich, cold-water habitat that attracts deep-diving mammals and large predatory fish, which feed on small fish, krill and squid. A number of cetaceans, predominantly pygmy blue whales, aggregate in the canyon during summer to feed on the prey aggregations. Arriving from November onwards, their numbers peak in March to May. The topographical complexity of the canyon is also believed to provide more varied habitat that supports higher levels of epibenthic biodiversity than adjacent shelf areas.

Demersal slope and associated fish communities of the central Western Province

National and/or regional importance

The demersal slope and associated fish communities are recognised as a KEF for their high levels of biodiversity and endemism.

Location

This KEF extends from the edge of the shelf to the limit of the exclusive economic zone, between Perth and the northern boundary of the South-west Marine Region.

Description and values

The western continental slope provides important habitat for demersal fish communities. In particular, the continental slope of the Central Western provincial bioregion supports demersal fish communities characterised by high diversity compared with other, more intensively sampled, oceanic regions of the world. Its diversity is attributed to the overlap of ancient and extensive Indo-west Pacific and temperate Australasian fauna. Approx. 480 species of demersal fish inhabit the slope of this bioregion, and 31 of these are considered endemic to the bioregion.

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 seafloor (such as a mouth position adapted to bottom feeding), and many do not appear to migrate vertically in their daily feeding habits.

Western rock lobster

National and/or regional importance

The Western rock lobster is defined as a KEF due to its presumed ecological role on the west coast continental shelf.

Location

The spatial boundary of this KEF includes Commonwealth waters in the South-west Marine Region, to a depth of 150 m, north of Cape Leeuwin.

Description and values

Western rock lobster (*Panulirus cygnus*) is the dominant large benthic invertebrate in this bioregion, and can be found north of Cape Leeuwin to a depth of 150 m. It is also an important part of the food web on the inner shelf, particularly as a juvenile, when it is preyed upon by octopus, cuttlefish, baldchin groper, blue groper, dhufish, pink snapper, wirrah cod and breaksea cod. Western rock lobsters are also particularly vulnerable to predation during seasonal moults in November–December and to a lesser extent during April–May. 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.

As an abundant and wide-ranging consumer, the western rock lobster is likely to play an important role in ecosystem processes on the shelf waters in the region. The ecological role of western rock lobster is best understood in shallow waters (<10 m) where it can significantly reduce the densities of invertebrate prey, such as epifaunal gastropods, through its varied and highly adaptable diet. However, there is a lack of similar studies in deeper water (>20 m). The little information available for deep-water populations suggests that lobsters forage primarily on animal prey, which is dominated by crustaceans such as decapod crabs and amphipods.

Naturaliste Plateau

National and/or regional importance

The Naturaliste Plateau is defined as a KEF due to its unique seafloor characteristics which are associated with ecological properties of regional significance.

Location

The Naturaliste Plateau lies approximately 170 km east of Augusta at its closest point. The Plateau covers an area of 29,825km^2, in water depths of approximately 2500 m.

Description and values

The Naturaliste Plateau is Australia’s deepest temperate marginal plateau, separated from the continental shelf by the Naturaliste Trough where water depths range between 3,000 and 5,000 m. The Naturaliste Plateau is characterised by raised seafloor isolated on the edge of the abyssal plain, where several water masses and currents converge, which has the potential to influence the diversity and endemism in deep water communities present in the area. The presence of a deep eddy field is also thought to influence productivity and aggregations of marine life.

Cape Mentelle Upwelling

National and/or regional importance

Cape Mentelle upwelling is defined as a key ecological feature for its relatively high productivity and aggregations of marine life.

Location

The Cape Mentelle upwelling occurs during summer months between Cape Leeuwin and Cape Naturaliste in the south-west corner of Australia.

Description and values

The Cape Mentelle upwelling is caused by prevailing southerly winds in the region, that counteract the Leeuwin Current’s driving force, drawing relatively nutrient-rich water from beneath the Leeuwin Current (where nutrient levels are higher), up the continental slope and onto the inner continental shelf (at depths of less than 50 m). The increase in nutrients support phytoplankton blooms at the surface that provide the basis of an extended food chain characterised by feeding aggregations of small pelagic fish, larger predatory fish, seabirds, dolphins and sharks.

Commonwealth marine environment within and adjacent to Geographe Bay

National and/or regional importance

The Commonwealth marine environment within and adjacent to Geographe Bay is defined as a key ecological feature for its high productivity and aggregations of marine life, and high levels of biodiversity and endemism in both benthic and pelagic habitats.

Location

Geographe Bay is a large, shallow (< 30 m deep), sheltered bay that encompasses a wide curve of the Western Australian coastline extending from Cape Naturaliste to Bunbury.

Description and values

Geographe Bay is an area of high productivity supported by extensive and diverse seagrass meadows that cover approximately 60 percent of the bay (McMahon et al., 1997). The conditions of the bay, and the south-flowing warm waters of the Leeuwin Current, make this an area of high biodiversity and endemism, with a mix of tropical and temperate species.

Geographe Bay provides important nursery habitat for many shelf species. For example, juvenile dusky whaler sharks use the shallow seagrass habitat as nursery grounds for several years, before ranging out to adult feeding grounds along the shelf break. The seagrass also provides valuable habitat for fish and invertebrates (Carruthers et al., 2007). Geographe Bay is also recognised as an important resting area for migrating humpback whales during the late winter–spring months (McCauley et al., 2000).

Perth Canyon and adjacent shelf break, and other west-coast canyons

National and/or regional importance

The Perth Canyon is defined as a key ecological feature because its high productivity that attracts feeding aggregations of deep-diving mammals and large predatory fish. It is also recognised as a unique seafloor feature with ecological properties of regional significance.

Location

The Perth Canyon (offshore from Rottnest Island, at 32° S) is prominent among the west coast canyons because of its magnitude and ecological importance; it is Australia's largest ocean canyon.

Description and values

The Perth Canyon is long, deep, narrow and steep-sided, cutting 4 km into the continental shelf (Pattiaratchi, 2007). The head of the canyon starts at the 200 m depth contour on the continental shelf and drops to a depth of 1000 m over a 6.5 km distance before doglegging down onto the abyssal plain (at about 4000 m) (Rennie et al., 2006). In the Perth Canyon, interactions between the canyon topography and the Leeuwin Current induce clockwise-rotating eddies that transport nutrients upwards in the water column from greater depths. Due to the canyon's depth and the Leeuwin Current's barrier effect, this remains a subsurface upwelling (depths greater than 400 m), which confers ecological complexity that is typically absent from canyon systems in other areas (Pattiaratchi, 2007). Deep ocean currents upwelling in the canyon create a nutrient-rich, cold-water habitat that attracts deep-diving mammals and large predatory fish, which feed on small fish, krill and squid (Pattiaratchi, 2007). A number of cetaceans, predominantly pygmy blue whales, aggregate in the canyon during summer to feed on the prey aggregations (Pattiaratchi, 2007). Arriving from November onwards, their numbers peak in March to May. The topographical complexity of the canyon is also believed to provide more varied habitat that supports higher levels of epibenthic biodiversity than adjacent shelf areas (Hayes et al., 2008). The Perth Canyon also marks the southern boundary for numerous tropical species groups on the shelf, including sponges, corals, decapods and xanthid crabs.

3.4.4 Commercial Fisheries

3.4.4.1 Commonwealth Managed Fisheries

Commonwealth fisheries are managed by the Australian Fisheries Management Authority (AFMA) under the *Fisheries Management Act 1991*, with the fisheries typically operating within 3 nm to 200 nm offshore (i.e. to the extent of the Australian Fishing Zone [AFZ]).

There are five Commonwealth managed commercial fisheries with management areas that intersect with the EMBA. However, not all the fisheries are active within the full extents of the management areas; based on historical fishing effort data (Patterson et al., 2018):

- North West Slope Trawl Fishery (NWSTF) is likely to be active in waters >200 m off the Pilbara and Kimberley coasts (Figure 3-23);
- Southern Bluefin Tuna Fishery (SBTF) is active within waters in the Great Australian Bight and south-eastern Australia; however, the spawning grounds for southern bluefin tuna are located in the north-east Indian Ocean (Figure 3-24);
- Western Deepwater Trawl Fishery (WDTF) is likely to be active in waters >200 m off the Gascoyne coast (Figure 3-25);
- Western Skipjack Tuna Fishery (WSTF), has had no active fishing operations since the 2008-2009 season;
- Western Tuna and Billfish Fishery (WTBF), is likely to be active in Commonwealth waters off the Gascoyne, Mid West and Southwest coasts (Figure 3-26).

Therefore, based on previous fishing effort, the only Commonwealth Fishery expected to be active within the immediate vicinity of the Ironbark Exploration Drilling Program is the NWSTF (Figure 3-23). A summary of the three fisheries that may be active within the EMBA are summarised in Table 3-20.

Table 3-19: Management Areas for Commonwealth Managed Fisheries relevant to the Ironbark Exploration Drilling Program

Fishery	EMBA	Operational Area	Hydrocarbon Exposure Area
North West Slope Trawl Fishery (NWTF)	x (a)	x (a)	x (a)
Southern Bluefin Tuna Fishery **(SBTF)**	x (n)	x (n)	x (n)
Western Deepwater Trawl Fishery **(WDTF)**	x (a)	-	x (a)
Western Skipjack Tuna Fishery (WSTF)	x (n)	x (n)	x (n)
Western Tuna and Billfish Fishery (WTBF)	x (a)	x (n)	x (a)

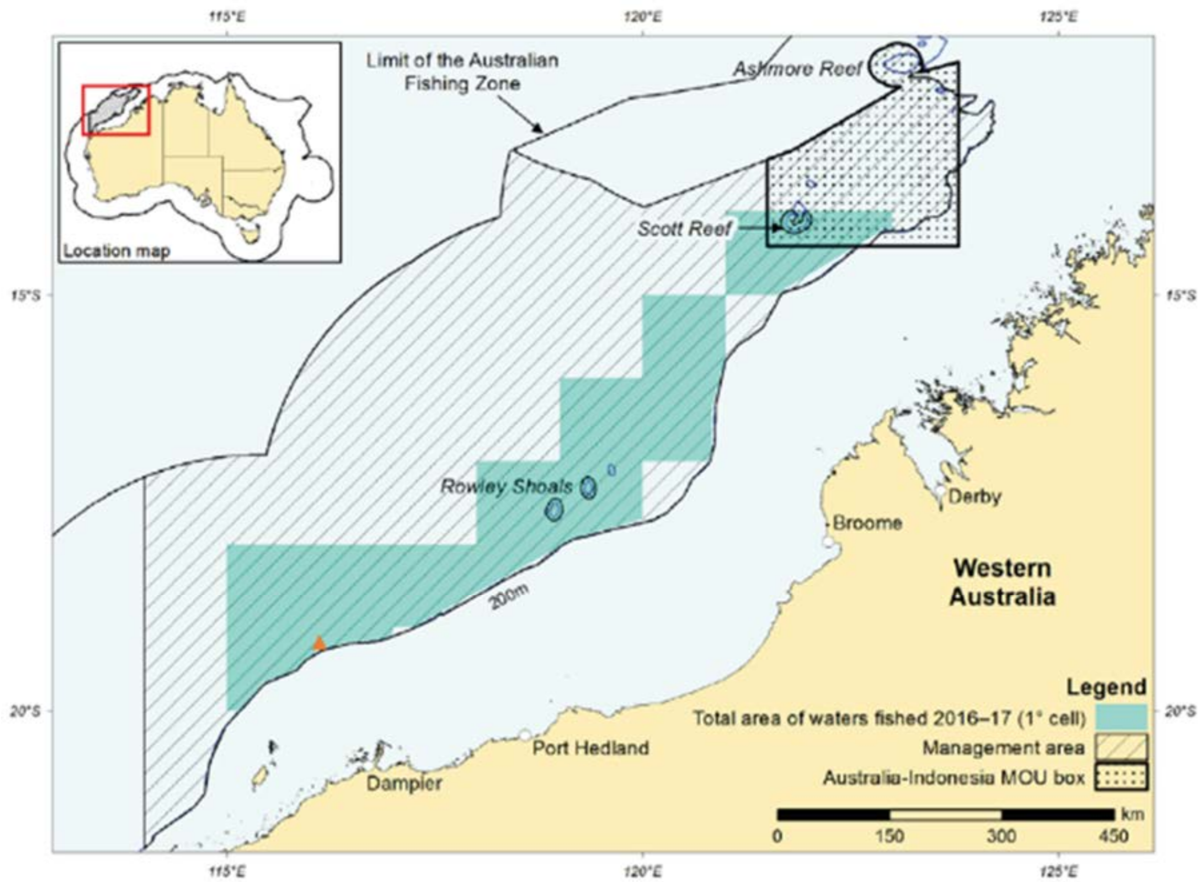
x = Present within area; - = not present within area

(a) = Management area present and active fishing expected; (n) = Management area present and no active fishing expected

Table 3-20: Commonwealth Managed Fisheries with active fishing effort relevant to the Ironbark Exploration Drilling Program

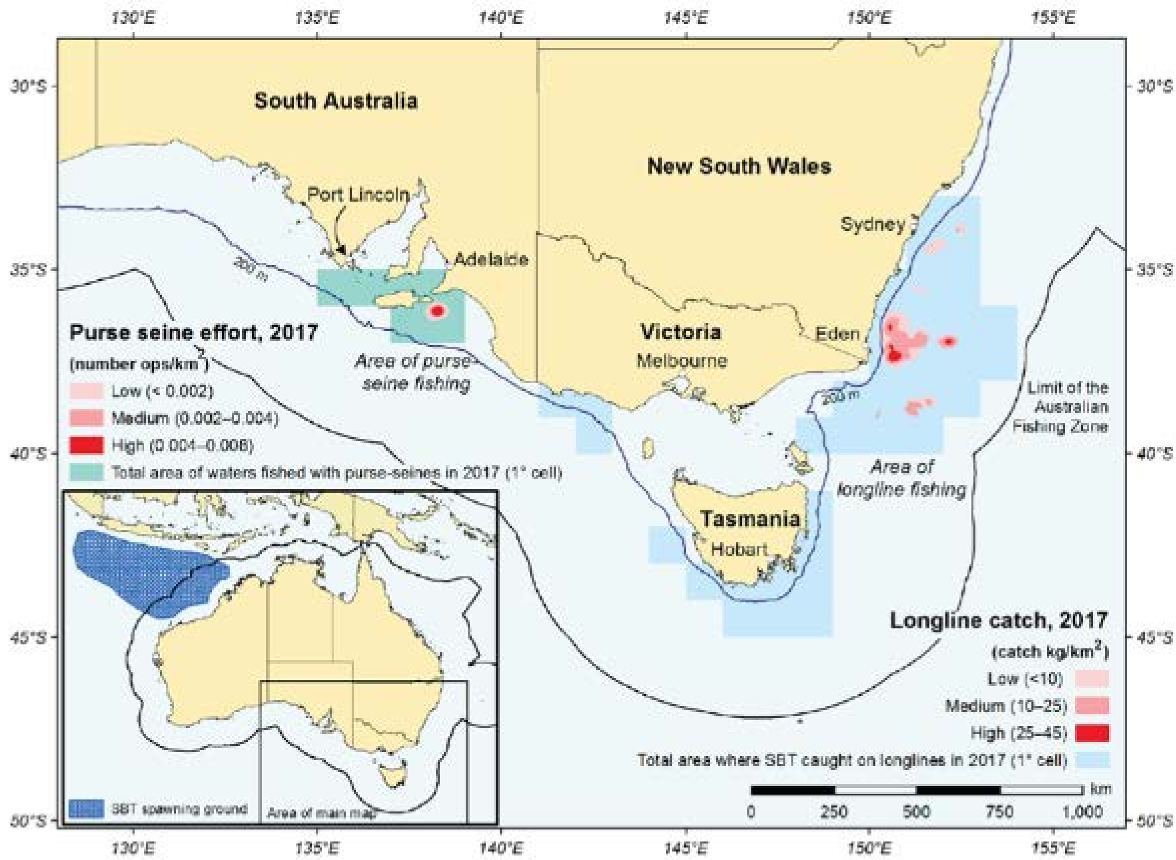
Fishery	Boundary	Method	Season	Permits / Vessels	Target Species	Main Landing Ports
NWSTF	200 m isobath to AFZ, Exmouth to Mitchell Plateau	Demersal trawl gear	Year round	2016-17 season: 4 permits, 2 active vessels	Scampi (*Metanephrops australiensis, M. boschmai, M. velutinus*)	Darwin (NT) Point Samson (WA)
WTBF	In the AFZ and high seas of the Indian Ocean, from Cape York to SA/VIC border	Pelagic longline, minor line and purse seine	Year round	2017 season: 95 boat SFR permits, 4 active vessels	Bigeye tuna (*Thunnus obesus*) Yellowfin tuna (*T. albacares*) Broadbill swordfish (*Xiphias gladius*) Striped marlin (*Tetrapturus audux*)	Fremantle (WA) Geraldton (WA)
WDTF	200 m isobath to AFZ, Exmouth to Augusta	Demersal trawl gear	1 July – 30 June	2016-17 season: 4 permits, 1 active vessel	Deepwater bugs (*Ibacus* spp.) Ruby snapper (*Etelis carbunculus, Etelis* spp.)	Carnarvon (WA) Fremantle (WA)

SFR = Statutory fishing right



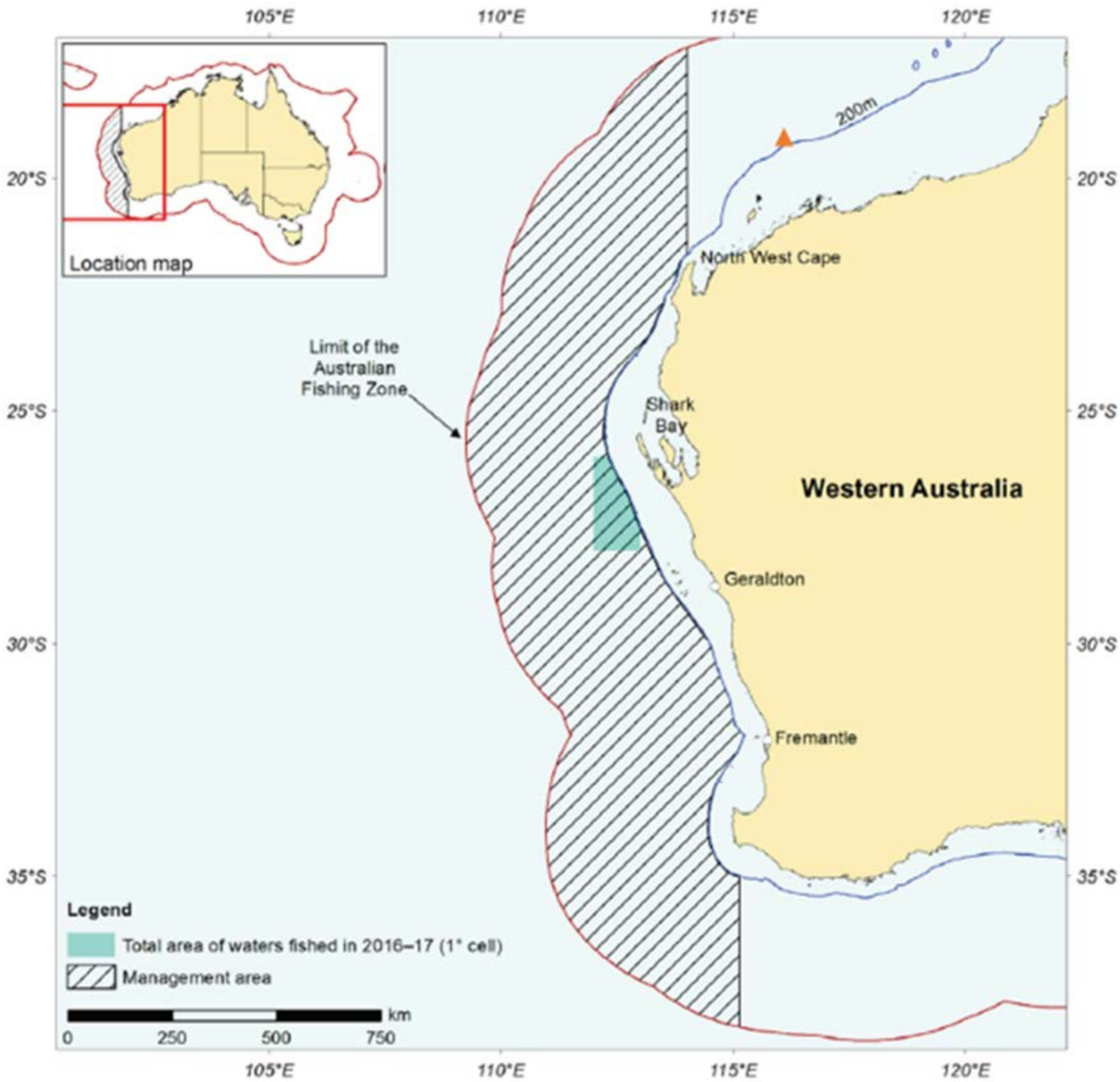
Source: Patterson et al., 2018

Figure 3-23: Management Area for the North West Slope Trawl Fishery, and area fished during 2016–2017 (approximate location of well and permit WA-359-P is shown by orange triangle)



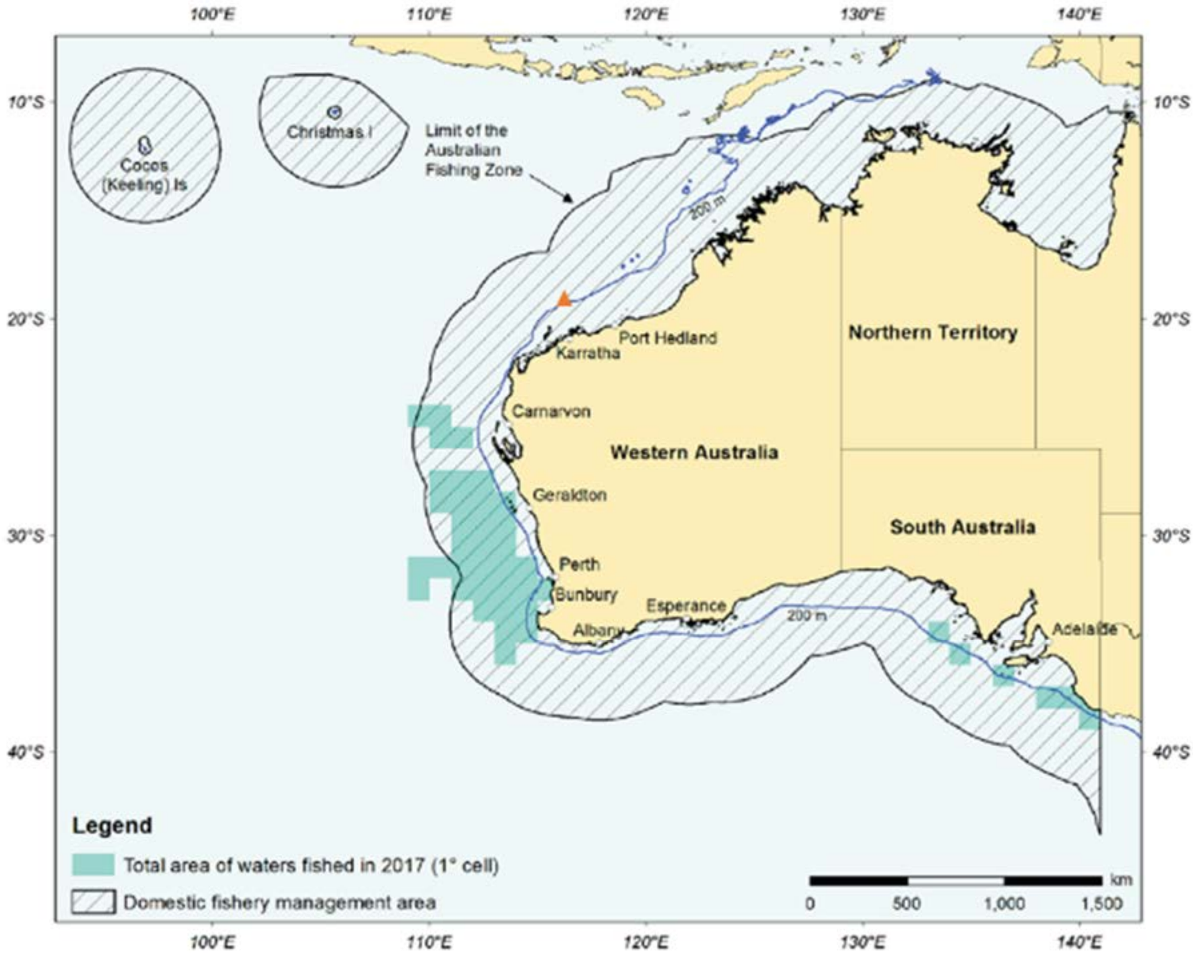
Source: Patterson et al., 2018

Figure 3-24: Management Area for the Southern Bluefin Tuna Fishery, with Indian Ocean spawning ground shown in inset



Source: Patterson et al., 2018

Figure 3-25: Management Area for the Western Deepwater Trawl Fishery, and area fished during 2016–2017 (approximate location of well and permit WA-359-P is shown by orange triangle)



Source: Patterson et al., 2018

Figure 3-26: Management Area for the Western Tuna and Billfish Fishery, and area fished during 2017 (approximate location of well and permit WA-359-P is shown by orange triangle)

3.4.4.2 State Managed Fisheries

The FishCube database (DPIRD, 2019) lists four State fisheries that may occur within the 60 nm grid block (No. 19160) that intersects with the Operational Area:

- Mackerel Managed Fishery
- Pilbara Fish Trawl (Interim) Managed Fishery
- Pilbara Line Fishery (Condition)
- Pilbara Trap Managed Fishery

For these fisheries less than 4 vessels per fishery were present in this area, with data for the Pilbara Fish Trawl (Interim) Managed Fishery spending a total of 281 days within the vicinity of the Operational Area (DPIRD, 2019).

The Pilbara Fish Trawl (Interim) Managed Fishery is the state fishery with the highest catch and known fishing days (e.g. 281 fishing days and a catch of 472,621 kg for 2018; and 191 fishing days and a catch of 147,564 kg for 2014).

Minor fishing activity (one record of 39,720 kg catch) was recorded in 2017 for the Pilbara Line Fishery (Condition), but nothing in the years before or after this.

Activity for the Pilbara Trap Managed Fishery varied between less than three to three vessels, and annual catches of 178,229 kg (in 2018) and 132,193 kg (in 2016) during the five-year period.

No activity was recorded for the Mackerel Managed Fishery.

It is also noted that the Mackerel Managed Fishery mainly relies on near-surface trolling and jig fishing around coastal reefs, shoals and headlands; and the Pilbara Line Fishery (Condition) is focussed on line fishing for tropical demersal scalefish.

Table 3-21: Management Areas for State Managed Fisheries relevant to the Ironbark Exploration Drilling Program

State Managed Fishery	EMBA	Operational Area	Hydrocarbon Exposure Area
Gascoyne Coast Bioregion			
Shark Bay Blue Swimmer Crab Fishery	x	-	-
Gascoyne Demersal Scalefish Fishery	x	-	x
West Coast Deep Sea Crustacean Fishery	x	-	x
Exmouth Gulf Prawn Fishery	x	-	-
Shark Bay Prawn and Scallop Managed Fisheries	x	-	-
North Coast Bioregion			
North Coast Crab Fishery	x	-	x
Beche-De-Mer (Sea Cucumber) Fishery	x	-	x
Pearl Oyster Fishery	x	-	x
Mackerel Managed Fishery	x	x	x
North Coast Demersal Scalefish Fisheries			
Pilbara Fish Trawl (Interim) Managed Fishery	x	x	x
Pilbara Trap Managed Fishery	x	x	x
Pilbara Line Fishery	x	x	x
North Coast Prawn Fisheries			
Onslow Prawn Managed Fishery (OPMF)	x	-	x
Nickol Bay Prawn Managed Fishery (NBPMF)	x	-	x
Broome Prawn Managed Fishery (BPMF)	x	-	x
Kimberley Prawn Managed Fishery (KPMF)	x	-	x
State-wide Bioregion			
Specimen Shell Managed Fishery (SSMF)	x	-	x

Marine Aquarium Fish Managed Fishery (MAFMF)	x	-	x
Aquaculture			
Pearl Hatcheries	x	-	x

x = Present within area; - = not present within area

Table 3-22: State Managed Fisheries with active fishing effort relevant to the Ironbark Exploration Drilling Program

Fishery	Boundary	Method	Season	Permits / Vessels	Target Species
Gascoyne Coast Bioregion					
Shark Bay Blue Swimmer Crab Fishery	Within Shark Bay	Commercial traps & trawls	Trawl season: Mar/April - Sept/Oct	5 permits	Blue Swimmer Crab (*Portunus armatus*)
Gascoyne Demersal Scalefish Fishery	Continental shelf waters	Mechanised handlines	Year-round (May – Aug for Pink Snapper)	16 vessels	Pink Snapper (*Chrysophrys auratus*) Goldband Snapper (*Pristipomoides multidens*)
West Coast Deep Sea Crustacean Fishery	Continental shelf edge waters (>150m, mostly 500-800m) of the Gascoyne Coast and West Coast Bioregions	Baited pots operated in a long-line formation	Year-round (for 2016)	7 licences	Crystal (snow) Crabs (*Chaceon albus*) Giant (King) Crabs (*Pseudocarcinus gigas*) Champagne (Spiny) Crabs (*Hypothalassia acerba*)
Exmouth Gulf Prawn Managed Fishery	Within Exmouth Gulf	Low opening, otter prawn trawl systems	Season arrangements are developed each year, depending on environmental conditions, moon phases and the fishery-independent pre-season surveys	15 licences	Western King Prawns (*Penaeus latisulcatus*) Banana Prawns (*Penaeus merguiensis*) Brown Tiger Prawns (*Penaeus esculentus*) Endeavour Prawns (*Metapenaeus endeavouri*)
Shark Bay Prawn Managed Fishery	Within inner Shark Bay	Low opening, otter prawn trawl systems	Varies each year depending on environmental conditions	18 licences	Western King Prawns (*Penaeus latisulcatus*) Brown Tiger Prawns (*Penaeus esculentus*) Endeavour (*Metapenaeus endeavouri*) Coral Prawns (*Metapenaeopsis*sp)
Shark Bay Scallop Managed Fishery	Within Shark Bay	Otter trawls	Dependant on stock and catch levels	11 licences	Saucer Scallops (*Ylistrum balloti*)

Fishery	Boundary	Method	Season	Permits / Vessels	Target Species
North Coast Bioregion					
North Coast Crab Fishery	Coastal embayments and estuaries between Geographe Bay and Port Hedland	Hourglass traps	Hot weather restricts fishing effort to between April and November	During 2012-13, two active vessels.	Blue Swimmer Crabs (*Portunus armatus*)
Beche-De-Mer (Sea Cucumber)	State waters only, from Exmouth to NT border	Diving and wading	Year round during neap tides	4 licences	Sandfish (*Holothuria scabra*) Redfish (*Actinopyga echinites*
Pearl Oyster Managed Fishery	Shallow coastal waters along North West Shelf	Drift diving	March - June	5 licences 14 hatchery pearling licences	Silver-lipped Pearl Oyster (*Pinctada maxima*)
Mackerel Managed Fishery (MMF)	Coastal areas around reefs, shoals and headlands. Cape Leeuwin to NT border	Near-surface trolling gear Jig fishing	All year round	78 permit holders (38 active in 2008/09)	Spanish Mackerel (*Scomberomorus commerson*)
North Coast Demersal Scalefish Fisheries					
Pilbara Demersal Scale Fisheries (PDSF) includes **Pilbara Fish Trawl (Interim) Managed Fishery, Pilbara Trap Managed Fishery, and Pilbara Line Fishery**	Exmouth to south end of Eighty Mile Beach, Commonwealth waters only	Trawl, trap and line fishing	Any nominated 5 month block period	15 licences	Bluespotted Emperor (*Lethrinus punctulatus*) Red Emperor (*Lutjanus sebae*) Rankin Cod (*Epinephelus multinotatus*)
North Coast Prawn Fisheries					
Onslow Prawn Managed Fishery (OPMF)	Western part of the North West Shelf from Exmouth Gulf to Cape Londonderry	High or low opening, otter prawn trawl systems	Generally March to Nov	31 licences	Western King Prawns (*Penaeus latisulcatus*) Brown Tiger Prawns (*Penaeus esculentus*) Endeavour Prawns (*Metapenaeus endeavouri*)
Nickol Bay Prawn Managed Fishery (NBPMF)	Western part of the North West Shelf from Exmouth Gulf to Cape Londonderry	High or low opening, otter prawn trawl systems	Year round, designated nursery areas open in May and close Aug - Nov	14 licences	Banana Prawn (*Penaeus merguiensis*)

Fishery	Boundary	Method	Season	Permits / Vessels	Target Species
Broome Prawn Managed Fishery (BPMF)	Waters off Broome	High or low opening, otter prawn trawl systems	Up to nine weeks during Northern Prawn Fishery closure period, usually 1 June to mid-August	5 licences	Western King Prawns (*Penaeus latisulcatus*) Coral Prawns (*Metapenaeopsis* sp)
Kimberley Prawn Managed Fishery (KPMF)	State and Commonwealth waters from Koolan Island to Cape Londonderry	High or low opening, otter prawn trawl systems	April – May And Aug – Dec	135 licences	Western King Prawns (*Penaeus latisulcatus*) Banana Prawns (*Penaeus merguiensis*) Brown Tiger Prawns (*Penaeus esculentus*) Endeavour Prawns (*Metapenaeus endeavouri*)
Statewide Bioregion					
The Specimen Shell Managed Fishery (SSMF)	Covers the entire WA coastline, some concentration adjacent to population centres	By hand by divers or by coastal wading		31 licences (7 active)	224 different Specimen Shell species
Marine Aquarium Fish Managed Fishery (MAFMF)	All State waters between NT border and SA border, typically more active south of Broome and around Capes region	SCUBA or surface supplied air (hookah) from small vessels		8 licences	More than 950 species of marine aquarium fishes, as well as coral, live rock, algae, seagrass and invertebrates
Aquaculture					
Pearl Hatcheries	Coastal waters of Exmouth Gulf, Broome, Dampier Peninsula, Buccaneer Archipelago, Roebuck Bay and Montebello Islands	Farm leases for hatchery-bred pearl oysters		14 hatchery pearling licences	Blacklip Oyster (*Pinctada margitifera*) Pearl oysters (*P. maxima*)

3.4.4.3 Traditional Indonesian Fishing

A Memorandum of Understanding (MoU) between Australia and the Republic of Indonesia has existed since 1974 and allows traditional Indonesian fishers to fish in an area known as the 'MoU Box'. The MoU defines ‘traditional fishermen’ as fishers who have traditionally taken fish and sedentary organisms in Australian waters using traditional fishing methods and non-motorised sailing vessels. Under the MoU, the taking of protected wildlife including marine turtles, dugongs and clams is prohibited, as is fishing within the Ashmore Reef National Nature Reserve and Cartier Island Marine

Reserve. Fishers may access the reefs of Cartier Island, Scott Reef, Seringapatam Reef and Browse Island, and visit Ashmore Reef for access to fresh water and to visit graves (DEWHA, 2008a).

3.4.5 Marine Tourism and Recreation

Charter fishing, marine fauna watching, and cruising are the main commercial tourism activities; and fishing, diving, snorkelling and other nature-based activities are the main recreational activities, that may occur within the EMBA (Table 3-23).

Table 3-23: Marine Tourism and Recreation relevant to the Ironbark Exploration Drilling Program

Activity	EMBA	Operational Area	Hydrocarbon Exposure Area
Recreational fishing	x	-	x
Charter vessel tours	x	-	x
Cruises	x	-	x
Recreational diving, snorkeling, and other nature-based activities	x	-	x

x = present within area; - = not present within area

Recreational fishing in Australia is a multi-billion-dollar industry. Most recreational fishing typically occurs in nearshore coastal waters (shore or inshore vessels), and within bays and estuaries. Offshore fishing (>5 km from the coast) only accounts for approximately 4% of recreational fishing activity in Australia; and charter fishing vessels are likely to account for the majority of this offshore fishing activity. The highest recreational fishing effort is typically concentrated near towns, and the closest to the Ironbark Exploration Drilling Program are coastal areas off Exmouth and Coral Bay (DEWHA, 2008a).

The charter fishing industry in WA is regulated by DPIRD with licences required to operate (except within AMPs where licences are regulated by the Director of National Parks). Charter fishing is a popular activity, with many fishing boat tours operating from Exmouth. Prime game-fishing locations can be found are around offshore atolls and reefs, including the Rowley Shoals (DEWHA, 2008a). Activities conducted on charter tours are not restricted to fishing, and may also include diving, snorkelling, marine fauna watching and sightseeing (DEWHA, 2008). However, except for charter fishing (which can operate in both State and Commonwealth waters), most marine tourism activities typically occur in State waters.

Whale watching is popular, particularly during the southward migration of humpback whales from September to late-November (DEWHA, 2008a). Other recreational activities, such as diving and snorkelling, are typically undertaken within State waters. Primary dive locations within the vicinity of the Ironbark Exploration Drilling Program are within the State Ningaloo MP and the Muiron Islands Marine Management Area (MMA) (DEWHA, 2008a).

Exmouth is occasionally utilised by the cruise ship industry; however, given the size of existing infrastructure and facilities available at Exmouth, this limits the size and number of vessels that utilise the marina.

3.4.6 State Protected Areas

There are 14 State marine protected areas within the EMBA. The closest State marine protected area to the Ironbark Exploration Drilling Program is the Montebello Islands Marine Park, approximately 145 km away. The Ningaloo Marine Park is located 350 km away. A summary of the description and values of these protected areas are provided below.

Table 3-24: State Marine Protected Areas relevant to the Ironbark Exploration Drilling Program

State Marine Protected Area	EMBA	Operational Area	Hydrocarbon Exposure Area
Camden Sound Marine Park	x	-	-
Roebuck Bay Marine Park	x	-	-
Eighty Mile Beach Marine Park	x	-	-
Rowley Shoals Marine Park	x	-	x
Montebello Islands Marine Park	x	-	x
Barrow Islands Marine Park and Marine Management Area	x	-	x
Muiron Islands Marine Management Area	x	-	x
Ningaloo Marine Park	x	-	x
Shark Bay Marine Park	x	-	-
Hamelin Pool Marine Nature Reserve	x	-	-
Jurien Bay Marine Park	x	-	-
Marmion Marine Park	x	-	-
Shoalwater Islands Marine Park	x	-	-
Ngari Capes Marine Park	x	-	-

x = present within area; - = not present within area

The Montebello Islands Marine Park comprises two sanctuary zones (approximately 28,626 ha or 49% of the marine park), two recreation zones (approximately 1,286 ha or 2% of the marine park), one special purpose zone (benthic protection) (approximately 1,040 ha or 2% of the marine park) and eleven special purpose zones (pearling) (approximately 550 ha or less than 1% of the marine park). All other areas in the marine park not included in sanctuary, recreation or special purpose zones will be zoned as general use (approximately 26,827 ha or 46% of the marine park).

The Northern Montebello Sanctuary Zone (approximately 5,294 ha or 9% of the marine park) includes representative areas of deep water habitats, seaward coral reef communities, macroalgal and seagrass communities, intertidal sand/mudflat communities and rocky shore/intertidal reef platform communities. It encompasses important turtle aggregation areas and has a high diversity of finfish and invertebrate species. The bathymetry in this zone is the most complex in the reserves and thus the area has high habitat diversity and may contain important fish spawning areas.

The Southern Montebello Sanctuary Zone (approximately 23,074 ha or 40% of the marine park) includes representative areas of seaward and leeward coral reef communities, the majority of the internationally significant mangrove communities in the protected area, macroalgal and seagrass communities, intertidal sand/mudflat communities and rocky shore/intertidal reef platform communities. It encompasses turtle aggregation areas, turtle and seabird breeding areas, as well as diverse finfish and invertebrate populations. It includes areas of complex geomorphology and seabed topography, as well as spectacular diving opportunities.

The Ningaloo Marine Park was originally gazetted in 1987, and then amended in November 2004 to include the whole of the Ningaloo Reef. The Muiron Islands Marine Management Area was also gazetted in November 2004. The Ningaloo Marine Park and Muiron Islands Marine Management Area are located off the North West Cape of WA and cover areas of approximately 263,343 ha and 28,616 ha respectively. These protected areas are managed simultaneously, with the same objectives, strategies and targets (CALM, 2005).

Ningaloo Reef is the largest fringing coral reef in Australia (CALM, 2005). Temperate and tropical currents converge in the Ningaloo region resulting in a high biological diversity, including areas of mangroves, coral reefs, algae and filter-feeding communities and abundant species of fish, turtles, whale sharks, dugongs, whales and dolphins (including some with recognised conservation status). The region is also known for its high ambient water quality (CALM, 2005).

The Ningaloo area also has a high social significance, for a variety of recreational pursuits and for nature-based tourism that centres on the reserve's natural attractions. Nature-based activities known to occur include wildlife viewing, boating, fishing, diving, snorkelling, and a variety of coastal uses (CALM, 2005). The seasonal aggregations of marine fauna (whale sharks, manta rays, sea turtles and whales) and the annual mass spawning of coral provide unique opportunities for visitors to observe these key features within the reserves (CALM, 2005). Cultural heritage is also acknowledged within the region, due to the long history of use and occupation of the area by Aboriginal groups (CALM, 2005).

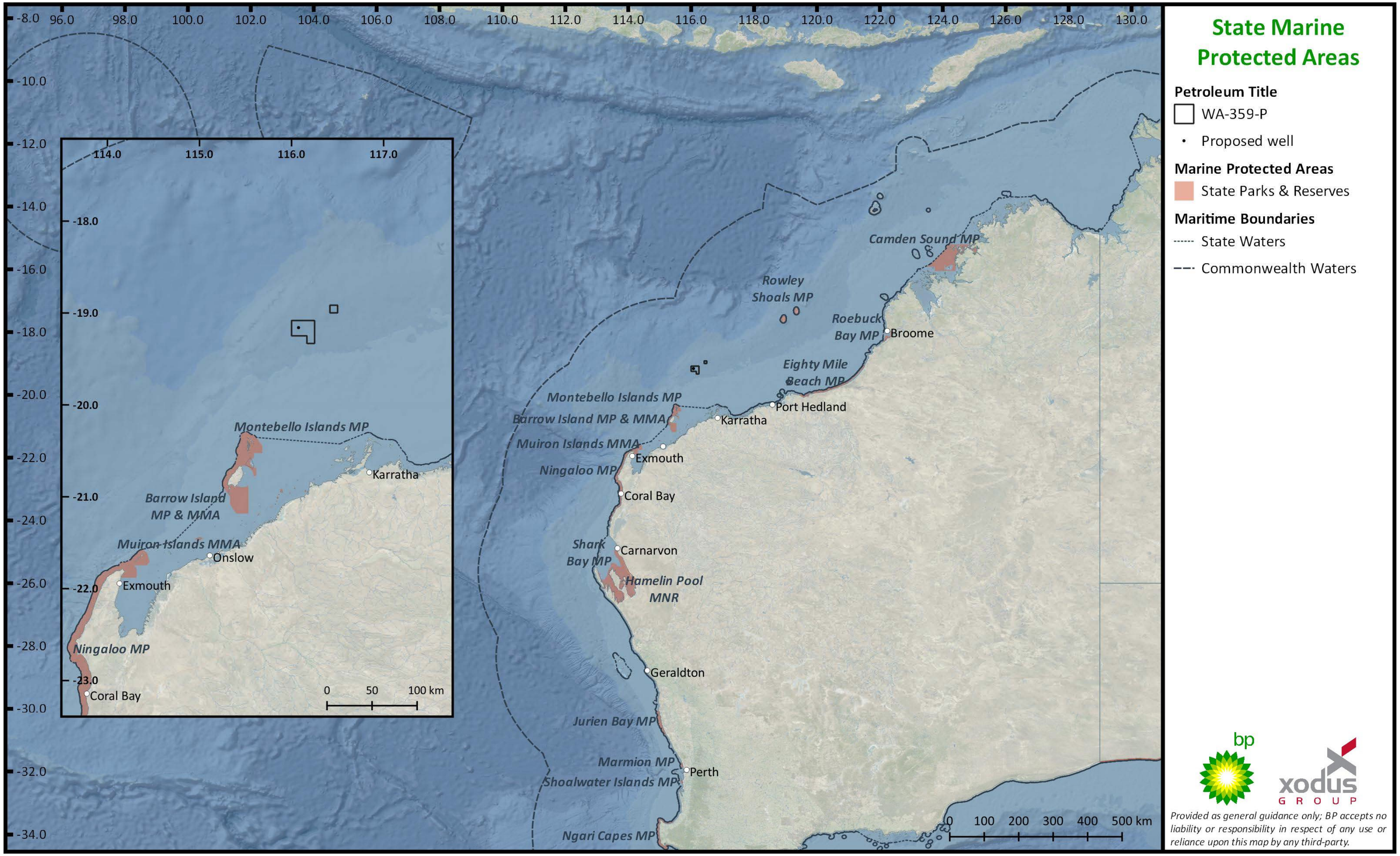


Figure 3-27: State Marine Protected Areas

3.4.7 Marine and Coastal Industries

There are a number of other industries or users that may be present within the EMBA (Table 3-25). Commercial fisheries and tourism/recreation have been described separately.

Table 3-25: Marine and Coastal Industries relevant to the Ironbark Exploration Drilling Program

Industry or User	EMBA	Operational Area	Hydrocarbon Exposure Area
Petroleum exploration and production	x	-	x
Ports	x	-	-
Commercial shipping	x	x	x
Defence	x	-	x
Submarine telecommunication cables	x	-	x

x = present within area; - = not present within area

The Ironbark Exploration Drilling Program is planned within the Northern Carnarvon Basin, one of the most heavily explored and developed basins in Australia. The Northern Carnarvon, Browse and Bonaparte basins together comprise most of Australia's natural gas reserves (DEWHA, 2008a). The Carnarvon Basin itself supports >95% of WA's oil and gas production, and accounts for ~63% of Australia's total production of crude oil, condensate and natural gas (DEWHA, 2008a).

Five wells have been drilled in the vicinity of the Operational Area:

- Banambu 1 (WA-525-P),
- Banambu Deep 1 (WA-368-P),
- Glatton 1 (WA-389-P),
- Brigadier 1 (WA-359-P, but outside of Operational Area), and
- Andromeda (No permit).

The closest operating petroleum production facility is the North Rankin Complex, operated by Woodside Energy Ltd, located approximately 45 km away.

The largest ports within the EMBA are the Ports of Dampier and Port Hedland. The Port of Dampier is one of the major tonnage ports in Australia, with prime export commodities of iron ore, LNG and salt. Port Hedland is the second largest Australian port, with its main bulk export commodities being iron ore and salt.

Commercial shipping traffic is high in north-west WA, with vessel activities including commercial fisheries, tourism, international shipping and oil and gas operations. AMSA have advised that heavy vessel traffic, including tanker, cargo, support and passenger vessels, pass in the vicinity of the Operational Area based on the location of the chartered shipping fairway located west of the Operational Area (AMSA, personal communication, 19 March 2019). There are no channels or navigation hazards that restrict the bearing vessels could take around the Operational Area (AMSA, 2019).

The Royal Australian Air Force (RAAF) have a base located at Learmonth, and there are training and practice areas associated with this base that extend offshore (Figure 3-30). The RAAF base and associated facilities occur on Commonwealth land. The Naval Communications Station Harold E. Holt is also located at North West Cape. This station communicates at very low frequencies with submarines in the Indian Ocean and the western Pacific.

Submarine telecommunications cables are underwater infrastructure linking Australia with other countries; the submarine communications cables carry the bulk of our international voice and data traffic. The JASURAUS (Port Hedland to Jakarta) and the SEA_ME_WE3 (Perth to Jakarta) cables are two submarine telecommunications cables of national significance currently in service within the EMBA. Under the *Telecommunications and Other Legislation Amendment Act 2005* protection zones cover the cables to prohibit and/or restrict activities that may damage them. The protection zones are generally the area within 1.8 km (1 nm) either side of the cable and include both the waters and seabed within the area.

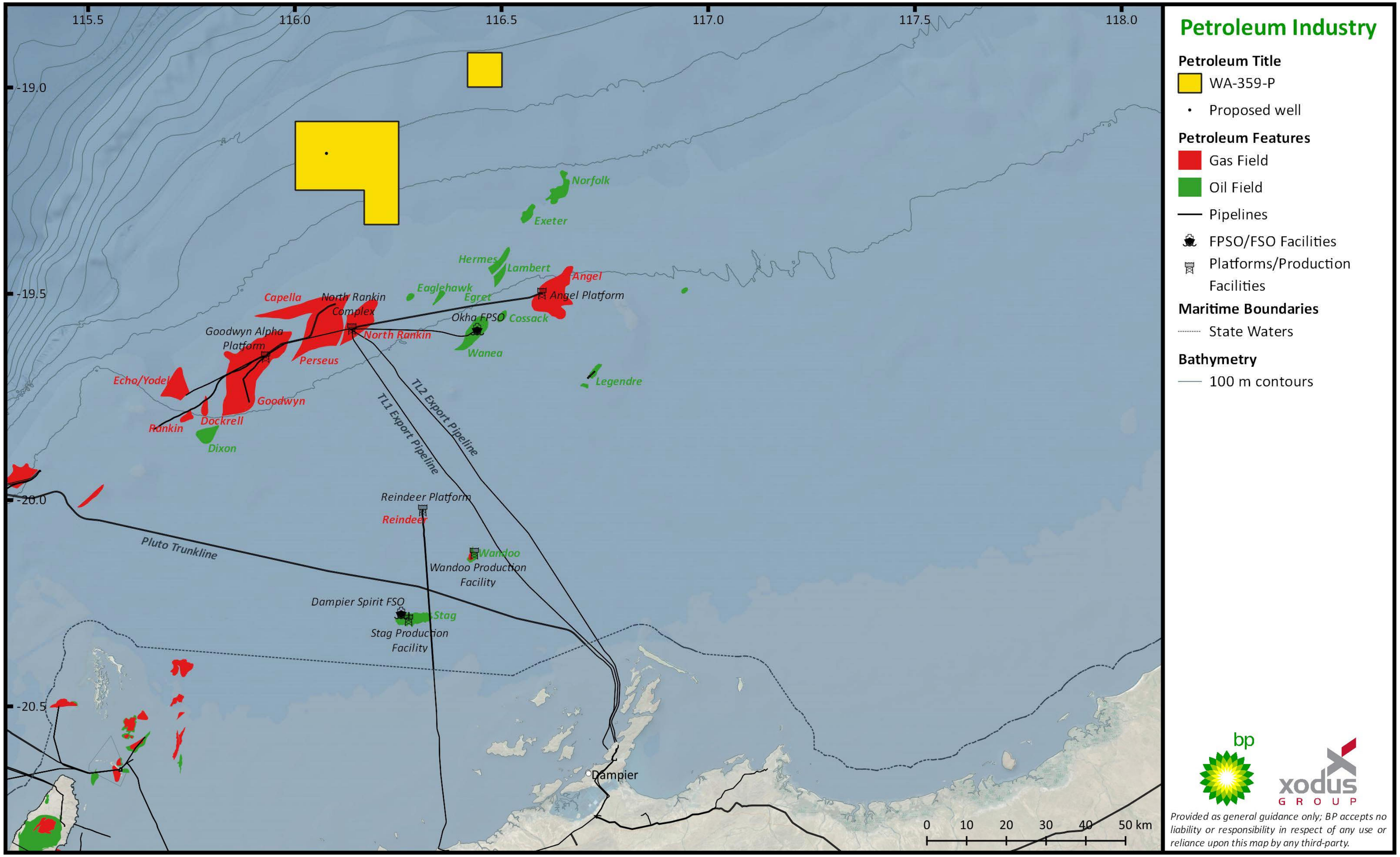


Figure 3-28: Petroleum industry facilities and features

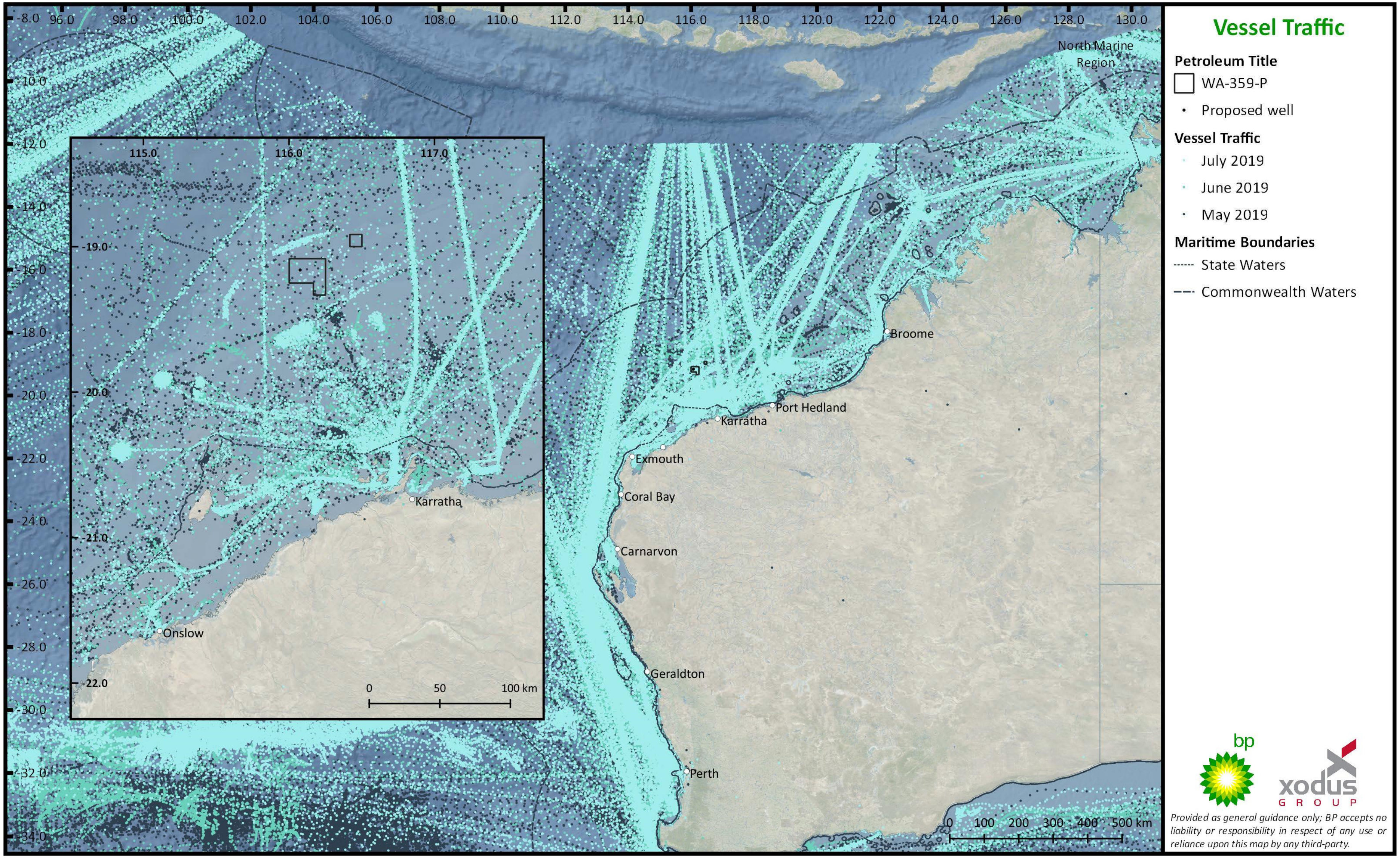


Figure 3-29: Commercial shipping traffic between May 2019 to July 2019

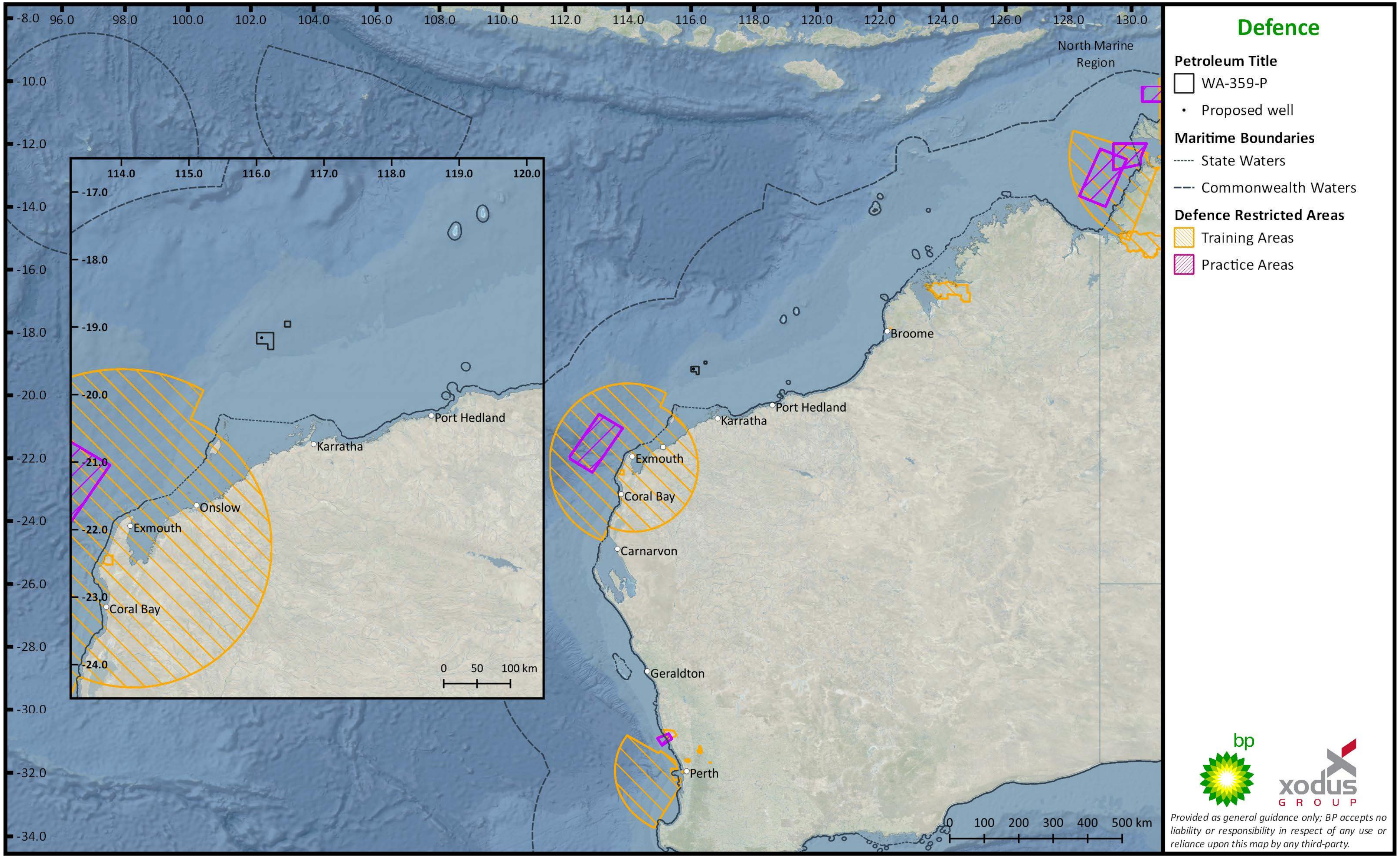


Figure 3-30: Defence training areas

3.4.8 Heritage and Cultural Features

There are a number heritage and cultural places and values that may be present within the EMBA; key features are further described below.

Table 3-26: Heritage and Cultural Features relevant to the Ironbark Exploration Drilling Program

Feature	EMBA	Operational Area	Hydrocarbon Exposure Area
World Heritage Properties			
The Ningaloo Coast	x	-	x
Shark Bay	x	-	-
Komodo National Park	x	-	-
National Heritage Properties			
The West Kimberley	x	-	-
The Ningaloo Coast	x	-	x
Shark Bay	x	-	-
Batavia Shipwreck (Houtman Abrolhos)	x	-	-
HMAS Sydney II and HSK Kormoran Shipwreck Sites	x	-	-
Commonwealth Heritage Places			
Ashmore Reef National Nature Reserve	x	-	x
Christmas Island Natural Areas	x	-	-
Scott Reef and Surrounds (Commonwealth area)	x	-	x
Mermaid Reef – Rowley Shoals	x	-	x
Ningaloo Marine Area (Commonwealth waters)	x	-	x
HMAS Sydney II and HSK Kormoran Shipwreck Sites	x	-	-
Garden Island	x	-	-
Aboriginal Heritage Places			
Registered sites	x	-	-
Indigenous Protected Areas			
State terrestrial protected areas that are proclaimed as Indigenous Protected Areas	x	-	-
Underwater Cultural Heritage			
Historic shipwrecks (>75 years)	x	-	x

Shipwrecks	x	-	x
Sunken aircraft	x	-	-
In-situ artefact	x	-	-

x = present within area; - = not present within area

The EPBC Act enhances the management and protection of Australia's heritage places, and provides for listings under three categories:

- World Heritage places considered as the best examples of world cultural and natural heritage and that have been included in the World Heritage List or declared by the Minister to be a World Heritage property
- National Heritage places, with natural, historic or Indigenous heritage value
- Commonwealth Heritage places with natural, historic or Indigenous heritage value on Commonwealth lands and waters.

3.4.8.1 World Heritage Properties and National Heritage Places

World Heritage Properties and National Heritage Places are both listed as MNES under the EPBC Act. There are three World and five National heritage places within the EMBA. The closest World and National heritage areas to the Ironbark Exploration Drilling Program is Ningaloo Coast, approx. 320 km from the indicative well location. A summary of the description and values of these heritage areas is provided below.

Ningaloo Coast

The Ningaloo Coast is recognised as both a World Heritage Area (WHA) and included on both the National and Commonwealth Heritage lists. The area includes both land and State and Commonwealth marine waters.

The Ningaloo Coast includes both a marine component (which is dominated by the Ningaloo Reef) and a land component (which extends into the limestone karst system of Cape Range). Values of the Ningaloo Coast are varied and include physical, biotic, and historic attributes. Together Ningaloo Reef and Cape Range, along with related interdependent marine and terrestrial ecosystems, form a functionally integrated limestone structure (DotEE, 2019c). The Ningaloo Coast is important in several ways:

- Biologically, through the combination of high terrestrial endemism and a rich marine environment
- Structurally, as a large nearshore coral reef off a limestone karst system
- Climatically, for the juxtaposition of a tropical marine setting and an arid coast
- Topographically, as a barrier reef lying alongside a steep limestone range.

The Ningaloo Coast has a high level of terrestrial species endemism and high marine species diversity and abundance (UNESCO, 2019).

The waters of the Ningaloo Coast include a diversity of habitats including reef, open ocean, estuaries and mangroves. The most dominant marine habitat is the Ningaloo Reef, which supports both tropical and temperate marine fauna and flora. Approximately 300–500 whale sharks aggregate annually coinciding with mass coral spawning events and seasonal localised increases in productivity (UNESCO, 2019).

The main terrestrial feature of the Ningaloo Coast is the extensive karst system and network of underground caves and water courses of the Cape Range (UNESCO, 2019). The karst system includes hundreds of separate features such as caves, dolines and subterranean water bodies and supports a rich diversity of highly specialized subterranean species. Above ground, the Cape Range Peninsula belongs to an arid ecoregion recognized for its high levels of species richness and endemism, particularly for birds and reptiles (UNESCO, 2019).

3.4.8.2 Commonwealth Heritage Places

There are seven Commonwealth Heritage listed places in the EMBA. The closest Commonwealth heritage place is Mermaid Reef (Rowley Shoals), approximately 320 km from the indicative well location.

Mermaid Reef Marine National Nature Reserve

Mermaid Reef Marine National Nature Reserve (Mermaid) surrounds Mermaid Reef, which is located about 290 kilometres north-west of Broome, Western Australia. Mermaid is located near the edge of Australia's continental slope and is surrounded by waters that extend to a depth of more than 500 metres.

Mermaid Reef is the most north-easterly of three reef systems forming the Rowley Shoals. Mermaid Reef is totally submerged at high tide and therefore falls under Australian Government jurisdiction. The other two reefs of the Rowley Shoals (Clerke Reef and Imperieuse Reef) are managed by the Western Australian Government as the Rowley Shoals Marine Park.

The Rowley Shoals, including Mermaid Reef, have an abundance and variety of marine wildlife that is in a relatively undisturbed condition, as well as spectacular and unusual underwater topography. Mermaid Reef is the most north-easterly of the reef systems of the Rowley Shoals. All three of the reefs are similar in shape, size, orientation and distance from each other. Each has a large lagoonal area containing small sand cays or islands, narrow lagoon entrance channels on the eastern side and an outer reef edge dropping off relatively steeply into oceanic waters between depths of 500–700 metres. Oval in shape, the reefs follow a south-west to north-east alignment along the edge of the continental shelf and lie 30–40 kilometres apart. The three reefs of the Rowley Shoals have been described as some of the best examples of shelf-edge reefs occurring in Australian waters.

Mermaid Reef is considered the 'youngest' of the three reefs, each of which shows a different stage in the development of a shelf atoll reef. There is no permanent land at Mermaid but a large sand bank near the northern edge of the lagoon and a series of small banks to the west become exposed at low tides.

These sandbanks are thought to be important resting sites for migratory birds. Nineteen species have been sighted at the Rowley Shoals and three of these are known to breed on Bedwell and Cunningham islands in the nearby Rowley Shoals Marine Park (under Western Australian jurisdiction).

The Rowley Shoals, including Mermaid Reef, are thought to be sites of enhanced biological productivity, as breaking internal waves cause mixing and the resuspension of nutrients in surface waters. The area supports a great variety of marine species in a relatively undisturbed condition. A number of species are at the limit of their distribution, and some are found nowhere else in Western Australia.

Ashmore Reef National Nature Reserve

Ashmore Reef National Nature Reserve covers 583 km^2 and includes two extensive lagoons, shifting sand flats and cays, seagrass meadows and a large reef flat covering an area of 239 km^2, as well as three small islands known as East, Middle and West islands.

Ashmore Reef National Nature Reserve supports large numbers of marine species including sea snakes, dugongs, reef-building corals, fish and other marine invertebrate fauna. The reserves also provide important nesting sites for seabirds and marine turtles and provide staging points and feeding areas for large populations of migratory shorebirds.

Ashmore Reef National Nature Reserve has a high diversity (over 255 species) of reef-building and non-reef building corals. There are three species of mollusc that are only found at Ashmore (*Amoria spenceriana, Cymbiola baili* and *Conus morrisoni*). Recent research has indicated that the total number of fish species at Ashmore Reef National Nature Reserve may be as high as 650 species.

It is estimated that Ashmore Reef National Nature Reserve supports approximately 11,000 marine turtles, including significant populations of green, loggerhead and hawksbill turtles. The Ashmore population of green turtles is genetically distinct from the other two breeding populations in the region.

Ashmore Reef National Nature Reserve also supports a small dugong population of less than 50 individuals. It is thought that this population is genetically distinct from other Australian populations and the extent to which this population interacts with Indonesian populations is unknown. It is possible that the population’s range extends to Cartier and other submerged shoals in the region.

It is estimated that before 2,000 there were 40,000 sea snakes from at least 13 species present at Ashmore Reef National Nature Reserve, representing the greatest number of sea snake species recorded globally. Three of the species at Ashmore are endemic to Australia’s North West Shelf. Recent research has shown a decline in sea snakes at Ashmore Reef National Nature Reserve.

Ningaloo Marine Park (Commonwealth waters)

Ningaloo Marine Park (Commonwealth waters) stretches approximately 300 kilometres along the west coast of the Cape Range Peninsula near Exmouth, Western Australia, approximately 1,200 kilometres north of Perth. The total area of the reserve is 2,435 square kilometres. Ningaloo Reef, the longest fringing barrier reef in Australia, and the only example in the world of extensive fringing coral reef on the west coast of a continent, is adjacent to the reserve and is protected by the Ningaloo Marine Park (State waters), which lies between the reserve and the WA coast. The combined state and Commonwealth waters of the Ningaloo Marine Park cover a total area of 5,070 square kilometres.

The reserve is located in a transition zone between tropical and temperate waters and sustains tropical and temperate plants and animals, with many species at the limit of their distribution. The reserve’s water depths range from a relatively shallow 30 metres to oceanic waters more than 500 metres.

Ningaloo Marine Park (Commonwealth waters) has a diverse range of marine species and unique geomorphic features. The reserve provides essential biological and ecological links that sustain Ningaloo Reef, which occurs in the state waters of the Ningaloo Marine Park, including the supply of nutrients to reef communities from deeper waters further offshore.

Whales are a major feature of the reserve, with humpback whales migrating through twice a year on their annual migration between calving grounds off the Kimberley and feeding grounds in Antarctica.

Blue and sperm whales have been observed in the offshore regions of the reserve as have minke, Bryde's, southern right and killer whales. Dolphins are also relatively common in the reserve.

The reserve is recognised internationally for its annual aggregations of whale sharks. It is thought that between 300 and 500 whale sharks visit each year. Aggregations generally occur between March and June, coinciding with mass coral spawning events and seasonal localised increases in productivity.

Scott Reef and Surrounds (Commonwealth area)

Scott and Seringapatam Reefs is a group of atoll-like reefs in the Timor Sea, on the edge of the continental shelf. Scott Reef comprises several reef formations, totalling approximately 250 km^2. Seringapatam Reef, located north of Scott Reef, is an egg-shaped reef, with a total area of approximately 50 km^2. Values and sensitivities of the Scott and Seringapatam reef complex have been described in Section 3.4.3.

HMAS Sydney II and HSK Kormoran Shipwreck Sites

The shipwrecks of HMAS Sydney II and HSK Kormoran and associated debris fields are located 290 kilometres west south west of Carnarvon, off the coast of Western Australia in 2,500 metres of water.

HMAS Sydney II sank after a battle with the German raider HSK Kormoran off the Western Australian coast on the 19 November 1941. HMAS Sydney II was Australia's most famous warship of the time and this battle has forever linked the stories of these warships to each other.

3.4.8.3 Underwater Cultural Heritage Sites

Australia's underwater cultural heritage is protected under the Underwater *Cultural Heritage Act 2018*; this legislation protects shipwrecks, sunken aircraft and other types of underwater heritage. There are numerous (>1,500) known shipwreck and historic (>75 years old) shipwreck sites listed to occur within Commonwealth waters offshore WA, as listed in the Australasian Underwater Cultural Heritage Database, including The *Batavia*, wrecked in 1629 offshore from the Houtman Abrolhos Islands, the *HSK Kormoran* and the *HMAS Sydney II*, sunk in 1941. There are also records of sunken aircraft and in-situ artefact within the EMBA, namely:

- RAAF B-24 Liberator A72-80, sunk north of Kalumburu in the Kimberley.
- DC3 PK-AFV Pelikaan, sunk in Carnot Bay, north of Broome in 1942.
- Eight aircraft, sunk in Roebuck Bay in 1942.
- Dornier Do-24-X-36, sunk off Eighty Mile Beach in 1942.
- Unidentified in situ artefact off Point Samson.

Some underwater cultural heritage sites are also within a declared protection zone, where entry and/or activities may be restricted; three of these occur within the EMBA and are associated with historic shipwrecks: *HSK Kormoran*, *HMAS Sydney II*, and *Zuytdorp*.

3.4.8.4 Other Heritage Values of Relevance to the EMBA

Aboriginal heritage sites in WA are protected under the *Aboriginal Heritage Act 1972*, whether or not they are registered with the Department of Planning, Lands and Heritage (DPLH). Those that have been formally registered with the DPLH are shown on Figure 3-31 are recognised for a variety of reasons including artefacts, middens, meeting places, hunting places, engravings or mythological significance. While sea country is a recognised value, the registered site list is land-based sites.

Indigenous Protected Areas (IPA) are a component of the National Reserve System, which is the formally recognised parks, reserves and protected areas across Australia. Indigenous Protected Areas are areas of land and sea country owned or managed by Indigenous groups, which are voluntarily managed as a protected area for biodiversity conservation through an agreement with the Australian Government. The following IPAs intersect the EMBA:

- The Dambimangari IPA spans 14,000 km^2 of country in the Buccaneer Archipelago, within the Dambimangari native title area.
- The Bardi Jawi IPA covers 950 km^2 of land and sea country on the Dampier Peninsula.
- The Yawuru IPA covers over 1,279 km^2. The IPA includes parts of the Yawuru Conservation Estate comprising Nagulagun Roebuck Bay Marine Park and the Birragun Coastal Conservation Park (KLC, 2019).
- the Nyangumarta Warrarn IPA extends across four areas, totalling 28,675 km^2: Proposed Walyarta Conservation Reserve, Proposed Kujungurru Warrarn Conservation Reserve Area, the Great Sandy Desert and Eighty Mile Beach Marine Park (Yamatji Marlpa Aboriginal Organisation 2015).

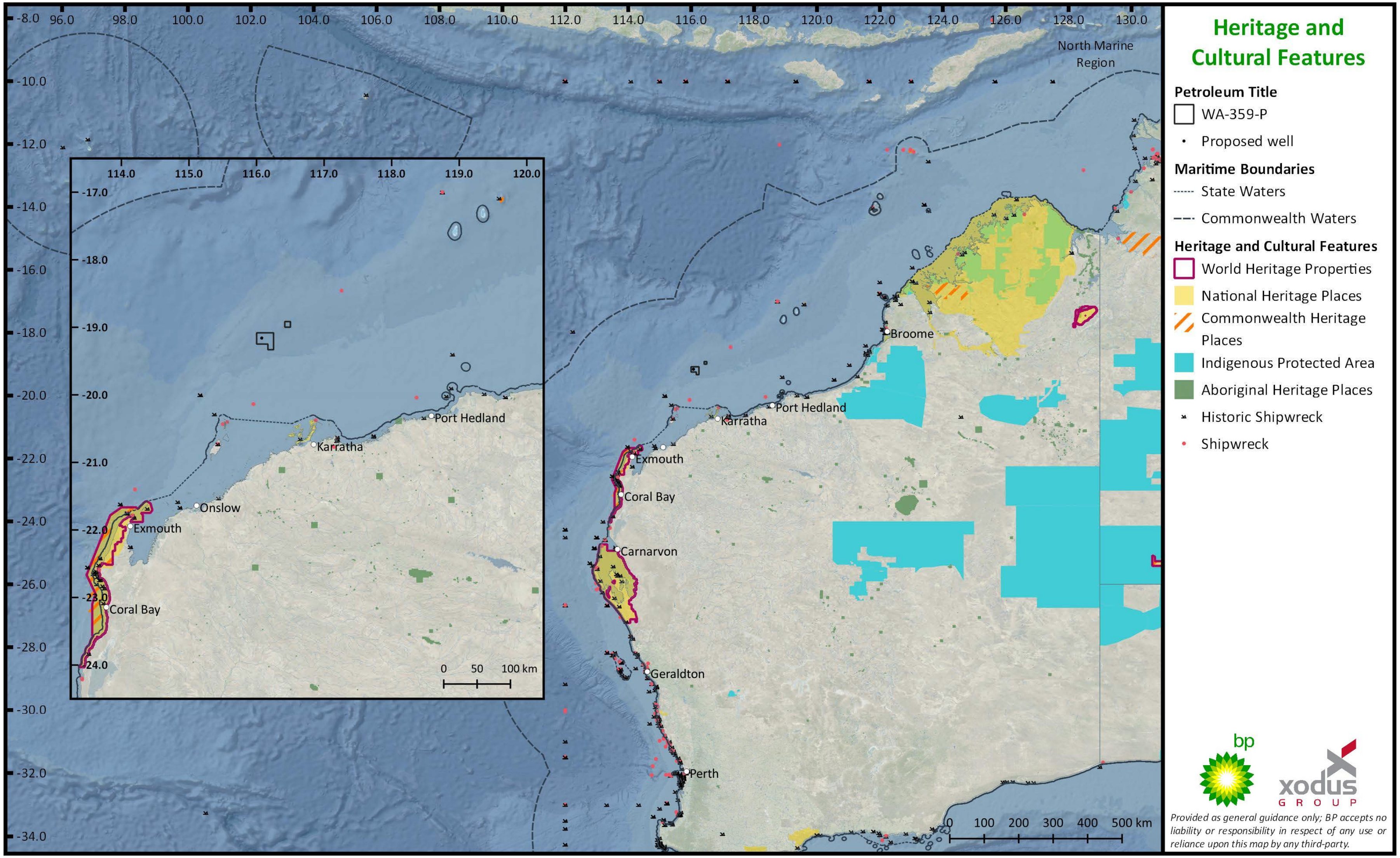


Figure 3-31: Cultural and heritage features

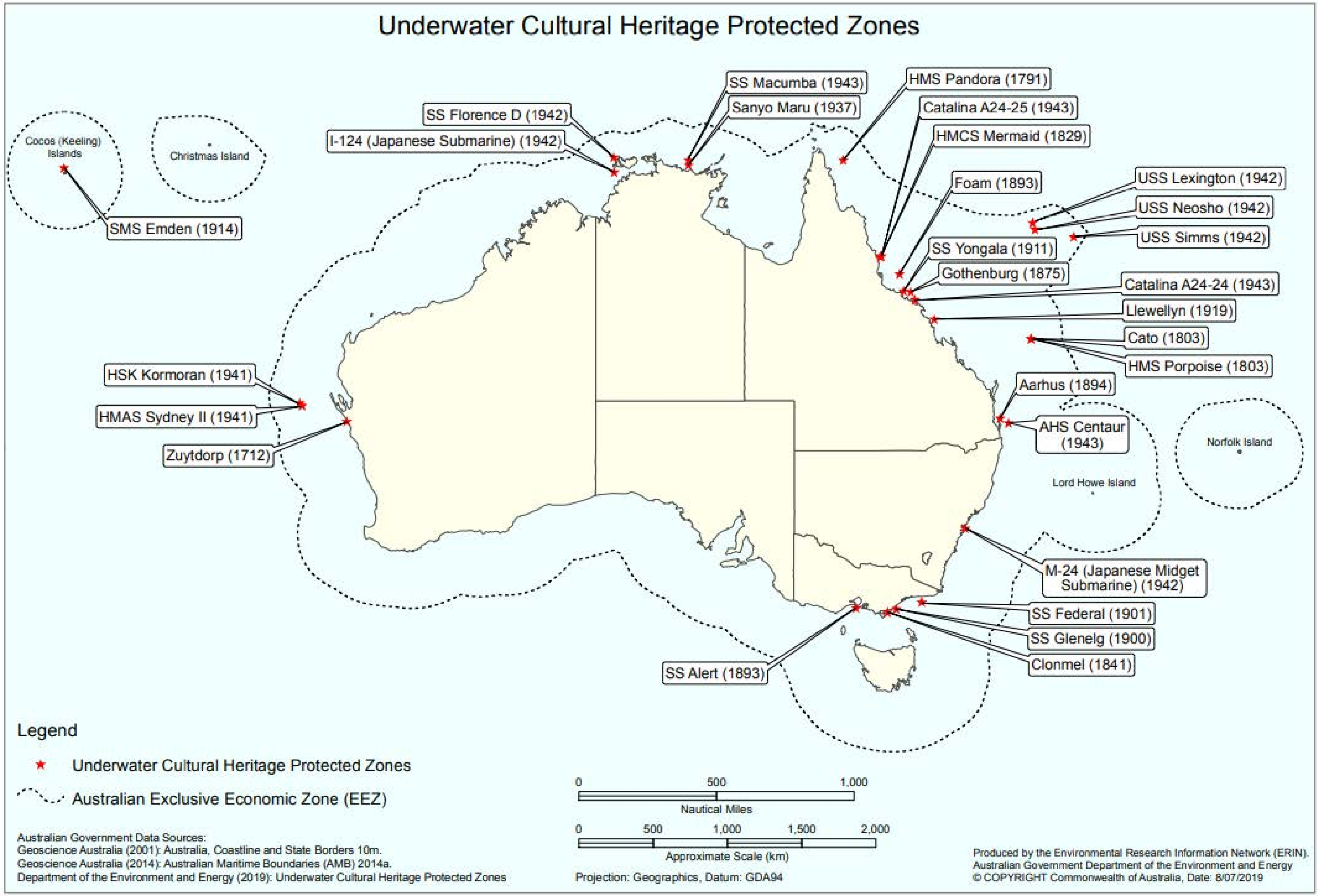


Figure 3-32: Underwater Cultural Heritage Protected Zones

4 Environmental Impact and Risk Evaluation

This section describes the environmental impact and risk assessment methodology employed for the drilling program. The method presented below follows the approach outlined in ISO 31000:2018 (Risk management - Guidelines) and HB203:2012 (Managing environment-related risk). Figure 4-1 illustrates the process adopted for identifying and managing impacts and risks associated with BP's drilling program.

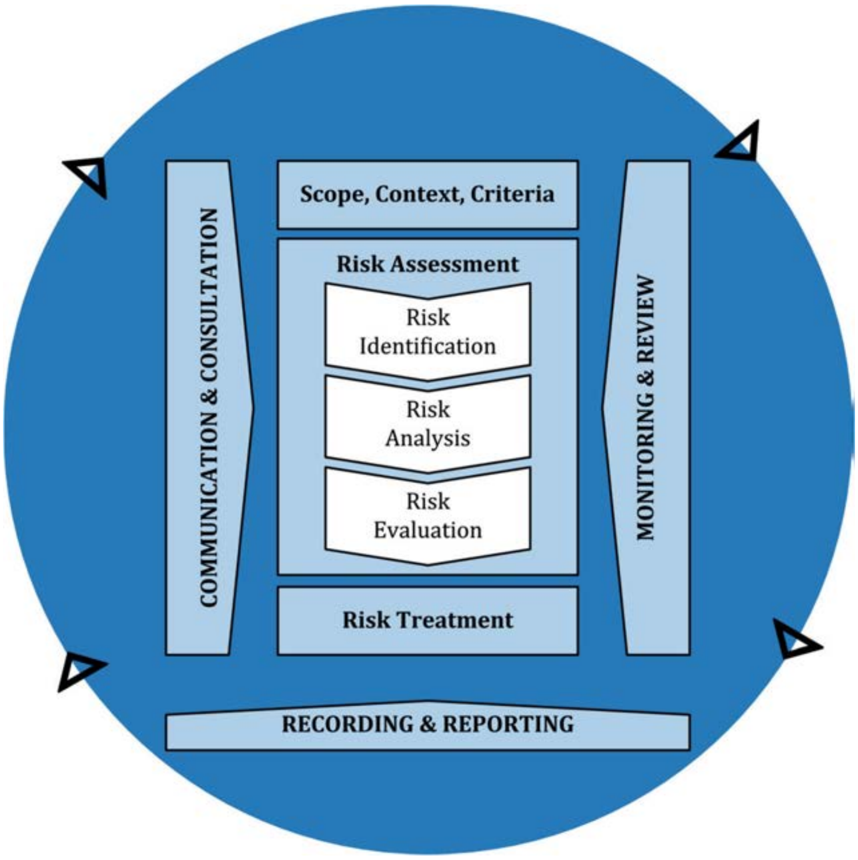


Figure 4-1: ISO 31000:2018 – Risk Management Process

4.1 Impact and Risk Assessment Methodology

For the drilling program, environmental aspects, impacts and risks have been identified and assessed in accordance with HB203:2012 (Managing environment-related risk). This process is consistent with the approach used within BP to:

a) Identify environmental aspects and impacts and risks associated with planned activities and potential unplanned events, respectively. For planned activities, assess the significance of the impacts. For potential unplanned events, prioritise such that they can be further evaluated through the risk process.
b) Identify and validate safeguards that are in place.
c) Identify areas of design, processes and/or activities that can be changed or modified to eliminate or further mitigate environmental impacts and risks.

d) Recommend actions (that can include undertaking further assessment) to eliminate or further mitigate impacts and risks.

In accordance with HB203:2012, BP has systematically identified environmental impacts and risks such that:

- 'Impacts' are from planned activities, and
- 'Risks' are associated with unplanned events.

To gain understanding and provide information and data to make informed decisions, BP has applied different assessment criteria for impacts from planned activities and risks associated with unplanned events:

- 'Impact assessments' are concerned with events that are reasonably certain to occur therefore only the impact severity for the impact is assessed. This type of assessment is used for all planned activities described in Section 5.
- 'Risk assessment' is concerned with events that may possibly occur therefore a risk assessment considers the likelihood and impact severity to determine the resultant risk ranking. This type of assessment is used for all unplanned events described in Section 6.

The OPGGS(E)R require the Environment Plan to detail all the environmental impacts and risks for the activity; and evaluate these impacts and risks appropriate to the nature and scale of each impact or risk.

In Table 4-1, BP has provided a list of terminology and definitions that is used by BP and in this EP to meet the requirements of the OPGGS(E)R.

Table 4-1: Defined Terms

Term	Definition
BP's Impact and Risk Management Terminology	
Operating condition	The state of activities at the facility. Each activity may be undertaken under normal, abnormal or emergency situations. Normal activity relates to planned, routine operations. Abnormal activity includes planned, non-routine operations, such as maintenance and shutdowns. Emergency conditions are unplanned events which can give rise to a situation that can threaten human life, environment, property and operational continuity, and requires intervention.
Aspect	Element of an organisation's activities that can interact with the environment.
Impact	Change to the environment, whether adverse or beneficial, wholly or partially resulting from planned activities (normal and abnormal conditions) or unplanned events (emergency conditions). In the latter case, this refers to risk.
Impact severity level	The nature, scale and duration of change to the environment resulting from planned activities and unplanned events. The degree of change (negligible, minor, moderate, major, catastrophic) is used to select and prioritise impact management strategies.
Likelihood	Probability of the consequence from a risk event happening (e.g. probability of a severe injury or death of a cetacean from a vessel strike during the drilling program)
Risk level	Function of the impact severity and likelihood, used to select and prioritise risk management strategies

Term	Definition
Cost	Cost in the context of ALARP is to mean the sacrifice required for implementing a control measure which includes an impost such as the money, time, or health and safety risks and other environmental impacts of implementing a particular control measure. Environmental cost may also be a cost in some circumstances e.g. dispersant use on an oil spill (NOPSEMA 2018).
Nature	'Nature' means the basic or inherent features, character, or qualities of the activity considered in the context of the environmental setting (NOPSEMA 2018).
Scale	'Scale' means the comparative or proportionate magnitude, size, extent of the activity considered in the context of its impact and risks (NOPSEMA 2018).
Planned activity	Components of the activity as described in the activity description (Section 2).
Unplanned event	Unintended incident as a result of the activity or component of the activity not described in the activity description (Section 2).
Duration	Timeframe of the impact as a result of the planned activity or unplanned event.
Extent and Severity Definitions Used in this EP	
Localised / immediate area	The extent of a localised (or immediate) area is limited to the Operational Area (per Section 2.1) only.
Medium area	The extent of a medium area is limited to an area within 10 km of the Operational Area.
Large / extensive area	The extent of a large (or extensive) area is an area beyond 10 km of the Operational Area.
Widespread area	The widespread area corresponds to an extent at a regional scale.
Sensitive environment	A "sensitive" environment is defined either as: 1. An area, species or habitat considered a particular value or sensitivities as defined by Regulation 13(3) of the OPGGS(E)R, 2. An area that supports a moderate number of businesses (that forms a local economy), 3. An area that supports high numbers of tourists. 4. An area that supports communities with moderate populations, or 5. National and World Heritage areas,
Regulation 4 of the OPGGS(E)R	
Control Measure	A system, an item of equipment, a person or a procedure, that is used as a basis for managing environmental impacts and risks.
Environmental Performance Outcome	Environmental performance outcome means a measurable level of performance required for the management of environmental aspects of an activity to ensure that environmental impacts and risks will be of an acceptable level.
Environmental Performance Standard	Environmental performance standard means a statement of the performance required of a control measure.

The impact assessment and risk assessment processes both involve seven key stages:

- Stage 1 – Activity definition (Section 4.1.1),
- Stage 2 – Aspect and impact identification (Section 4.1.2),
- Stage 3 – Identification of inherent / design control measures (Section 4.1.3),
- Stage 4 – Impact and risk evaluation (Section 4.1.4),
- Stage 5 – Identification of control measures and 'as low as reasonably practicable' (ALARP) (Section 4.1.5).

- Stage 6 – Acceptability assessment (Section 4.1.6)
- Stage 7 – Environmental performance management (Section 4.1.7)

For Stages 1 to 5, the drilling engineering team were consulted through an iterative process to define each stage as appropriate.

4.1.1 Stage 1 – Activity Definition

For the purposes of this EP, the defined scope of this petroleum activity is exploration drilling activities as detailed in Section 2. These scopes were then broken down to understand the relevant systems and system related activities. These then were evaluated to determine the operational condition and events that could arise from their implementation.

4.1.2 Stage 2 – Aspect and Impact and Risk Identification

Each activity was then screened by a multidisciplinary team with relevant experience to identify the environmental aspects and whether these aspects result in either an impact or risk. The multidisciplinary team involved in screening the Ironbark exploration drilling activity included specialists in a range of disciplines including: wells and drilling engineering, regulatory, fluids and cementing, drilling waste & discharges, logistics and infrastructure, environment, community engagement, emergency response, rig operations and health and safety.

The multidisciplinary team also considered the potential of cumulative impacts (refer to cumulative impact assessment sub-section below). Impacts are identified based on the aspect being considered, details of the source of the hazard, pathway and presence of sensitive receptors.

4.1.3 Stage 3 – Identification of Inherent / Design Control Measures

As per HB203:2012, once the environmental impacts and risks were identified, control measures that were considered inherently part of the activity or program design were identified. Evaluating the effectiveness of inherent controls is part of the analysis process. Whilst identifying inherent or verified design control measures for this activity, BP also identified those Good Practice control measures that will apply (refer Section 4.1.5).

4.1.4 Stage 4 – Impact Assessment / Risk Assessment

For each planned impact arising from normal and abnormal operating conditions, an assessment of impact severity was undertaken against the defined impact severity levels detailed in Table 4-2.

For each unplanned event an assessment of the risk was undertaken, considering the impact severity level against the likelihood of the impact severity level occurring. This was completed having regard to the severity of impacts (Table 4-2), likelihood of impact severity occurring (Table 4-3) then assigning a risk level (Table 4-4).

Where the general impact severity level definitions are not applicable to the potential impact or risk, professional judgement from the relevant multidisciplinary team was used to determine the impact severity level. Details on impact severity level justification is provided in Sections 5 and 6.

Table 4-2: Impact Severity Levels (Planned Activities and Unplanned Events)

Value	Impact Severity Level				
	1 Negligible	**2 Minor**	**3 Moderate**	**4 Major**	**5 Catastrophic**
Environmental	Alteration or disturbance to an immediate area that is unlikely to affect the sensitive environments. Immediate area affected is restored in a period of days or weeks (<30 days)	Alteration or disturbance to a localised area where less than 5% of a sensitive environment is affected. Localised area affected is restored within one year.	Alteration or disturbance to medium area where 5-30% of a sensitive environment is affected. Medium area affected is restored within one to two years.	Alteration or disturbance to large area where 30-70% of a sensitive environment is affected. Large area affected is restored within two to five years.	Alteration or disturbance to widespread area where more than 70% of a sensitive environment is affected. Widespread area affected is restored in a period of greater than five years.
Socio-economic	Negligible impact to communities, workers or cultural heritage. Example: • Community disturbance impact e.g. lighting.	Minor negative impacts to communities, workers or cultural heritage: Example: • Community disturbance impact e.g. noise, vibration.	Moderate negative impacts to communities, workers or cultural heritage: Example: • Damage or exclusion to fisheries, causing short term disruption to fishing activities.	Major negative impacts to communities, workers or cultural heritage: Example: • Damage or exclusion to fishing area, resulting in medium term suspension of fishing activity.	Catastrophic negative impacts to communities, workers or cultural heritage: Example: • Long term widespread damage or exclusion to fishers.

Table 4-3: Likelihood of occurrence (Unplanned event)

Rating level	Descriptor	Frequency	Probability
A	Rare	Once in 15 years or less	Highly unlikely but may occur in exceptional circumstances. It could happen but most probably never will.
B	Unlikely	At least once in 10 years.	Not expected but there is a slight possibility it may occur at some time.
C	Possible	At least once in 3 years.	This event might occur at some time as there is a history of casual occurrence of similar issues with past BP activities or other operator activities.
D	Likely	At least once per year.	There is a strong possibility the event will occur as there is a history of frequent occurrence with past activities internally or externally.
E	Almost certain	More than once per year.	The event is expected to occur at some time as there is a history of continuous occurrence with past activities internally or externally.

Table 4-4: Risk Matrix (Unplanned events)

Impact Severity						
	5 Catastrophic					
	4 Major					
	3 Moderate					
	2 Minor					
	1 Negligible					
		A	**B**	**C**	**D**	**E**
	Likelihood					

	Low risk level
	Medium risk level
	High risk level
	Very High risk level

Cumulative Impacts Assessment

As cumulative impacts are also required to be considered under the OPGGS(E)R, BP applies a cumulative assessment process consistent with the guidelines detailed in Hegmann et al (1999), as follows:

1. Determine if the drilling program will have an impact or risk on values and sensitivities of the region.
2. Determine if the identified impact or risk may act cumulatively with similar impacts or risks associated with third-party activities, either past, existing or reasonably foreseeable in the future.
3. Determine if the impacts or risk of the drilling program, in combination with other impacts or risks associated with different aspects of the project or other activities, may cause a significant change now or in the future in the values and sensitivities of the region after the application of mitigation measures for the drilling program.

4.1.5 Stage 5 – Identification of Control Measures and ALARP

The process for identifying control measures depends on the 'as low as reasonably practicable' (ALARP) decision context set for that particular aspect. Regardless of the process, control measures are assigned according to defined environmental performance outcomes, with the objective to eliminate, prevent, reduce, or mitigate potential impacts associated with each identified environmental impact and risk.

In alignment with NOPSEMA's ALARP Guidance Note (GN0166), BP has adapted the approach developed by Oil and Gas UK (OGUK 2014) for use in an environmental context to determine the assessment technique required to demonstrate that potential impacts and risks are ALARP (Figure Figure 4-2).

Specifically, the framework considers an 'ALARP Decision Context' as a function of impact severity and several guiding factors:

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

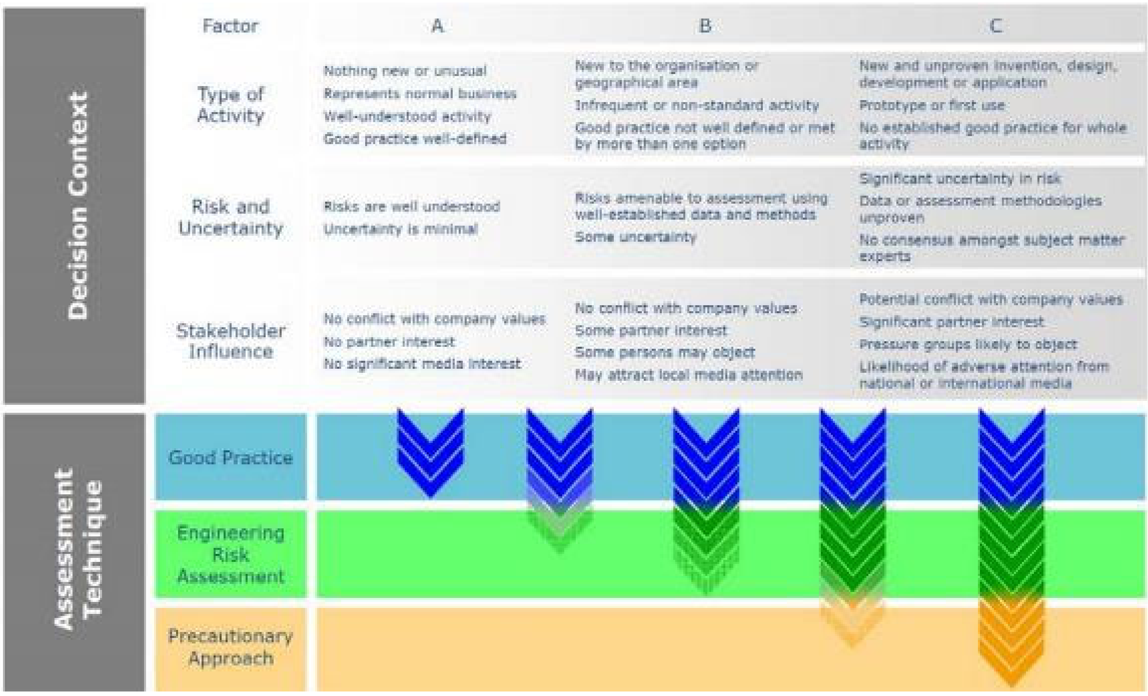


Figure 4-2: ALARP decision support framework (NOPSEMA, 2015)

In accordance with the regulatory requirement to demonstrate that environmental impacts and risks are ALARP, BP has considered the above decision context in determining the level of assessment required, and applied it to each aspect described in Section 5, in accordance with the definitions provided in Table 4-5.

Table 4-5: BP's ALARP Decision Support Approach

ALARP Decision	Context	Impact or Risk Ranking Concordance
Type A decision	The impact or risk is relatively well understood, the impact or risk is **low**, activities are well practiced, and there is no significant stakeholder interest. However, if good practice is not sufficiently well-defined, additional assessment may be required	BP has defined a **low** impact level for planned aspects where an impact severity level has been ranked "**Negligible**" or "**Minor**" (Table 4-2). BP has defined a **low** risk level for unplanned events where a risk level has been ranked "**Low**" (Table 4-4).
Type B decision	There is greater uncertainty or complexity around the activity, impact and/or risk, the impact or risk is **moderate**, and the impact or risk generates several concerns from stakeholders. In this case, established good practice is not considered sufficient and further assessment is required to	BP has defined a **moderate** impact level for planned aspects where an impact severity level has been ranked "**Moderate**" (Table 4-2). BP has defined a **moderate** risk level for unplanned events where a risk level has been ranked "**Medium**" (Table 4-4).

ALARP Decision	Context	Impact or Risk Ranking Concordance
	support the decision and ensure the impact or risk is ALARP.	
Type C decision	There is sufficient complexity, the impact or risk is high, uncertainty, or stakeholder interest to require a precautionary approach. In this case, relevant good practice still has to be met, additional assessment is required, and the precautionary approach applied for those controls that only have a marginal cost benefit.	BP has defined a high impact level for planned aspects where an impact severity level has been ranked "**Major**" or "**Catastrophic**" (Table 4-2). BP has defined a high risk level for unplanned events where risk level has been ranked as "**High**" or "**Very High**" (Table 4-4).

The assessment techniques considered as part of the ALARP decision support framework are described in the following subsections and include:

- Good practice,
- Engineering risk assessment,
- Precautionary approach.

Good Practice

OGUK (2014) defines 'Good Practice' as:

> *The recognised risk management practices and measures that are used by competent organisations to manage well-understood hazards arising from their activities.*

'Good Practice' can also be used as the generic term for those measures that are recognised as satisfying the law. For this EP, sources of good practice include:

- Requirements from Commonwealth and State legislation and regulations,
- Relevant Commonwealth and State policies,
- Relevant Commonwealth and State guidance,
- Relevant industry standards,
- Relevant international conventions.

If the ALARP technique is determined to be 'Good Practice', further assessment ('Engineering Risk Assessment'; see subsection below) is not required to identify additional controls. This is because the implementation of control measures implemented as part of ensuring Good Practice are inherently ALARP. However, additional controls that provide a suitable environmental benefit for an insignificant cost are identified.

Engineering Risk Assessment

All impacts and risks that require further assessment are subject to an engineering risk assessment. Based on the various approaches recommended by OGUK (2014), the methodology suited to this activity is a comparative assessment of impacts or risks, costs, and environmental benefit. Reducing impacts and risks to ALARP is based on the concept of reasonable practicability; the weighing up of the magnitude of impact or risk reduction against the cost of that reduction (NOPSEMA 2018). A cost–benefit analysis should show the balance between the risk benefit (or environmental benefit) and the cost of implementing the identified measure, with differentiation required such that the benefit of the risk or impact reduction measure can be seen and the reason for the benefit understood. Cost benefit analysis is a numerical assessment of the costs of implementing a control measure and the likely reduction in impact or risk that this would be expected to achieve. The quality of the modelling or the data will affect the robustness of the numerical estimate and the uncertainties must be considered when using the estimate in defining control measures. In making this assessment there is a need to set criteria on the environmental values or implied cost of averting a potential impact or risk. There is no simple cut-off and a whole range of factors, including uncertainty need to be taken into account in the decision-making process (NOPSEMA 2017).

Precautionary Approach

NOPSEMA states that if an impact or risk assessment identifies both a:

> *"threat of serious or irreversible environmental damage and scientific uncertainty as to the environmental damage, there is a need to apply the precautionary principle"* (NOPSEMA 2018).

A 1998 consensus statement by Raffensperger et al. (1999 cited in Kriebel et al. 2001) defined the precautionary approach as:

> *"when an activity raises threats of harm to … the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically".*

The statement went on to list four central components of the principle:

- Taking preventive action in the face of uncertainty,
- Shifting the burden of proof to the proponents of an activity,
- Exploring a wide range of alternatives to possibly harmful actions, and
- Increasing public participation in decision making.

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

4.1.6 Stage 6 - Acceptability Assessment

In summary, BP applies the following process in determining acceptability:

- Impacts from planned activities and risks from unplanned events that are ranked as Decision Context Type A (Table 4-5) are considered inherently acceptable as it is assumed that ALARP has been achieved and no further evaluation is required.
- Impacts from planned activities and risks from unplanned events that are ranked as Decision Context Type B or C are considered acceptable once impacts and risks are demonstrated to be reduced to ALARP (via the evaluation of additional control measures) and the following have been considered:
  - Principles of ecologically sustainable development (ESD) (subsection below),
  - Legal and regulatory requirements,
  - Internal context, related to BP policies and standards,
  - External context, in particular whether stakeholder expectations have been addressed (refer to Section 7.11 for details on ongoing stakeholder engagement), and
  - Defined acceptable level of impact for planned aspects only (see subsection below).

This evaluation of acceptability generally aligns with guidance provided by NOPSEMA in demonstrating that impacts and risks will be of an acceptable level (NOPSEMA 2018). Further information regarding the application of the principles of ESD and a definition of an acceptable level of impact is provided in the following subsections.

Principles of Ecologically Sustainable Development

Under the EPBC Act, considerations for approving taking of actions (or in this case a petroleum activity) in accordance with a plan includes considering the principles of ESD. A description of how BP has considered the principles of ESD listed under the EPBC Act with regards to the drilling program is provided in Table 4-6.

Table 4-6: Consideration of Principles of ESD in Evaluation of Acceptability of Planned Activities and Unplanned Events

Principles of ESD	How They Have Been Applied
(a) decision-making processes should effectively integrate both long-term and short-term economic, environmental, social, and equitable considerations;	BP's impact and risk assessment process integrates long-term and short-term economic, environmental, social, and equitable considerations. This is demonstrated via Stage 4 – Impact Assessment / Risk (Section 4.1.4), which includes provision for understanding the potential long-term and short-term impacts associated with its activities, and the ALARP process that balances the economic cost against environmental benefit. As this principle is inherently met through the application of the EP assessment process, this principle is not considered separately for each evaluation.
(b) if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;	BP consider if there is the potential for serious or irreversible environmental damage when Impact Severity or Risk levels of "Catastrophic" or "Very High" are identified (Table 4-2and Table 4-4, respectively). Where this was identified, BP is required to assess if there is significant lack of scientific certainty about the potential impacts of a planned activity or unplanned event.
(c) the principle of inter-generational equity—that the present generation should ensure that the health, diversity, and productivity of the environment is maintained or enhanced for the benefit of future generations;	BP's impact and risk assessment methodology ensures that potential impacts and risks are reduced to levels that are considered ALARP. If the potential impacts and risks are determined to be serious or irreversible, the precautionary principle (Section 4.1.5) is implemented with the intent that potential impacts and risks are managed, and that the environment is maintained for the benefit of future generations. The precautionary principle is applied for all impacts and risks that are assigned an ALARP Decision Context Type C.
(d) the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision making;	As part of the impact and risk evaluation, BP considers if there is the potential to affect biological diversity and ecological integrity from the proposed activities; this assessment relates to all planned activities and unplanned events ranked to have impact severity of 'Major' and above.
(e) improved valuation, pricing, and incentive mechanisms should be promoted.	The consideration of environmental factors in the valuation of assets, goods and services forms part of the demonstration of financial assurance required under section 571(2) of the OPGGS Act.

Defining an Acceptable Level of Impact

In alignment with NOPSEMA's Environment Plan Decision Making Guideline (2019), BP has used the EPBC Act Significant Impact Guidelines to support the definition of an acceptable level of impact.

The EPBC Act Significant Impact Guidelines 1.2 (DSEWPaC 2013) provide a definition of 'the severity of an impact on Commonwealth land that may persist long after an action ceases or that may be irreversible'. The general test for significance is whether an impact is 'important, notable or of consequence, having regard to its context of intensity'. The Significant Impact Guidelines 1.2 (DSEWPaC 2013) state that a severe impact:

> *generally, has two or more of the following characteristics: permanent/ irreversible; medium–large scale; moderate–high intensity.*

Defined significant impacts to various receptor groups are detailed in Table 4-7. Impacts associated with the exploration drilling program that fall below these are considered acceptable.

Table 4-7: Significant Impact Levels to Receptor Groups

Receptor	Definition of Significant Impact	Source
Physical Environment		
Physical Environment - **water quality, sediment quality or air quality**	Substantial change in water quality, sediment quality or air quality which may adversely impact on biodiversity, ecological integrity, social amenity or human health.	MNES Significant guidelines for Commonwealth Marine Waters
Physical Environment - light and sound	Substantial change to ambient light or sound levels which may modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results.	MNES Significant guidelines for Commonwealth Marine Waters
Ecological Environment		
Habitat	Substantial change that may modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results.	MNES Significant guidelines for Commonwealth Marine Waters
Marine Fauna	Change that may have a substantial adverse effect on a population of marine fauna, including its life cycle and spatial distribution, or Change that may modify, destroy or isolate an area of important habitat for a migratory species, or Change that may seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	MNES Significant guidelines for Commonwealth Marine Waters
Social Environment		
Natural Systems	Modification, destruction, fragmentation, isolation or disturbance of an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area, State Parks and Reserves or wetlands of national and international importance results.	MNES Significant guidelines for Commonwealth Marine Waters
Human Systems	Substantial adverse effect on the sustainability of commercial fishing.	OPGGS Act 2006

Receptor	Definition of Significant Impact	Source
	Interference with other marine users to a greater extent than is necessary for the exercise of right conferred by the titles granted. Substantial adverse impact on heritage values of the Commonwealth marine area, including damage or destruction of an historic shipwreck. Expose social surroundings to significant harm.	MNES Significant guidelines for Commonwealth Marine Waters

4.1.7 Stage 7 - Environmental Performance Management

Environmental performance outcomes, performance standards, and measurement criteria were defined (Table 4-1) and developed to address the environmental impacts and risks identified during the impact and risk assessment and listed in the performance management sections of the assessment found in Sections 5 and 6.

BP aims to implement good practice environmental management as part of a program of continual improvement to reduce impacts and risks to ALARP. Environmental performance management was developed by BP in the context of the environmental values and sensitivities identified in Section 4.

5 Impact Assessment – Planned Activities

To meet the requirements of the OPGGS(E)R, Regulation 13(5) and (6), *Evaluation of environmental impacts and risks* and Regulation 13(7) *Environmental performance outcomes and standards,* this Section evaluates the potential impacts associated with the petroleum activity appropriate to the nature and scale of each impact, and details the control measures that are used to reduce the potential impacts to ALARP and an acceptable level. Additionally, Environmental Performance Outcomes, Environmental Performance Standards, and Measurement Criteria have been developed and are described in the following sections.

A review of other activities likely to occur within the EMBA scheduled at the same time as the Ironbark Exploration Drilling Program was undertaken, through stakeholder engagement as well as interrogation of NOPSEMA's status search tool. No other activities were identified to have impacts and risks that have the potential to affect either cumulatively or in-combination the values and sensitivities identified to be relevant to the Ironbark Exploration Drilling Program. Based on this review and the nature and scale of the Ironbark Exploration Drilling Program, a cumulative impacts assessment was not developed further for this activity.

5.1 Impact Assessment Summary

A summary of the impact assessment for all planned activities as detailed in Section 2.3 is provide in Table 5-1.

Table 5-1: Impact Assessment Summary – Planned Activities

Activity	EP Section	Environmental Aspect	Impact Severity Level (Table 4-2)	ALARP Decision Context (Table 4-5)	ALARP Statement	Acceptability Assessment Statement
Physical Presence – Displacement of Other Marine Users	5.2	• MODU operations (Section 2.3.2) • Vessel operations (Section 2.4)	Level 1 - Negligible	Type A	Good Practice control measures are well defined and therefore the impact is managed to ALARP in accordance with Good Practice.	In accordance with Section 4.1.6, impacts are considered inherently acceptable given that ALARP has been achieved, therefore no further evaluation is required.
Seabed Disturbance	5.3	• MODU positioning - anchoring (Section 2.3.1) • Exploration drilling operations (Section 2.3.3) • Contingency drilling operations - physical presence of the well (Section 2.3.4)	Level 1 - Negligible	Type A	Good Practice control measures are well defined and therefore the impact is managed to ALARP in accordance with Good Practice.	In accordance with Section 4.1.6, these impacts are considered inherently acceptable given that ALARP has been achieved, therefore no further evaluation is required.
Light Emissions	5.4	• MODU operations – navigational lighting (Section 2.3.2) • Vessel operations – navigational lighting (Section 2.4)	Level 1 - Negligible	Type A	Good Practice control measures are well defined and therefore the impact is managed to ALARP in accordance with Good Practice.	In accordance with Section 4.1.6, these impacts are considered inherently acceptable given that ALARP has been achieved, therefore no further evaluation is required.
Underwater Sound Emissions	5.5	• Exploration drilling -MODU positioning (Section 2.3.1) • Operations (Section 2.3.2) • Formation evaluation - VSP (Section 2.3.7) • Support operations – MODU operations (Section 2.4) • Support operations – vessel operations (Section 2.4)	Level 1 - Negligible	Type A	Good Practice control measures are well defined and therefore the impact is managed to ALARP in accordance with Good Practice.	In accordance with Section 4.1.6, existing controls are considered inherently acceptable and no further evaluation is required.

		• Support operations – helicopter operations (Section 2.4)				
Atmospheric Emissions	5.6	• MODU operations (Section 2.3.2) • Vessel operations (Section 2.4)	Level 1 - Negligible	Type A	Good Practice control measures are well defined and therefore the impact is managed to ALARP in accordance with Good Practice.	In accordance with Section 4.1.6, existing controls are considered inherently acceptable and no further evaluation is required.
Planned Discharge - Drilling Fluids and Cuttings	5.7.1	• Exploration drilling operations (Section 2.3.3) • Contingency drilling operations (Section 2.3.4)	Level 2 - Minor	Type A	Good Practice control measures are well defined and therefore the impact is managed to ALARP in accordance with Good Practice.	In accordance with Section 4.1.6, existing controls are considered inherently acceptable and no further evaluation is required.
Planned Discharge - Cement and Spacer Fluids	5.7.2	• Exploration drilling operations (Section 2.3.6) • Contingency drilling operations (Section 2.3.4)	Level 1 - Negligible	Type A	Good Practice control measures are well defined and therefore the impact is managed to ALARP in accordance with Good Practice.	In accordance with Section 4.1.6, existing controls are considered inherently acceptable and no further evaluation is required.
Planned Discharge - BOP Control Fluids	5.7.3	• Exploration drilling – BOP function testing (Section 2.3.5)	Level 1 - Negligible	Type A	Good Practice control measures are well defined and therefore the impact is managed to ALARP in accordance with Good Practice.	In accordance with Section 4.1.6, existing controls are considered inherently acceptable and no further evaluation is required.
Planned Discharge - Cooling Water and	5.7.4	• MODU operations (Section 2.3.2) • Vessel operations (Section 2.4)	Level 1 - Negligible	Type A	Good Practice control measures are well defined and therefore the impact is managed to ALARP in accordance with Good Practice.	In accordance with Section 4.1.6, existing controls are considered inherently acceptable and no further evaluation is required.

Planned Discharge - Sewage, Greywater and Putrescible Waste	5.7.5	• MODU operations (Section 2.3.2) • Vessel operations (Section 2.4)	Level 1 - Negligible	Type A	Good Practice control measures are well defined and therefore the impact is managed to ALARP in accordance with Good Practice.	In accordance with Section 4.1.6, existing controls are considered inherently acceptable and no further evaluation is required.
Planned Discharge - Firefighting Foam	5.7.6	• MODU operations – firefighting system test (Section 2.3.2) • Vessel operations – firefighting system test (Section 2.4)	Level 1 - Negligible	Type A	Good Practice control measures are well defined and therefore the impact is managed to ALARP in accordance with Good Practice.	In accordance with Section 4.1.6, existing controls are considered inherently acceptable and no further evaluation is required.
Planned Discharge - Bilge	5.7.7	• MODU operations (Section 2.3.2) • Vessel operations (Section 2.4)	Level 1 - Negligible	Type A	Good Practice control measures are well defined and therefore the impact is managed to ALARP in accordance with Good Practice.	In accordance with Section 4.1.6, existing controls are considered inherently acceptable and no further evaluation is required.

5.2 Physical Presence – Displacement of Other Marine Users

The potential impacts associated with physical presence – displacement of other marine users is evaluated in Table 5-2.

Table 5-2: Impact Assessment: Physical Presence – Displacement of Other Marine Users

<table>
<tr><th colspan="2">Planned Activity</th></tr>
<tr><td colspan="2">The following activities were identified as having the potential to result in the displacement of other marine users:
• MODU / vessel operations (Section 2.3.2/ Section 2.4)</td></tr>
<tr><th colspan="2">Potential Impact Associated with Physical Presence – Displacement of Other Marine Users</th></tr>
<tr><td colspan="2">Location of Potential Impact - Water Surface</td></tr>
<tr><td colspan="2">The displacement of other marine users may impact commercial activities in the Operational Area (within 10.5 km of the indicative Ironbark-1 exploration well per Section 2.1.2). Several fisheries may have an active presence in the Operational Area, however data from state managed fisheries indicates that fishing effort in the vicinity of the operational area is low (Table 3-22). The NWSTF only has two active vessels that are known to fish in the vicinity of the operational area, therefore fishing effort from Commonwealth managed fisheries is also considered low.
Vessel traffic is known to exist within the Operational Area; however there are no designated shipping channels (AMSA 2019) as identified in (Section 3.4.7) or navigation hazards which could limit other vessel movements.
The drilling activities are limited to the drilling of a single well, in an open ocean location. Furthermore, the operation of the MODU and support vessels will be of a short duration (90-100 days excluding weather and operational delays), which is not expected to impact the functions, interests or activities of other marine users as confirmed from stakeholder consultation records.
As such, the impact is considered to be insignificant with the potential for limited disturbance to other users of the area, therefore the impact severity was assessed as Level 1 - Negligible.</td></tr>
<tr><th colspan="2">Inherent / Design Control Measures (Validated Control Measures) and Good Practice Control Measures</th></tr>
<tr><td>Control Measure</td><td>Context of Control Measures</td></tr>
<tr><td>Pre-start notifications</td><td>Under the Navigation Act 2012, the Australian Hydrographic Service (AHS) is responsible for maintaining and disseminating hydrographic and other nautical information and nautical publications, including Notices to Mariners and AUSCOAST warnings. Through Notices to Mariners and AUSCOAST warnings other marine users can plan their activities to minimise disruption from these activities.</td></tr>
<tr><td>Ongoing consultation</td><td>In accordance with the OPGGS(E)R, additional consultation as requested by relevant stakeholders will be implemented to ensure they are aware of the activity in advance.</td></tr>
<tr><th colspan="2">Impact Severity Level (Table 4-2)</th></tr>
<tr><td colspan="2">1 Negligible</td></tr>
<tr><th>ALARP Decision Context (Table 4-5)</th><th>Type</th></tr>
<tr><td>The use of MODUs and support vessels in offshore locations is a common activity which represents normal business. Impacts associated with these activities are well understood and uncertainty is considered minimal. The inherent controls are requirements of Commonwealth legislation which are used by all competent organisations to manage well understood hazards arising from vessel operations.
No objections or concerns were raised during stakeholder consultation regarding this activity or its potential impacts and risks.
ALARP Decision Context Type A applies. Inherent controls are good practice and no control measures beyond good practice are required.</td><td>A</td></tr>
</table>

Acceptability Assessment			
Potential impacts associated with the displacement of other marine users due to the physical presence of the MODU and support vessels are ranked as Decision Context Type A. In accordance with Section 4.1.6, these impacts are considered inherently acceptable given that ALARP has been achieved, therefore no further evaluation is required.			
Performance Management			
Environmental Performance Outcomes	Performance Standards	Measurement Criteria	Responsibility
• To not interfere with other marine users to a greater extent than is necessary for the exercise of right conferred by the titles granted.	**Pre-start notifications** The AHS will be notified no less than four working weeks before operations commence to enable Notices to Mariners to be published.	Email records confirm AHS were notified of at least four weeks prior to commencement of operations to enable the Notice to Mariners to be published.	Wells Superintendent
	Pre-start notifications AMSA's Joint Rescue Coordination Centre (JRCC) will be notified 24–48 hours before operations commence to enable AMSA to distribute an AUSCOAST warning.	Email records confirm that information to distribute an AUSCOAST warning was provided to the JRCC via email rccaus@amsa.gov.au	Wells Superintendent
	Ongoing consultation In accordance with requests from relevant stakeholders during the consultation period, BP will implement the requirements as described in Section 7.11.	Consultation records confirm BP has implemented ongoing consultation with relevant stakeholders identified in Table 7-8.	Communications and External Affairs Lead

5.3 Seabed Disturbance

The potential impacts associated with seabed disturbance are evaluated in Table 5-3.

Table 5-3: Impact Assessment: Seabed Disturbance

Planned Activity

The following activities were identified as having the potential to result in seabed disturbance:

- MODU positioning (anchoring) (Section 2.3.1), and
- Exploration drilling operations (Section 2.3.3) and contingency operations (Section 2.3.4) (physical presence of the well).

Potential Impact Associated with Seabed Disturbance

Location of Potential Impact – Seabed

During the activity, the MODU is required to be anchored for station keeping. Anchors are secured to the MODU via chains and ropes. The presence of anchors, chains and ropes as wells as the physical footprint of the well will cause disturbance to benthic habitats. BP understand that the benthic habitat with the potential to be disturbed is limited to soft sediment communities as was confirmed by the site surveys (Section 3.3.2.1). The sensitivity of soft sediment communities to seabed disturbance was reviewed to understand potential extent of impact exposure to identified values and sensitivities (Table 5-4).

Table 5-4: Sensitivity of Soft Sediment Communities to Seabed Disturbance

Reference	Summary
UK Marine SAC 2001 cited in NERA 2018	Suggests that where seabed sediments are soft and there are no sensitive communities or other underwater obstructions, damage caused by anchoring is likely to be minimal and any disturbance is generally temporary.
Dernie et al. 2003	An experimental study showed that the full recovery of soft sediment assemblages from physical disturbance could take between 64 and 208 days following physical disturbances of different intensities.
Ingole et al. 2013 and Bluhm 2001 cited in NERA 2018	Suggest that following the recovery of anchors, impacts to soft sediment communities from the disturbance are expected to be localised and short-term, with the underlying conditions present to support re colonisation and recovery.

The area of benthic habitat expected to be disturbed by the MODU is approximately 30 - 60 m^2 per anchor which based upon the use of up to twelve anchors could result in a disturbance area of 720 m^2. Additional impacts from the drilling program will be much smaller in comparison, including the footprint of any clump weights that may be used with transponders if used (2 m^2 per transponder if these were to be used), and the diameter of the wellbore (42” surface hole). Seabed disturbance from activities such as drill cuttings and cementing discharges are evaluated in Section 5.7.1 and Section 5.7.2 respectively.

When considering the disturbance footprint of the drilling program, whereby the drilling activities are limited to the drilling of a single well, in an open ocean location with no known seabed features, against the widespread nature of soft sediment infauna communities characteristic of the region, the potential disturbance is considered highly localised. Given these habitats are expected to recover rapidly once the activity has been completed (Table 5-4), the potential environmental impact has been determined as having a negligible negative impact on the environment, thus the impact severity has been ranked as Level 1 - Negligible.

Inherent / Design Control Measures (Validated Control Measures) and Good Practice Control Measures

Control Measure	Context of Control Measures
Small Scale Geotechnical and Geophysical Site Survey	Well location and/or anchor locations will be positioned in areas that do not contain hard substrate recognised for biodiversity values. Benthic surveys undertaken within the Operational Area prior to drilling commencing are used to confirm the absence of areas of hard substrate recognised for biodiversity values with the potential to be impacted by the activity.

Impact Severity Level (Table 4-2)			
1 Negligible			
ALARP Decision Context (Table 4-5)			**Type**
Seabed disturbance from MODU anchoring and the physical presence of the well occurs commonly in both national and international waters. Disturbed marine habitat is expected to be limited to soft sediment communities, and this is being verified by seabed surveys in the operational area across the extent of the anchor spread. Preliminary geophysical data and photographic records from grab samples taken during the surveys suggest that the seabed is devoid of hard seafloor or distinct sediment facies, with only soft sediment observed No objections or concerns were raised during stakeholder consultation regarding this activity or its potential impacts and risks. ALARP Decision Context Type A applies. Inherent controls are good practice and no control measures beyond good practice are required.			A
Acceptability Assessment			
Potential impacts associated with seabed disturbance are ranked as Decision Context Type A. In accordance with Section 4.1.6, these impacts are considered inherently acceptable given that ALARP has been achieved, therefore no further evaluation is required.			
Performance Management			
Environmental Performance Outcomes	**Performance Standards**	**Measurement Criteria**	**Responsibility**
• Undertake the activity in a way that does not modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results.	**Benthic surveys** BP will review site survey outputs to verify the absence of sensitive benthic habitats (hard substrate) at anchor locations once site surveys and mooring analysis are complete.	Analysis of site surveys outputs confirm proposed anchor locations are outside sensitive benthic habitat locations.	Wells Superintendent

5.4 Light Emissions

The potential impacts associated with light emissions are evaluated in Table 5-5.

Table 5-5: Impact Assessment: Light Emissions

Planned Activity
The following activities were identified as having the potential to result in the generation of light emissions: • MODU / vessel operations (navigational lighting) (Section 2.3.2/ Section 2.4)
Potential Impact Associated with Light Emissions
Location of Potential Impact - Water Surface / Air
During the drilling program, the MODU and support vessel on-location will generate light. Lighting is used for marine safety to ensure clear identification of the MODU and support vessels to other marine users and to allow activities to be undertaken safely 24 hours a day. Lighting will typically consist of bright white (i.e. metal halide, halogen, fluorescent) lights, and are not dissimilar to lights used for other offshore activities in the region, including fishing and shipping. The sensitivity of environmental receptors to changes in ambient light levels (relevant to this activity) was reviewed to understand potential extent of impact exposure to identified values and sensitivities (Table 5-6).

Table 5-6: Sensitivity of Receptors to changes in Ambient Light Levels

Reference	Summary
Meekan et al. (2001)	Experiments using light traps and confirmed that some fish and zooplankton species are attracted to light sources.
Lindquist et al. (2005)	Investigation of larval fish populations around an oil and gas platform in the Gulf of Mexico showed that an enhanced abundance of clupeids (herring and sardines) and engraulids (anchovies) was caused by the platforms' light fields.
Shaw et al. (2002)	Juvenile tunas (Scombridae) and jacks (Carangidae) may have been preying upon concentrations of zooplankton attracted to the light field associated with an offshore platform.
Marchesan et al. (2005)	Localised aggregation of fish in the immediate vicinity of a vessel may have resulted in an increase in predation on prey species aggregating in the area, or exclusion of nocturnal foragers/predators from the area.
Morandi (2018)	Concluded that fish will likely not be affected by navigational lighting for mariners.
Wiese et al. (2001)	A literature review identified: • Seabirds are highly visually orientated organisms, and light emissions are known to cause attraction. • Studies indicate within 500 m of an offshore oil platform, bird density was 19-38 times higher than on survey transects leading to it. Platform structures attract both seabirds and their prey in the immediate surroundings from the availability of roosting refuge at sea and increased food availability. • Light emissions can be expected to result in mortality where illuminated objects extend into an open air-space where birds are flying. Documented mortality is higher during migration periods when large numbers of birds are forced to a lower flight path or to the sea surface by inclement weather.
Marquenie et al. (not dated)	Birds travelling within a 5 km radius of illuminated offshore platforms deviate from their intended route and either circle or landed on the nearby platform.
Simmonds (2004)	Cetaceans predominantly use acoustic senses to monitor their environment rather than visual sources, so light is not considered to be a significant factor in cetacean behaviour or survival.

For the purpose of conducting a conservative assessment of potential impacts, it is considered that light emissions from the MODU (and support vessels within the Operational Area) have the potential to result in impacts within 5 km of the MODU. Although studies indicate that changes in ambient light levels may attract many species of plankton, fish, reptiles,

and seabirds, no particular values and sensitivities associated with these species were identified as having the potential to be exposed to changes in light emissions. Plankton communities have a naturally patchy distribution in both space and time (ITOPF 2011). They are known to have naturally high mortality rates (primarily through predation); where water quality has been altered, plankton populations will return to previous conditions once water quality returns to ambient levels. Plankton populations have evolved to respond to these environmental perturbations by copious production within short generation times (ITOPF 2011 and UNEP 1985). Although over the course of the activity, there may be an increase in plankton predation rates within close proximity of the MODU, plankton populations are expected to recover rapidly once the activity is complete. In addition to this, no particular values or sensitivities linked to planktonic foraging or increased planktonic abundance have been identified as having the potential to occur within 5 km of the well, thus indirect impacts to matters of NES and other transient fauna species are not expected. As the indicative well location is, at its closest, is 150 km from coastal habitats, only a small number of Threatened or Migratory listed seabird species would be expected to be present in this area. It is not expected that light acting as an attractant to a small number of individual seabirds would result in a significant impact to an individual or to the greater population. Although the Recovery Plan for Marine Turtles in Australia (CoA, 2017) identifies light emissions as a key threat as it disrupts critical behaviours, it notes that the threat is focused on nesting behaviours (nearshore) as well as disrupting hatchling orientation and sea finding behaviours of hatchlings. Given the distance offshore, lighting emissions from this activity are not expected to affect critical behaviours of marine turtles discussed in the aforementioned turtle recovery plan, nor significantly alter sensitive behaviours that would lead to impacts to individuals or the greater population. As the potential environmental impact has been determined to be a localised and negligible negative impact on the environment, the environmental impact severity has been ranked as Level 1 - Negligible.			
Inherent / Design Control Measures (validated control measures) and Good Practice Control Measures			
Control Measure	**Context of Control Measures**		
No control identified	N/A		
Impact Severity Level (Table 4-2)			
1 Negligible			
ALARP Decision Context (Table 4-5)			**Type**
The use of navigational lights and other lights to enable 24-hour operations to be undertaken, is a routine activity in the offshore petroleum sector. The impacts and risks associated with light emissions are well understood and uncertainty is considered minimal given the Operational Area does not contain shorelines that support light sensitive species. The use of lighting for safe work and navigation are requirements of Commonwealth legislation and generally well implemented by industry. No objections or concerns were raised during stakeholder consultation regarding this activity or its potential impacts and risks. ALARP Decision Context Type A applies. Inherent controls are good practice and no control measures beyond good practice are required.			A
Acceptability Assessment			
Potential impacts associated with light emissions are ranked as Decision Context Type A. In accordance with Section 4.1.6, these impacts are considered inherently acceptable given that ALARP has been achieved, therefore no further evaluation is required.			
Performance Management			
Environmental Performance Outcomes	**Performance Standards**	**Measurement Criteria**	**Responsibility**
N/A – no control identified			

5.5 Underwater Sound Emissions

The following activities were identified as having the potential to result in underwater sound emissions:

- Exploration drilling (MODU positioning (transponders) (Section 2.3.1) and drilling operations (Section 2.3.2)),
- Formation evaluation (VSP) (Section 2.3.7),
- Support operations – MODU operations (Section 2.3.2),
- Support operations – vessel operations (Section 2.4),
- Support operations – helicopter operations (Section 2.4).

5.5.1 Background

Examples of typical sound source levels associated with activities planned as part of the Ironbark exploration drilling program are summarised in Table 5-7.

Table 5-7: Sound Source Levels Applicable to the Ironbark-1 Exploration Drilling Program

Source	Frequency	Sound Pressure Level (SPL)	Reference
Continuous			
Vessels (e.g. support vessel)	20 to 300 Hz (hertz)	~192 dB re 1 µPa @ 1 m RMS	Hannay et al. 2004 cited in Genesis Oil and Gas Consultants (2011)
Drilling unit (without propulsion / dynamic positioning)	0.01 to 32 kHz (kilohertz)	169 dB re 1 µPa @ 1 m RMS	Austin and Hannay (2018)
Drillship (without dynamic positioning) [a]	0.01 to 32 kHz	175 dB re 1 µPa @ 1 m RMS	Austin and Hannay (2018)
MODU (with dynamic positioning) [a]	0.02 to 1.2 kHz	196 dB re 1 µPa @ 1 m RMS	McPherson et al. 2013 cited in Woodside 2017
Helicopter	10.8 Hz	149 dB re 1 µPa @ 1 m RMS	Richardson 1995 cited in Seiche 2008
Impulsive			
VSP	Predominantly <500 Hz	~227 dB re 1 µPa @ 1 m RMS	Illingworth & Rodkin 2014 cited in Fairweather Science 2018
Transponders	7 to 60 kHz	180 to 200 dB re 1 uPa @ 1 m RMS	Ward et al. 2001 cited in Seiche 2008

[a] Included for assessment of potential relief well rig. The planned activity will use a moored drilling unit, without dynamic positioning, as detailed in Section 2.

Underwater sound emissions associated with the use of helicopters, vessels and general MODU operations without dynamic positioning (location fixed by anchoring or other means) are lower in magnitude and duration compared to MODU operations with dynamic positioning. Thus the latter is considered a more conservative continuous sound source for impact assessment. The former sources are therefore not subject to further sound propagation investigation, as the evaluation of the most conservative sound source represents a worst-case scenario. The calculated propagation for vessel operations has been added to Table 5-7 for comparison.

Sound generated by acoustic positioning transponders is higher frequency, but lower in magnitude and duration compared to emissions during VSP operations. The latter is considered a more conservative impulsive sound source for impact assessment. Transponder related sound emissions are therefore not subject to further sound propagation investigation as the evaluation of the most conservative sound source represents a worst-case scenario.

5.5.2 Sound Propagation Calculations

BP has used three methods to further understand propagation of sound from the drilling activities:

- NOAA Fisheries' User Spreadsheet Tool (NOAA 2018b), using auditory weighted spherical spreading propagation model, to predict distances to PTS threshold values for marine mammals,
- auditory weighted spherical spreading calculations, using the same method as NOAA (2018b), to predict distances to TTS threshold values for marine mammals, and
- an unweighted spherical spreading model (Richardson et al. 1995) to predict distances to impact threshold values for other sound sensitive receptors and marine mammal behaviour (refer to Table 5-9).

The spherical spreading model (both weighted and unweighted) is highly simplified, and does not consider directionality, reflection, refraction or absorption of sound at the seabed. The weighted spherical spreading model (using the NOAA User Spreadsheet Tool and weighted spherical spreading calculations) is also highly simplified and likely more conservative for broadband sound sources (NOAA 2018b). The weighted spherical spreading models attempt to capture cumulative sound exposure by focusing on the more predictable characteristics of the sound sources (refer to Table 5-7 for sound source characteristics and Section 2.3.7for accumulation period of 24 hours against thresholds listed in Table 5-9) and accounts for auditory weighing functions by the incorporation of a single frequency based on each marine mammal hearing group (NOAA, 2018b). Using the spherical spreading model (both weighted and unweighted) provides an indication of estimated distances at which received levels from underwater sound emissions associated with drilling activities are likely to decrease to below threshold values.

Duncan & Parsons (2011) identified spherical spreading calculations can result in significant over estimation of transmission loss and underestimation of received levels. More sophisticated methods to predict sound propagation would predict more realistic exposure levels. To ensure the estimated distances derived from spherical spreading methods used for the Ironbark drilling program do not underestimate distances to sound threshold values, this assessment also uses results from ad the modelling study for the Browse to North West Shelf Project (McPherson et al. 2019) as a comparison against simplified spherical spreading and weighting factor adjusted estimates. Predictions of underwater sound propagation as detailed in the McPherson et al. (2019) modelling study is considered comparable to those predicted for the Ironbark-1 drilling program given model inputs such as sound source (VSP/MODU), location (North West Shelf) and water depths (391 m - Torosa TRD Well location, 467 m - Brecknock MODU centre location and 300 m – Ironbark-1 well location) are similar.

To provide an indication of estimated distances of sound propagation from the Ironbark drilling program regardless of the receptor, Table 5-8 details the unweighted spherical spreading calculated distances based on a maximum sound source level of 227 dB re 1µPa @1 m RMS for impulsive sound (VSP source) and 196 dB re 1µPa @ 1m RMS for continuous sound (MODU dynamically positioned). Conversions have then been applied to convert SPL RMS to SPL PK and SPL PK to unweighted SEL source levels for impulsive sound sources associated with VSP activities (Green 1997 cited in Richardson 1997; McCauley et al. 2000).

Table 5-8: Parameters of Sound Generated During the Drilling Program

Approximate Distance	Predicted Sound Level (Continuous) – MODU Dynamic Positioning dB re 1µPa RMS (dB RMS)	Predicted Sound Level (Continuous) – vessel operation dB RMS	Predicted Sound Level (Impulsive) - VSP dB RMS	Predicted Sound Level (Impulsive) - VSP dB re 1µPa PK (dB PK)	Predicted Sound Level (Impulsive) - VSP dB SEL re 1µPa^2.s (dB SEL)
1 m	196	192	227	237	214
10 m	176	172	207	217	194
50 m	162	158	193	203	180
100 m	156	152	187	197	174
250 m	148	144	179	189	166
500 m	142	138	173	183	160
1 km	136	132	167	177	154
1.5 km	132	128	163	173	150
2 km	130	126	160	170	147
3 km	126	122	157	167	144
5 km	122	118	153	163	140
6 km	120	116	151	161	138

Note: The converted SEL values shown above are unweighted, per pulse, and not cumulative over 24 hours. However SEL threshold values associated with potential hearing impairment impacts for marine mammals are typically expressed in terms of weighted (to account for species hearing sensitivities) cumulative SEL over 24 hours (dB SELcum 24 hr). Given the different types of receptors evaluated in Section 5.5.4 and varying auditory weighting functions, Table 5-11 includes an assessment, specifically for marine mammals, that uses weighted spherical spreading to determine cumulative SEL impact thresholds for the evaluation of impacts to marine mammals from underwater sound generated during the drilling program. This assessment is based on available literature and tools that provide weight adjustment factors (refer to Section 5.5.2). To confirm the outputs from this assessment, comparisons are presented with results from an existing study, which uses more complex modelling methods for an area considered to be representative of the indicative Ironbark-1 well location.

5.5.3 Hazard Identification / Scoping

The potential impacts associated with underwater sound emissions include:

- Behavioural changes (including masking);

- Hearing impairment, including:
  - Temporary Threshold Shift (TTS); and
  - Permanent Threshold Shift (PTS); and
- Mortality or potential mortal injury.

Available threshold criteria for impulsive and continuous sound exposure associated with behavioural changes, TTS, PTS, mortality or potential mortal injury for sound sensitive receptors are provided in Table 5-9.

Masking is defined as the reduction of the ability to detect relevant sounds of interest in the presence of other sounds, which may in turn lead to changes in behaviour (NRC 2003, Peng et al. 2015). Richardson et al. (1995) identified four zones of influence associated with a sound source for marine mammals. The largest zone is that of audibility, followed by responsiveness, then masking, and finally the zone of hearing impairment, or auditory injury. The zones of audibility, responsiveness and masking can be the same (NRC 2003). The zone of audibility is defined as the area in which the behaviour of sound sensitive receptors may be affected (Lewis 1990). Therefore, the boundary for the zone of masking for this assessment is also defined as the zone of audibility (calculated zone of behavioural affects).

A scoping analysis based upon optimum hearing frequencies of receptor groups has been conducted, to identify which sound sources may be heard by the various receptor groups and therefore may result in potential impact (Table 5-10).

Table 5-9: Threshold Criteria for Impulsive and Continuous Sound

Receptor	Threshold criteria for Potential Impacts							
	Mortal or potential mortal injury	Recoverable Injury	PTS		TTS		Behavioural	
	Impulsive	Continuous	Impulsive	Continuous	Impulsive	Continuous	Impulsive	Continuous
Low-Frequency (LF) cetaceans	-	-	219 dB PK [a] Or 183 dB SEL$_{cum}$ 24 hr [a]	199 dB SEL$_{cum}$ 24 hr [a]	213 dB PK [a] Or 168 dB SEL$_{cum}$ 24 hr [a]	179 dB SEL$_{cum}$ 24 hr [a]	160 dB RMS [b]	120 dB RMS [b]
Mid-Frequency (MF) cetaceans			219 dB PK [a] Or 185 dB SEL$_{cum}$ 24 hr [a]	198 dB SEL$_{cum}$ 24 hr [a]	224 dB PK [a] Or 170 dB SEL$_{cum}$ 24 hr [a]	178 dB SEL$_{cum}$ 24 hr [a]		
High-Frequency (HF) cetaceans			219 dB PK [a] Or 155 dB SEL$_{cum}$ 24 hr [a]	173 dB SEL$_{cum}$ 24 hr [a]	196 dB PK [a] Or 140 dB SEL$_{cum}$ 24 hr [a]	153 dB SEL$_{cum}$ 24 hr [a]		
Fish and sharks (no swim bladder)	210 dB SEL$_{cum}$ [c] Or >207 dB PK[c]	Low risk within tens of metres of source. [c]	-	-	186 dB SEL$_{cum}$ [c]	Moderate risk within tens of metres of source. [c]	High risk within tens of metres of source. [c]	Moderate risk within tens of metres of source. [c]
Fish (swim bladder)	207 dB SEL$_{cum}$ [c] Or >207 dB PK[c]	170 dB RMS for 48 hours[c]			186 dB SEL$_{cum}$ [c]	158 dB RMS for 12 hours[c]	High risk within tens of metres of source. [c]	High risk within tens of metres of source. [c]
Turtles	210 dB SEL$_{cum}$ [c] Or >207 dB PK[c]	Low risk within tens of metres of source. [c]			High risk within tens of metres of source. [c]	Moderate risk within tens of metres of source. [c]	153 dB SEL [d]	High risk within tens of metres of source. [c]
Eggs and larvae	>210 dB SEL$_{cum}$ [c] Or >207 dB PK[c]	Low risk within tens of metres of source. [c]			Moderate risk within tens of metres of source. [c]	Low risk within tens of metres of source. [c]	Moderate risk within tens of metres of source. [c]	Moderate risk within tens of metres of source. [c]

[a] NMFS 2018a,

[b] NMFS 2013,

[c] Popper et al. 2014,

[d] McCauley et al. 2000 - it is widely recognised that caged/captive studies are limited as they do not represent a real world exposure response scenario whereby free moving animals are able to move away.

Table 5-10: Analysis of Sensitive Receptors Hearing Frequencies to Source Frequencies

			Sound Source Frequencies			
Receptor Group	Potential to be exposed to underwater sound	Optimum Hearing Frequency	**Support Operations - Vessel (20 to 300 Hz)**	**Support Operations - MODU (<2 kHz)**	**Exploration drilling (MODU positioning - transponders) (30 kHz)**	**VSP (<500 Hz)**
LF Cetaceans (baleen whales i.e. Blue and Humpback Whales)	Yes, within EMBA and hearing range	7 - 35,000 Hz	Yes	Yes	Yes	Yes
MF Cetaceans (dolphins, toothed whales, beaked whales, bottlenose whales)	Yes, within EMBA and hearing range	150 - 160,000 Hz	Yes	Yes	Yes	Yes
HF Cetaceans (porpoises, river dolphins)	No, not within EMBA	275 - 160,000 Hz	Not present thus not considered further.			
Fishes (Popper et al 2014)	Yes, within EMBA and hearing range	100 – 20,000 Hz	Yes	Yes	No	Yes
Marine Turtles (Popper et al 2014)	Yes, within EMBA and hearing range	50 – 1,200 Hz	Yes	Yes	No	Yes
Plankton (Larval fish same as adult fish – Popper et al 2014)	Yes, within EMBA and hearing range	100 – 20,000 Hz	Yes	Yes	No	Yes
	No overlap with receptor optimum hearing range; but potential for physical impact exists					
	Receptor's optimum hearing within sound source range					
	Receptor's optimum hearing not within sound source range					

5.5.4 Impact Assessment

The potential impacts associated with Underwater Sound Emissions are evaluated in Table 5-11.

Table 5-11: Impact Assessment: Underwater Sound Emissions

Activity

The following activities were identified as having the potential to result in underwater sound emissions:

- Exploration drilling (MODU positioning (transponders) (Section 2.3.1) and drilling operations (Section 2.3.2)),
- Formation evaluation (VSP) (Section 2.3.7),
- Support operations – MODU operations (Section 2.4),
- Support operations – vessel operations (Section 2.4),
- Support operations – helicopter operations (Section 2.4).

Potential Impact Associated with Underwater Sound Emissions

Location of Potential Impact - Water Column

LF and MF Cetaceans

SPL dB RMS and dB PK Threshold Evaluation

The evaluation using the unweighted spherical spreading model in this instance provides highly conservative estimates of the potential range at which received sound levels decrease below threshold values in terms of RMS sound pressure level (dB RMS) for behavioural changes and peak sound pressure level (dB PK) for TTS and PTS for LF and MF cetaceans (refer to unweighted calculated distances based on a maximum sound source level of 227 dB re 1µPa @1 m RMS for impulsive sound (VSP source) and 196 dB re 1µPa @ 1m RMS for continuous sound (MODU dynamically positioned) SPL RMS to SPL PK and SPL PK Table 5-8). Wahlberg and Westerberg (2005) state it is generally accepted that spherical spreading of underwater sound occurs in deeper waters, where the distance between the receiver and source is less than the depth. Based on the description of the existing environment, it is anticipated that sound sensitive receptors will be transient within distances less than the water depth of the drilling location. The estimated ranges to PTS and TTS threshold values in terms of PK assuming a spherical spreading model are in the order of tens of metres (i.e. less than the 300 m water depth). Estimated ranges to behavioural change threshold values in terms of SPL are greater.

In addition to using the spherical spreading model, BP has used the modelling study for the Browse to North West Shelf Project (McPherson et al. 2019). Predictions of underwater sound propagation as detailed in the McPherson et al. (2019) modelling study is considered comparative for the Ironbark-1 drilling program given model inputs such as sound source, location and water depths are similar.

SPL dB RMS and dB PK Impulsive Sound Assessment Boundary

The SPL RMS and PK assessment includes SPL and dB PK impulsive sound impact threshold valuess includes for PTS, TTS and SPL dB RMS for behavioural change criterion of 160 dB re 1uPa (RMS) in MF and LF cetaceans.

McPherson et al. (2019) using a VSP sound source value of 239.7 dB re 1uPa @1 m PK in north west shelf (NWS) waters at depths of 391 m (Torosa TRD Well location) and 467 m (Brecknock MODU centre location), predicted the maximum distances where sound levels decrease to below threshold criteria as:

- Behavioural change for MF and LF cetaceans within 1.7 km (longest distance predicted from Brecknock),
- PTS and TTS not predicted to occur for MF cetaceans (from both Torosa and Brecknock locations),
- PTS (PK threshold) for LF cetaceans within 12 m (from both Torosa and Brecknock locations),
- TTS (PK threshold) for LF cetaceans within 21 m (from both Torosa and Brecknock locations).

The model inputs are considered comparable to those assumed to be representative for the Ironbark-1 location (North West Shelf waters), with respect to water depth (300 m) and VSP sound source level (227 dB re 1 µPa @ 1 m RMS which corresponds to 237 dB re 1 µPa @ 1 m PK).

The unweighted spherical spreading model (Table 5-8) predicts the following maximum distances at which sound levels decreased to below threshold criteria:

- Behavioural change for MF and LF cetaceans within 2 km,

- PTS (PK threshold) for MF and LF cetaceans within 10 m,
- TTS (PK threshold) for MF and LF cetaceans within 10 m and 50 m, respectively.

The range predictions of received sound levels relative to dB RMS and dB PK threshold values for behavioural change, TTS and PTS to LF and MF cetaceans using the spherical spreading model are comparable in this instance to the more complex modelling used in the McPherson study.

The maximum distance of 2 km will be used as the dB RMS and dB PK impulsive sound assessment boundary for behavioural change, TTS and PTS to LF and MF cetaceans.

SPL dB RMS and dB PK Continuous Sound Assessment Boundary

The SPL RMS and PK assessment of continuous sound levels compared to impact thresholds is limited to the marine mammal behavioural change criterion of 120 dB re 1uPa (RMS). The sound impact thresholds for PTS and TTS in MF and LF cetaceans only considers cumulative metric (NMFS 2018).

McPherson et al. (2019) using a MODU under dynamic positioning sound source value of 191 dB re 1uPa @1 m PK in water depths of 391 and 467 m, predicted range to the behavioural change threshold value for cetaceans is 10.5 km from the source at the Torosa location.

The unweighted spherical spreading model (Table 5-8) predicts a range of 6 kms to the behavioural change threshold value for cetaceans assuming a sound source value of 196 dB re 1uPa @1 m RMS to represent a MODU under dynamic positioning.

The McPherson et al. (2019) study provides the most conservative range estimate of continuous received sound levels decreasing to below the behavioural change threshold value for cetaceans.

Therefore 10.5 km will be used as the dB RMS and dB PK continuous sound assessment boundary for behavioural change to MF and LF cetaceans.

It should be noted that the source sound level values are typically derived based on a number of assumptions, including considering the source to be a point source, where by measured or modelled sound levels at some distance from the source are back projecting or corrected to represent sound levels to 1 m from the source. In reality, this is a simplified representation used for modelling purposes. In reality a large offshore facility such as a MODU, has multiple sound sources (thruster units) distributed over a spatial area. Measurement studies suggest sound levels close to a distributed sound source are significantly lower than those predicted for modelling purposes (Jimenez-Arranz et al 2019).

Cumulative SEL Impact Threshold Evaluation

The NOAA Fisheries' (2018b) User Spreadsheet Tool has been used to calculate 'safe distance' values associated with PTS threshold values. A spherical spreading propagation model is implemented by selecting appropriate user defined parameters. The tool also uses weighting factor adjustments (WFA) to account for the frequency weighting functions for the different marine mammal hearing groups. TTS spherical spreading calculations including weighting factor adjustments (marine mammal auditory weighting functions) were conducted using the same methodology as the tool to define cumulative SEL estimates for TTS for LF and MF cetaceans.

NOAA (2018) states that the weighted SELcum metric accounts for the level and duration of exposure, which are contributing factors of the sound source to induce hearing loss. However, NOAA (2018) recognises that accounting for duration of exposure is complicated due to various real-world variables, such as relative source and receiver movement. For example, when there are moving animals relative to an offshore activity, such as the migrating pygmy blue whales within the migratory BIA for Blue Whales.

Cumulative SEL Impulsive Sound Assessment Boundary

The assessment of cumulative sound impact thresholds is limited to PTS and TTS in MF and LF cetaceans.

McPherson et al. (2019) using a VSP sound source value of 239.7 dB re 1uPa @1 m PK in water depths of 391 and 467 m, predicted sound levels would be below SEL threshold criteria at the maximum distances below:

- PTS and TTS not predicted to occur for MF cetaceans (from both Torosa and Brecknock locations),
- PTS (SEL24h threshold) for LF cetaceans within 200 m (from both Torosa and Brecknock locations),
- TTS (SEL24h threshold) for LF cetaceans within 1.7 km (from both Torosa and Brecknock locations).

The NOAA calculation tool, assuming a spherical spreading propagation model and weighting factor adjustment predicts the following maximum distances at which sound levels decrease to below SEL threshold criterion for a VSP sound source value of 227 dB re 1µPa @1 m RMS:

- PTS (SEL24h threshold) for MF cetaceans within 18 m,
- TTS (SEL24h threshold) for MF cetaceans within 103 m,
- PTS (SEL24h threshold) for LF cetaceans within 654 m,
- TTS (SEL24h threshold) for LF cetaceans within 3.6 km.

Using the weighted spherical spreading calculation provides the most conservative range estimate for cumulative impulsive received levels for the TTS and PTS SEL threshold values for LF and MF cetaceans.

The maximum distance of 3.6 km will be used as the cumulative impulsive sound assessment boundary to assess the potential of PTS and TTS impacts to MF and LF cetaceans.

Cumulative SEL Continuous Sound Assessment Boundary

McPherson et al. (2019) using a MODU under dynamic positioning sound source value of 191 dB re 1uPa @1 m PK in water depths of 391 and 467 m, predicted sound levels would be below SEL threshold criteria at the maximum distances below:

- PTS not predicted to occur for MF cetaceans (from both Torosa and Brecknock locations),
- TTS (SEL24h threshold) for MF cetaceans within 120 m (from both Torosa and Brecknock locations),
- PTS (SEL24h threshold) for LF cetaceans within 110 m (from both Torosa and Brecknock locations),
- TTS (SEL24h threshold) for LF cetaceans within 1 km (from both Torosa and Brecknock locations).

The NOAA calculation tool, assuming a spherical spreading propagation model, and weighting factor adjustment predicts the following maximum distances at which sound levels decrease to below SEL threshold criterion for a sound source value of 196 dB re 1uPa @1 m RMS to represent a MODU under dynamic positioning:

- PTS (SEL24h threshold) for MF cetaceans within 24 m,
- TTS (SEL24h threshold) for MF cetaceans within 240 m,
- PTS (SEL24h threshold) for LF cetaceans within 208 m,
- TTS (SEL24h threshold) for LF cetaceans within 2 km.

Using the weighted spherical spreading calculation provides the most conservative range estimate for cumulative continuous received levels for the TTS and PTS SEL threshold values for LF and MF cetaceans.

The maximum distance of 2 km will be used as the cumulative continuous sound assessment boundary to assess the potential of PTS and TTS impacts to MF and LF cetaceans.

Impact Assessment

Behavioural Changes

A comparison of the sound assessment boundaries for potential behavioural changes of MF and LF cetaceans suggests an SPL continuous sound assessment boundary of 10.5 km from the source is the largest isopleth. Therefore this distance will be used as the sound assessment boundary for potential behavioural changes of MF and LF cetaceans.

The behavioural change sound assessment boundary is within the migratory BIA for Blue Whales however does not overlap known or possible foraging areas for Blue Whales (Commonwealth of Australia 2017a). Although there is the potential for a larger number of cetaceans to be present during migration periods (Blue Whales) exposure to sound levels above the behavioural change thresholds is not expected to significantly affect migration behaviours.

Studies on the effect of seismic surveys on Humpback Whales (McCauley et al, 1998; Dunlop et al. 2017) found that although no gross changes in migration paths were observed, behavioural and avoidance reactions to the sound source were documented. There is currently a lack of scientific evidence to validate potential behavioural impacts to Blue Whales from exposure to impulsive sound sources (DoE 2015). Effects of impulsive sound sources on Blue Whales are anticipated to be similar to that observed by Humpback Whales. The known Blue Whale migration pathways do not include areas which are characterised by narrow corridors or bottlenecks resulting from physical and other barriers (DoE 2015; TSSC 2015). The behavioural change sound assessment boundary (10.5 km from the MODU), overlaps parts of the Blue Whale migration pathway; however it is in open ocean with no obstacles to prevent movement of cetaceans transiting through or near the indicative well location. Therefore, potential behavioural changes from the short duration VSP activity are expected to be limited to temporary and insignificant avoidance reactions by migrating LF cetaceans.

Stakeholder consultation with AMSA determined that heavy vessel traffic, including tanker, cargo, support and passenger vessels, pass through the Operational Area based on the location of the chartered shipping fairway (AMSA, personal communication, 19 March 2019). High levels of existing vessel/shipping traffic is expected within the behavioural change sound assessment boundary. The presence of the MODU and support vessels within the boundary is unlikely to contribute significantly to increasing the overall levels of sound associated with existing vessel traffic and there are no obstacles to prevent movement of cetaceans transiting through the area. No further behavioural disturbance to cetaceans from continuous vessel sound is anticipated. Thus, any potential disturbance would result in short-term effects to species.

Potential behavioural change of MF and LF cetaceans are expected to be temporary and limited to avoidance reactions within 10.5 km from the source. In accordance with the Conservation Management Plan for Blue Whales, the activity is not expected to displace whales from foraging areas as a result of potential behavioural impacts given the behavioural change sound assessment boundary does not overlap Pygmy Blue Whale foraging BIA.

The assessed environmental impact severity for behavioural changes as a result of impulsive underwater sound emissions is Level 2 – Minor given introduction of a different type of sound source within the Pygmy Blue Whale migration BIA and the potential impact on EPBC Act Listed Threatened / Migratory Marine Species. The environmental impact severity for behavioural changes as a result of continuous underwater sound emissions is Level 1 – Negligible given the existing background noise generated from high levels of vessel/shipping traffic within the Pygmy Blue Whale migration BIA.

Hearing impairment - PTS and TTS

A comparison of the sound assessment boundaries for potential PTS or TTS to MF and LF cetaceans suggest a cumulative SEL impulsive sound assessment boundary of 3.6 km from the source is the largest isopleth. Therefore this distance will be used as the sound assessment boundary for potential PTS or TTS impacts for MF and LF cetaceans.

The PTS and TTS sound assessment boundary is within the migratory BIA for Blue Whales (0.003% overlap of the total migration BIA and 4.6% ingress on the migration BIA corridor) however does not overlap known or possible foraging areas for Blue Whales (Commonwealth of Australia 2017a). The likelihood of MF and LF cetaceans to remain within the PTS and TTS sound assessment boundary for over 24 hours and therefore result in PTS or TTS is negligible. Pygmy Blue Whales can be expected to transit the area in less than half a day (McCauley and Jenner 2010 cited in McPherson et al. 2019). Owen et al. (2016) tagged a northbound Pygmy Blue Whale, assumed to be migrating, off the southwest coast of Western Australia and determined the mean speed for a potential migrating Pygmy Blue Whale as 2.8 ± 2.2 km/h. Based on this speed, a migrating Pygmy Blue Whale is expected to transit the PTS and TTS sound assessment boundary distance within 1.4 to 12 hours (based on standard deviated mean speed range), which is less than the exposure timeframe assumed for assessing the potential onset of PTS or TTS (SEL 24h criterion) to the LF cetacean hearing group (representative of Pygmy Blue Whale species). Migrating Blue Whales may exhibit behavioural changes (avoidance, changing movement direction or vocalisation characteristics) at further distances (10.5 km from the MODU - behavioural change sound assessment boundary) which will further reduce the likelihood of MF and LF cetaceans entering the PTS and TTS sound assessment boundary (3.6 km from the MODU) while undertaking the activity.

Therefore MF and LF cetaceans will not experience PTS or TTS impacts during the activity. In accordance with the Conservation Management Plan for the Blue Whale, the activity is not expected to injure migrating Pygmy Blue Whales within the migration BIA.

The assessed environmental impact severity for hearing impairment as a result of impulsive underwater sound emissions is Level 2 – Minor given introduction of a different type of sound source within the Pygmy Blue Whale migration BIA and the potential impact on EPBC Act Listed Threatened / Migratory Marine Species. The environmental impact severity for hearing impairment as a result of continuous underwater sound emissions is Level 1 – Negligible given the existing background noise generated from high levels of vessel/shipping traffic within the Pygmy Blue Whale migration BIA.

Sea Snakes and Marine Turtles

There is currently no scientific information on how or whether sea snakes use sound and therefore how susceptible they might be to underwater sound emissions. For this assessment, because snakes and turtles are both marine reptiles, it has been assumed that sea snakes are similarly or less sensitive to low level sounds than turtles. Therefore, the thresholds established and assessment of potential impacts for marine turtles are used as a proxy for sea snakes (McPherson et al. 2016). Popper et al (2014) extrapolated sea turtle hearing abilities and vulnerability to sound exposure from the fish function hearing category 'fish where swim bladder is used in hearing' i.e. the most sensitive fish hearing group.

Mortality and Potential Mortal Injury

Five marine turtle species (or species habitat) may occur within the EMBA. No BIAs or habitat critical to the survival of the species occur within the EMBA. Given the open ocean environment of the EMBA and lack of features where marine turtles are likely to accumulate, transient individuals are only expected to be within the area.

The potential for mortality or potential mortal injury has been estimated to be within the following ranges based upon the modelling outcomes in Table 5-8 for SPL PK and using thresholds identified in Table 5-9.

- **Impulsive Source** - mortality or potential mortal injury may occur if turtles are present within less than 50 m of the impulsive source.

Potential for recoverable injury and TTS to marine turtles from continuous sound from shipping is suggested to be of low and moderate risk respectively within tens of metres of the sound source (Popper et al 2014; Table 5-14). These ranges do not overlap any critical habitat or BIA for marine turtles. With only low numbers of individual marine turtles transiting the area, no population level effects would be expected.

A behavioural response (avoidance) is likely to occur prior to marine turtles coming close to the MODU or Vessel while conducting the activity. It is therefore expected that marine turtles will not experience mortality and potential mortal injury from the drilling program.

TTS and Behavioural Responses

Behavioural responses by marine turtles from impulsive sound, including rising to the surface and altered swimming patterns, have been elicited in caged animals exposed to a seismic sound source at received levels of 153 dB SEL (McCauley et al. 2000), estimated to be within 1 km of the source (Table 5-8), which is a conservative source in comparison to VSP.

The area affected by sound levels that can cause behavioural responses does not contain critical habitat or BIAs for marine turtles and is in open ocean where marine turtles can move away from increased sound levels. It is anticipated that potential sound generated behavioural effects on marine turtles is unlikely to have a significant impact on individuals or at a population level.

Therefore, the assessed environmental impact severity for impulsive and continuous underwater sound emissions is Level 1 - Negligible for marine reptiles.

Fishes

Mortality, Potential Mortal Injury and TTS

The EMBA is likely to contain pelagic fish species (fish with swim bladders used for hearing), sharks and rays (fish without swim bladders) and syngnathid (fish with swim bladders used for hearing) species or habitats for those fish species. In terms of important behaviours, the EMBA overlaps the Whale Shark BIA for foraging behaviours along the 200 m isobath. However, the Approved Conservation Advice for the Whale Shark does not identify sound emissions as a threat (Table 1-4). There are no features (lack of distinct habitat features or conditions for site-attached fishes) within the area exposed to increased sound levels where fishes are likely to be site-attached in large numbers.

The potential for Mortality, Potential Mortal Injury and TTS has been estimated to be within the following ranges based upon the propagation calculations shown in Table 5-8 for dB PK and using thresholds identified in Table 5-9:

- **Impulsive Source** - Mortality or Potential Mortal Injury may occur if fishes of all hearing sensitivities (with or without swim bladder) are present within less than 50 m of the impulsive source.
- **Continuous Source** - Recoverable Injury may occur if hearing sensitive fishes (with swim bladder) are present within less than 10 m of the continuous source. TTS may occur if hearing sensitive fishes (with swim bladder) are present within less than 50 m of the continuous source.

Potential for recoverable injury to fishes without a swim bladder from continuous sound from shipping is suggested to be of low risk while the potential for TTS has a moderate risk within tens of metres of the sound source (Popper et al 2014; Table 5-8). As there are no features within these ranges where fish are likely to be site-attached, only individual transient and foraging fish or common bottom-dwelling fish are expected to be near the support vessels.

Studies to date have not shown fish mortality from exposure to seismic sound sources under field-operating conditions; though prolonged or extreme exposure to high-intensity, low-frequency sound, may lead to physical damage such as threshold shifts in hearing or barotraumatic ruptures (DFO 2004; Carroll et al. 2017). Prolonged exposure of wild, unrestrained, transient fish from stationary VSP activities within close enough proximity for injury is considered negligible. It is therefore expected that fishes are unlikely to experience mortality, potential mortal injury and TTS during the activity.

Behavioural Responses

There are no quantitative criteria for behavioural responses of fish to impulsive sound. Popper et al. (2014) considered the likelihood of behavioural responses based as a function of distance between fishes and the sound source. Popper et al (2014) did not quantify distances because of insufficient data but suggests fishes are highly likely to exhibit a behavioural response to continuous sound within tens of metres of the sound source and impulsive sound within hundreds of metres from the sound source. Behavioural response (startle and avoidance) is therefore likely to occur prior to fish coming close to the MODU or support vessels.

Seismic source discharges have been reported to elicit varying degrees of startle and alarm response in caged fish, however, studies on unrestrained fish are scarce (Carroll et al. 2017). Wardle et al. (2001) exposed free ranging marine fish inhabiting an inshore reef to sounds from a seismic source (195-218 dB re 1 µPa) found fish exhibited a startle response but no avoidance behaviour was observed. A study of captive marine fish exposed to a single sound source off the coast of Western Australia observed that fish returned to their pre-sound exposure position within 31 min after the final seismic signal for the study (Fewtrell and McCauley 2012).

In relation to continuous sound, changes to fish schooling patterns and distribution have been observed from the presence of commercial shipping, ferries and research vessels (McPherson et al. 2016).

Based on the observations of these studies, impulsive and continuous sound generated from the drilling program is likely to result in temporary and short-range displacement to transient and foraging fish. McCauley noted that the temporary, short-range displacement of pelagic or migratory fish populations may have insignificant repercussions at a population level (McCauley 1994). The area affected by sound levels that can cause behavioural responses (within hundreds of metres from the sound source) does not contain critical habitat or BIAs for fishes and is in open ocean where fish can move away from increased sound levels. Based on this assessment, it is anticipated that the potential sound generated behavioural effects on fishes unlikely to have a significant impact on individuals or at a population level.

Therefore, the assessed environmental impact severity for impulsive and continuous underwater sound emissions is Level 1 – Negligible for fishes.

Plankton

Based on scientific literature and underwater acoustic modelling (McCauley et al 2017, McPherson et al. 2016, Richardson et al 2017), planktonic organisms likely to be affected significantly by acoustic source discharges include eggs, larvae and other zooplanktonic organisms within 1.2 km of a sound source. An assessment on the potential for sound from the VSP source to cause mortality in eggs, larvae and zooplanktonic organisms has been undertaken using a combination of the seismic threshold values proposed by Popper et al and a qualitative discussion of available literature on seismic surveys (McCauley et al. 2017 cited in Richardson 2017; Fields et al. 2019). No data is available for mortality or damage to eggs and larvae from shipping and continuous sound (Popper et al 2014).

- **Impulsive Source** – Using the SPL PK measure, mortality or potential mortal injury may occur if plankton is present within less than 50 m of the impulsive source.

McCauley et al (2017 cited in Richardson 2017) conducted a study which observed the impact of seismic activity on zooplankton to be within 1.2 km of the sound source. Contrary to McCauley et al (2017), Fields et al (2019) conducted a study which observed no immediate mortality at distances greater than 5 m from a seismic airgun. Either range cited does not overlap fish spawning grounds, critical primary productive habitat such as coral reefs or the Whale Shark foraging behaviours BIA located northward from Ningaloo along the 200 m isobath. Primary productivity within the NWMR is generally low and this is also to be expected within the area with the potential to illicit injury to eggs and larvae.

Saetre and Ona (1996 cited in Popper et al 2014) concluded that mortality rates caused by exposure to seismic sounds are so low compared to natural mortality that the impact from seismic surveys must be regarded as insignificant. Based upon the understanding that:

- natural mortality of plankton (including fish larvae) is quite high, in the order of 21.3% per day (Houde and Zastrow 1993), and
- fast growth rates of zooplankton, and the dispersal and mixing of zooplankton from both inside and outside of the impacted region and therefore expected to rapidly recover (Richardson et al 2017),

potential impacts are expected to be localised to within close proximity of the sound source and temporary in nature due to the short duration of VSP activity and rates of recovery. Findings of a study by Richardson et al (2017) concluded a substantial impact on zooplankton from a 39 day seismic survey was identified on a local scale (within 15 km of the survey area); however on a regional scale the impacts were minimal. Over time zooplankton biomass recovered to pre-seismic survey conditions within 15 km of the survey area only 3 days following the completion of the survey.

Consequently, potential impacts to planktonic organisms from the drilling program, which is expected to have much less of an impact than a seismic survey, is not expected to have a significant impact at a population level.

Therefore, the assessed environmental impact severity for impulsive and continuous underwater sound emissions is Level 1 - Negligible for plankton.

Commercial Fisheries

Reduction in Catch Rates for Fishes

The potential impact assessment of underwater sound to fishes as described above indicated that fishes will generally avoid sound sources generated by the activity. The likely impacts on fishes are expected to be limited to short-term behavioural responses, including avoidance of the operating acoustic source. It is highly unlikely that underwater sound emissions would cause lethal and sub-lethal injuries, with no immediate and delayed mortality and physiological effects.

The potential impact assessment of fish eggs and larvae as previously described indicated that mortality rates by exposure to impulsive sounds are so low compared to natural mortality it must be regarded as insignificant.

Cumulatively, the temporary avoidance of fish species and insignificant mortality of fish eggs and larvae within the Operational Area may have the potential to impact commercial fisheries through a reduction in catch rates. While commercial fishing licences overlap the Operational Area, FishCube historical data between 2014-2018 shows variable fishing activity from State fisheries that target fishes: Pilbara Fish Trawl (Interim) Managed Fishery, Pilbara Trap Managed Fishery and Pilbara Line Fishery. Underwater sound generated by support vessels are anticipated to reflect existing background levels given shipping operations within the Operational Area. Underwater sound generated from VSP operations are generally undertaken over a period of 24 hours. Temporary VSP operations are unlikely to impact variable fishing activity within the Operational Area. It is therefore expected that a reduction in catch rates for fishes is not a credible impact as a result of the drilling program.

Reduction in Catch Rates for Benthic Invertebrates

McCauley (1994) proposed that seismic surveys must be run in very shallow water to influence the hearing mechanisms of invertebrates. McCauley (1994) suggested zones of effect for invertebrates as follows:

- Audible zone - 20 m from the source,
- Response zone - 10 m from the source,
- Pathological zone - 2 m from the source.

A review by Moriyasu et al. (2004) indicated that behavioural responses such as startle response and rapid swimming have generally been observed for benthic invertebrates when exposed to seismic sources at close ranges. A few studies also generally found unaffected catch levels in fisheries targeting benthic crustaceans after exposure to seismic surveys (Andriguetto-Filho et al. 2005; Parry & Gason 2006; Day et al. 2016). These studies have indicated that only surveys occurring in very shallow water would have observed impacts to benthic invertebrates. A conservative figure for the minimum depth for a response would be 15 m from the source (McCauley 1994). Application of this response range for VSP activities is therefore considered highly conservative. Water depth at the Ironbark-1 exploration well is in the order of 300 m, therefore benthic invertebrates are considered out of range to be potentially impacted.

The only Commonwealth fishery to have active operations within the Operational Area is the North West Slope Trawl fishery. This fishery targets three commercially important species of scampi (*M. velutinus, M. australiensis, and M.boschmai*) which are usually fished between 260 to 500 m water depths. Given benthic invertebrates are out of range for potential impact, it was determined that the proposed activities are not expected to result in an impact to commercial operations (via loss of catches) of benthic invertebrates.

Inherent / Design Control Measures (Validated Control Measures) and Good Practice Control Measures

Control Measure	Context of Control Measures
Marine Fauna Observer	EPBC Act Policy Statement 2.1 – Interaction between Offshore seismic exploration and whales: Part A describes practical standards to minimise the risk of acoustic injury to whales in the vicinity of seismic survey operations. These include procedures for start-up and shutdown, and night-time/low-visibility operations. These are required to be implemented for VSP activities associated with drilling programs.
Pre-start monitoring procedures	
Start-up procedures	
Power down procedures	
Shutdown procedures	
Operations procedures	

Low-visibility / night-time procedures			
Impact Severity Level (Table 4-2)			
Aspect	**Impact Severity Level (Table 4-2)**		
Impulsive underwater sound emissions	1 Negligible		
Continuous underwater sound emissions	1 Negligible		
ALARP Decision Context (Table 4-5)			**Type**
Although the drilling program will generate sound, the effects associated with short duration VSP operations, and vessel and MODU operations are well understood and regularly practised offshore. No values or sensitivities, within the range of potential impact, were identified that indicate sound-sensitive species would be practising sedentary behaviours, and given the open nature of the marine environment, it is not expected that any behavioural disturbance would result in impacts greater than incidental changes to transitory behaviours, with population impacts from changes to migration behaviours not expected. The inherent controls are requirements of Commonwealth legislation and relevant industry standards and generally well implemented by the industry. The risk matrix presented within the Conservation Management Plan for Blue Whales (DoE (2015)) (LF cetacean) provides a risk rating of low to moderate associated with industrial and shipping noise. Given inherent controls and relevant industry standards are applied, controls align with the priority for action recommended in this management plan. The Department of Primary Industries and Regional Development (DPIRD) was a stakeholder who identified an interest in impacts of our activities on fish stocks, marine habitats and fishing and requested additional information on controls BP will implement to demonstrate ALARP. The Australian Southern Bluefin Tuna Industry Association (ABSTIA) was a stakeholder who identified an interest in impacts of our activities on fish stocks. We continue to engage with DPIRD on information requests, to date no objection or claim has been identified. ALARP Decision Context Type A applies. Inherent controls are good practice. Although underwater sound emissions are ranked as Decision Context Type A, additional control measures have been considered to demonstrate that potential impacts to pygmy blue whales within the migration BIA are ALARP.			A
ALARP Decision Context A – Additional Assessment			
Control Measure	**Benefit**	**Cost**	**Outcome**
Conducting the activity outside of peak migratory periods for pygmy blue whales.	Peak migration periods for blue whales along the coast of Western Australia are reported in the literature as northbound from mid-February to early June; and the southbound from mid-November to early January (Gavrilov et al., 2018). BP has considered conducting the activity outside of peak migratory periods for pygmy blue whales/sound sensitive marine fauna; however the timing of the activity is dependent on	If BP was to avoid periods of pygmy blue whale migration (northbound: from mid-February to early June; southbound: from mid-November to early January), this would require BP to bring forward its drilling program to start in July/August; or further delay until Q3 2021, which would result in BP not meeting permit drilling commitments and facing increased costs (e.g. from additional MODU	Not selected.

	MODU scheduling. MODU availability and operational requirements would limit the ability for the activity to be undertaken outside of peak migratory periods for sound sensitive marine fauna.	operating costs) which would make the project unviable. The area of potential impact is small (approx. 0.003% overlap of the pygmy blue whale migration BIA) and impacts can be managed to an acceptable level via the implementation of existing controls. The cost of implementation of this additional control is disproportionally higher than the benefit. The control of conducting the activity outside of peak migratory periods for pygmy blue whales is not considered feasible and therefore not selected.	
Increasing the safe operating distance to whales to 2 km when vessels/MODU are within the operational area during periods of increased pygmy blue whale presence.	EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans describes strategies to ensure whales and dolphins are not harmed during offshore interactions with vessels and helicopters. Typically, vessels follow the EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans in relation to distances to cetaceans. These regulations stipulate a safe operating distance of 300 m. As the activity has the potential to be undertaken within the pygmy blue whale migration, where drilling is being conducted between mid-November and early January and mid-March to June, the safe operating distance to whales could be increased to 2 km when vessels are within the operational area. The maximum distance of 2 km is the cumulative continuous sound assessment boundary used to define the potential area where PTS and TTS impacts to MF and LF cetaceans may occur. If a 2 km distance is maintained between MF and LF cetaceans and vessels/MODU, pygmy blue whales will not experience PTS or TTS as a result of the sound generated by the vessels/MODU. Using 2 km adds a level of conservatism to the safe operating distance. As the PTS/TTS criteria is determined over a 24-hour period, the	The control of increasing the safe operating distance to whales to 2 km when vessels/MODU are within the operational area has not been selected. This additional control will not be selected given pygmy blue whales are commonly distributed in water depths over 1000 m (outside the defined migration BIA corridor centred between the 500 and 1000 depth contours, and outside the cumulative sound assessment boundary for LF cetaceans). When considering the defined pygmy blue whale migration corridor, the area of potential impact is small (the cumulative continuous sound assessment boundary used to define the potential area where PTS and TTS impacts to MF and LF cetaceans may occur extends over approx. 0.003% of the pygmy blue whale migration BIA). Potential impacts from sound generated by the activity can be managed to an acceptable level via the implementation of EPBC Act Policy Statement 2.1, and the cost of implementation of the additional control is disproportionally higher than the benefit.	Not selected.

	vessels/MODU would need to be within 2 km of a whale for 24 hours for PTS/TTS impacts to occur. Thus, night-time surveillance is not required to ensure whales that may be in the area for 24 hours are not impacted.		
Pre-start observations for drilling activities.	It is unlikely that whales would come into the area where sound levels are above the PTS and TTS criteria once the MODU and vessel(s) are on location. However, they may be disturbed if they are present in the area. To ensure whales undertaking biologically important behaviour such as migrating through the operational area are not impacted by the activity, the following pre-start observations could be implemented if drilling is undertaken from mid-February to early June or mid-November to early January when pygmy blue whales are migrating: - Observations by a person who has proven experience in whale observation, distance estimation and reporting will be undertaken from the MODU out to 2 km for 30 minutes prior to commencing drilling. If whales are present within the 2 km zone drilling will not commence until they have moved outside the 2 km zone or 30 minutes has lapsed since the last whale sighting within 2 km. - Observations by a person who has proven experience in whale observation, distance estimation and reporting will be undertaken from the MODU out to 2 km for 30 minutes prior to commencing resupply operations. If whales are present within the 2 km zone the resupply vessel will not come closer than 2 km of the whale/s and resupply will not commence until the whale/s have moved outside the 2 km zone or 30 minutes has lapsed since the last whale sighting within 2 km. - Drilling is unlikely to commence at night, however, if it is required it may only occur if there have been no whales sighted within the corresponding	The control to include pre-start observations for drilling activities has not been selected. This additional control will not be selected given pygmy blue whales are commonly distributed in water depths over 1000 m (outside the defined migration BIA corridor centred between the 500 and 1000 depth contours, and outside the cumulative sound assessment boundary). When considering the defined pygmy blue whale migration corridor, the area of potential impact is small (the cumulative continuous sound assessment boundary used to define the potential area where PTS and TTS impacts to MF and LF cetaceans may occur extends over approx. 0.003% of the pygmy blue whale migration BIA).	Not selected.

	observations zones in the preceding daylight hours. Commencing drilling at night if no whales have been sighted within the corresponding observations zones in the preceding daylight hours is acceptable as the MODU would have been on location for a period prior to the activity commencing so the presence of whales within the observation zones would be known. 2 km is deemed an appropriate distance for the vessel/MODU based on the modelled distance of 2 km cumulative continuous sound assessment boundary. 30 minutes is deemed appropriate to account for maximum migratory dive duration of 26.7 min for pygmy blue whales (Owen et al., 2016).		
Not conducting VSP	No benefit – control is not feasible.	VSP is required for well logging which is should not be limited to a certain timeframe as it is considered critical for well data interpretation.	Not selected

Acceptability Assessment

Potential impacts associated with underwater sound emissions are ranked as Decision Context Type A, therefore the selected controls are considered inherently acceptable and no further evaluation is required.

Performance Management

Environmental Performance Outcomes	Performance Standards	Measurement Criteria	Responsibility
Undertake the activity in a way that does not result in: • Injury to blue whales within known BIAs or displacement of blue whales from a foraging area. • a substantial adverse effect on a population of marine fauna, including its life cycle and spatial distribution.	**Marine Fauna Observer** At least one dedicated MFO (with no other duties) will be on active duty during daylight hours when VSP activities are undertaken	Records demonstrate MFO's presence during VSP activities for daylight hours	Wells Superintendent
	Pre-start procedures Pre-start visual observations will be conducted out to the extent of the observation zone (3 km horizontal radius from the VSP acoustic source) for at least 30 minutes before commencing the soft start	VSP operations report verifies that pre-start visual observations were conducted	Wells Superintendent
	Shutdown procedures The MFO on active duty will ensure observation and shutdown zones are adhered to, including the requirement to shut down VSP activity if any cetaceans are sighted within the shutdown zone: • Observation zone: 3 km horizontal radius from the VSP acoustic source	VSP operations report verifies observation, powerdown and shutdown zones were adhered to	Wells Superintendent

• modification, destruction or isolation of an area of important habitat for a migratory species. • serious disruption to the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species. • a substantial adverse effect on the sustainability of commercial fishing. • interference with other marine users to a greater extent than is necessary for the exercise of right conferred by the titles granted.	• Power down zone: 2 km horizontal radius from the VSP acoustic source • Shutdown zone: 500 m horizontal radius from the VSP acoustic source		
	Start-up procedures • A soft start-up procedure will commence if no cetaceans have been sighted within the shutdown zone during the pre-start visual observations • The soft start-up will include starting the VSP acoustic source at the lowest setting, gradually ramping up the acoustic source over a 20-minute period until full operating power is reached	VSP operations report verifies that soft start-up procedures commenced in pre-start visual observations and soft start-up was implemented over a 20-minute period	Wells Superintendent
	Operations procedures • Continuous visual observations of the extent of the observation zone (3 km horizontal radius from the VSP acoustic source) to identify if any cetaceans are present • If a cetacean is sighted within the observation zone, the operator of the acoustic source will be placed on standby to power down the acoustic source • If a cetacean is sighted within the shutdown zone, the acoustic source will be shut down completely	VSP operations report verifies operational procedures were implemented	Wells Superintendent
	Low-visibility / night-time procedures During periods of low visibility (including night-time), where observations cannot be clearly conducted out to the extent of the observation zone (3 km horizontal radius from the VSP acoustic source), the VSP source will be used in accordance with the Operations Procedures, provided that during the preceding 24-hour period: • there have been fewer than three cetacean-instigated shutdown situations • a two-hour period of continual observations was undertaken in good visibility (out to the extent of the observation zone) and no cetaceans were sighted	VSP operations report verifies low-visibility procedures were implemented	Wells Superintendent

5.6 Atmospheric Emissions

The potential impacts associated with atmospheric emissions are evaluated in Table 5-12.

Table 5-12: Impact Assessment: Atmospheric Emissions

Planned Activity
The following activities were identified as having the potential to result in the generation of atmospheric emissions: • MODU operations (Section 2.3.2) • Vessel operations (Section 2.4).

Potential Impact Associated with Atmospheric Emissions
Location of Potential Impact - Air
Atmospheric emissions have the potential to result in chronic effects to sensitive receptors from localised and temporary decrease in air quality. The sensitivity of environmental receptors to changes in ambient air quality (relevant to this activity) was reviewed to understand potential impact thresholds of this release to identified values and sensitivities (Table 5-13).

Table 5-13: Sensitivity of Receptors to changes in Atmospheric Emissions

Reference	Summary
National Environment Protection (Ambient Air Quality) Measure	The Australian Ambient Air Quality National Environmental Protection (Air Quality) Measures (NEPM) recommends that hourly exposure to NO_2 is <0.12 ppm and annual average exposure is <0.03 ppm.

As there is limited information regarding impacts to environmental receptors from changes in air quality and using impacts on human health as a proxy for environmental receptors, an impact threshold of 0.03 ppm (NO_2) has been used in this evaluation.

The quantities of atmospheric emissions generated by diesel generators on the MODU and support vessels, and related impacts, will be temporary and similar to other vessels operating in the NWMR. Atmospheric emissions are likely to include greenhouse gases, including carbon dioxide (CO_2) and methane (CH_4), and other gases such as oxides of sulphur (SOx) and nitrogen (NOx), as well as particulate matter (PM) which have the potential to result in chronic effects to sensitive receptors from localised and temporary decrease in air quality.

Modelling was undertaken for nitrogen dioxide (NO_2) emissions from MODU power generation for another offshore BP project (BP 2013). NO_2 is the focus of the modelling because it is considered the main atmospheric emission of concern based on the larger predicted volumes as compared to other emissions (SOx, CO and non-methane hydrocarbons) and its potential to impact upon the environment. Modelling indicates that on an hourly average, there is the potential for an increase in ambient NO_2 concentrations of 0.0005 ppm within 10 km of the source and an increase of less than 0.00005 ppm in ambient NO_2 concentrations more than 40 km away. The modelling also indicates that the highest hourly averages of 0.00039 ppm were restricted to a distance of approximately 5 km from the MODU (BP 2013). While this modelling was carried out for a different MODU, the modelled distances provide a good measure of the order of magnitude over which an increase in ambient concentration could be predicted.

Using the NEPM, atmospheric emissions emitted during the drilling program are expected to be below hourly exposure levels immediately adjacent to the source. Noting that within this area, no particular values and sensitivities were identified as having the potential to be exposed to changes in atmospheric emissions.

Based on the distance to sensitive habitats, limited sensitivities, and expected outcome that limited exposure will not result in any impacts, the environmental impact severity was assessed to be Level 1 - Negligible.

Inherent / Design Control Measures (Validated Control Measures) and Good Practice Control Measures	
Control Measure	**Context of Control Measures**
Reduced sulphur content fuel	Sulphur content of diesel/fuel oil complies with Marine Order Part 97 and Regulation 14 of MARPOL 73/78 Annex VI (fuel oil with sulphur content less than 3.50% mass/mass)
Marine Orders – Part 97: Marine Pollution Prevention – Air Pollution	All vessels and MODU will comply with Marine Orders – Part 97: Marine Pollution Prevention – Air Pollution (appropriate to vessel class) for emissions from combustion of fuel including: • vessels will hold a valid International Air Pollution Prevention (IAPP) certificate and a current international energy efficiency (IEE) certificate. • All vessels (as appropriate to vessel class) will have a Ship Energy Efficiency Management Plan (SEEMP) as per MARPOL 73/78 Annex VI. • Vessel engine NOx emission levels will comply with Regulation 13 of MARPOL 73/78 Annex VI. • Operation of engines, generators and deck equipment in accordance with manufacturer's instructions and ongoing maintenance to ensure efficient operation.
Impact Severity Level (Table 4-2)	

1 Negligible	
ALARP Decision Context (Table 4-5)	**Type**
Atmospheric emissions from vessel and MODU power generation are a common type of emissions that are experienced both nationally and internationally. Emissions will be low in comparison to other marine traffic and will be reduced to below measurable levels in close proximity to the release location. The inherent controls are well understood requirements of Commonwealth legislation and generally well implemented by the industry. No objections or concerns were raised during stakeholder consultation regarding this activity or its potential impacts and risks. ALARP Decision Context Type A applies. Inherent controls are good practice and no control measures beyond good practice are required.	A
Acceptability Assessment	
Potential impacts associated with atmospheric emissions are ranked as Decision Context A, therefore the existing controls are considered inherently acceptable and no further evaluation is required.	

Performance Management

Environmental Performance Outcomes	Performance Standards	Measurement Criteria	Responsibility
Undertake the activity in a way that does: • not result in chronic effects to sensitive receptors from localised and temporary decrease in air quality. • not have a substantial adverse effect on a population of marine fauna, including its life cycle and spatial distribution. • not modify, destroy or isolate an area of important habitat for a migratory species. • not seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	**Reduced sulphur content fuel** Only low-sulphur (<3.5% m/m) marine-grade diesel will be used in order to minimise SOx emissions.	Bunker receipts verify the use of low-sulphur marine grade diesel.	Vessel Master and Offshore Installation Manager
	Marine Orders – Part 97: Marine Pollution Prevention – Air Pollution All combustion equipment is maintained in accordance with the Preventative Maintenance System (PMS) (or equivalent).	PMS records verify that combustion equipment is maintained to schedule.	Vessel Master and Offshore Installation Manager
	Marine Orders – Part 97: Marine Pollution Prevention – Air Pollution Vessels with diesel engines>130 kW must be certified to emission standards (e.g. IAPP, EIAPP).	Certification documentation	Vessel Master and Offshore Installation Manager
	Marine Orders – Part 97: Marine Pollution Prevention – Air Pollution Vessels implement their Ship Energy Efficiency Management Plan (SEEMP) to monitor and reduce air emissions (as appropriate to vessel class).	SEEMP records verify energy efficiency records have been adopted.	Vessel Master and Offshore Installation Manager
	Marine Orders – Part 97: Marine Pollution Prevention – Air Pollution Fuel consumption is monitored on vessels (and portable back-deck	Fuel use is recorded in the daily operations reports.	Vessel Master and Offshore Installation Manager

	equipment) and abnormally high consumption investigated.		

5.7 Planned Discharges

The activities described in this plan have been evaluated to identify all planned discharges to water. This evaluation included both operational discharges (associated with drilling activities) and standard discharges associated with general marine operations. This evaluation identified the following temporary discharge waste streams associated with planned discharges for the Ironbark Exploration Drilling Program:

- Drilling fluids and cuttings,
- Cement and spacer fluids,
- BOP control fluids,
- Cooling water and brine,
- Sewage, greywater and putrescible waste, and
- Firefighting foam.

The potential impacts associated with these discharges are evaluated in the following sections.

5.7.1 Drilling Fluids and Cuttings

The potential impacts associated with drilling fluids and cuttings discharges are evaluated in Table 5-14.

Table 5-14: Impact Assessment: Drilling Fluids and Cuttings

Planned Activity
The following activities were identified as having the potential to result in a planned release of drilling fluids and cuttings: • Exploration drilling operations (Section 2.3.3). • Contingency drilling operations (Section 2.3.4). Planned releases of drilling fluids and cuttings, as detailed in Table 2-5, have the potential to result in an impact to values and sensitivities in the water column through: • Turbidity, and • Chemical toxicity, and values and sensitivities associated with the seabed through: • Smothering and sedimentation, and • Chemical toxicity.
Potential Impact Associated with Drilling Fluids and Cuttings Discharges
Location of Potential Impact - Water Column
Turbidity The sensitivity of environmental receptors to temporary changes in Total Suspended Solids (TSS) was reviewed to understand potential impact thresholds associated with this planned release. Drilling fluids and cuttings typically consist of coarse cuttings particles, fine drilling mud particles from viscous bentonite pills and barite weight materials. A summary of the literature used to inform this assessment is included as Table 5-15.

Table 5-15: Sensitivity of Receptors to changes in TSS

Reference	Summary
Smit et al. (2008)	Lethal median concentration of suspended bentonite and barite to 12–15 species of pelagic biota was 1830 mg/L and 3010 mg/L, respectively.
Nelson et al. (2016 cited in RPS 2019)	Predicted total suspended solids concentrations of <10 mg/L as a minimal or no effect, whilst concentrations above 10 mg/L have a sublethal effect to pelagic biota.
IOGP (2016)	Cite that very high concentrations (>1830 mg/L) of TSS has been shown to result in mortality of pelagic biota.
Todd et al. 2015	Increased turbidity… is unlikely to have a substantial direct impact on marine mammals that often inhabit naturally turbid or dark environments.

For the purpose of conducting a conservative assessment to receptors with the potential to be impacted by this activity, an impact threshold of 10 mg/L, based upon Nelson et al. (2016) cited in RPS (2019), was selected to determine the extent to which the environment may be exposed to TSS concentrations above impact concentrations.

Modelling was commissioned by BP to understand the predicted extent of exposure associated with drilling fluid discharges based on the volumes detailed in Table 2-5. Using the impact threshold of 10 mg/L, modelling predicted that the environment may be affected via turbidity impacts up to approximately 4 km away, and the estimated area affected by concentrations of 10 mg/L limited to an area of 3 km^2 (RPS 2019).

Simply, it is expected that approximately 4 km away from the MODU, turbidity concentrations are below thresholds that have the potential to cause environmental impacts. As the average monthly oceanic currents in this region range from 0.16-0.27 m/s these discharges are expected to disperse below 10 mg/L, conservatively, within ~3 minutes. Given the rapid dilution and dispersion associated with this temporary release, an impact threshold of 1830 mg/L (IOGP (2016) over a shorter exposure period (assumed instantaneous) was considered more appropriate for this release. Exposures to TSS in the order of 1830 mg/L were not reached, such that a modelling-predicted maximum TSS concentration of 1632 mg/L was immediately adjacent to the discharge point (<30 m), which is below the 1830 mg/L threshold.

Along with plankton and transient marine fauna that are present within the marine environment, the particular values and sensitivities with the potential to be exposed to this discharge include:

- Blue Whale (migration and presence).

Chosen impact thresholds are based upon species that are more sensitive to changes in turbidity (coral) rather than identified particular values and sensitivities (Blue Whales). Modelling indicates that exposures above 10 mg/L are expected to be limited to within approximately 4 km of the indicative well location.

Given the rapid dilution (and limited exposure to TSS concentrations above impact thresholds), direct impacts to matters of NES and transient marine fauna are not expected, with direct impacts limited to planktonic organisms that are unable to avoid or move through the discharge plume. Indirect impacts to transient fauna may be experienced where those species rely on planktonic organisms as a food source.

No particular values or sensitivities linked to planktonic foraging or increased planktonic abundance have been identified as having the potential to be affected by this discharge within approximately 4 km, thus indirect impacts to matters of NES and other transient fauna species that prey on plankton are not expected.

Plankton communities have a naturally patchy distribution in both space and time (ITOPF 2011). Plankton populations have evolved to respond to these environmental perturbations by copious production within short generation times (ITOPF 2011 and UNEP 1985). They are known to have naturally high mortality rates (primarily through predation), however once water quality returns to ambient, plankton populations will return to previous conditions.

Increased turbidity is unlikely to have a substantial direct impact on marine mammals that often inhabit naturally turbid or dark environments (Todd et al. 2015) given marine mammals such as Blue Whales depend on sound to communicate.

As the potential environmental impact has been determined as having a localised and minor negative impact on the environment, the environmental impact severity has been ranked as Level 1 - Negligible.

Chemical Toxicity

The sensitivity of environmental receptors to changes in water quality associated with drilling fluids was reviewed to understand potential impact thresholds associated with this planned release. A summary of the literature used to inform this assessment is included as Table 5-16.

Table 5-16: Sensitivity of Water Column Receptor Exposure to Drilling Fluids Chemicals

Reference	Summary
US EPA	The US EPA Oil and Gas Extraction Point Source Category; Offshore Subcategory Effluent Limitations Guidelines and New Source Performance Standards have a limit for toxicity set 96-hr LC50 of 30,000 ppm
Neff et. al. (2005)	Noted that 62 species of marine animals from the Atlantic and Pacific Oceans, the Gulf of Mexico, and the Beaufort Sea had been tested in 400 bioassays with 72 different WBM (National Research Council, 2003). Nearly 80 percent of the median lethal concentrations (96-h LC50) recorded were greater than 10,000 mg/L (ppm) drilling fluid, which is considered non-toxic by IMO's Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection toxicity classification.
Garcia et al. (2014)	No observed effect concentration (NOEC) for SBM that do not form turbid suspension in the water column was defined as 10, 000 mg/L to 30,000 mg/L..
Aldredge et al. (1986 cited in US EPA 2013)	Noted that significant biological effects of WBM and WBM chemicals on phytoplankton communities from the Santa Barbara Channel could not be detected.
EPA (2000 cited in IOGP 2016)	Noted that because non-aqueous based fluid drill cuttings are hydrophobic and do not disperse or dissolve in the water column, toxicity tests with water column organisms, such as phytoplankton, zooplankton, and water column crustaceans, are not appropriate for assessing environmental performance of drill cuttings. Results of studies reviewed by IOGP (2016) indicate that where dilution is rapid, discharge of WBM and SBM drill cuttings would not significantly alter the primary production of natural phytoplankton assemblages in the vicinity of the drilling activity.
Jones et al.(1996 cited in Neff et al. 2005)	Due to the inert / PLONOR nature of its components, water-based drilling fluids have been shown to have little or no toxicity to marine organisms

Studies listed in Table 5-15 highlight the low toxicity of modern WBMs and SBMs and that marine water column organisms such as phytoplankton, zooplankton and water column crustaceans are at low risk of harm from drill cutting discharges.

Along with marine water column organisms such as plankton, particular values and sensitivities such as transient marine fauna that are present within the marine environment, that may be exposed to this discharge include:

- Blue whale (migration and presence).

Given the rapid dilution (and low risk of toxicity to species that are more sensitive to changes in toxicity i.e. phytoplankton and zooplankton), direct impacts to matters of NES and transient marine fauna are not expected, with direct impacts limited to planktonic organisms that are unable to avoid or move through the discharge plume. Indirect impacts to transient fauna may be experienced where those species rely on planktonic organisms as a food source.

No particular values or sensitivities linked to planktonic foraging or increased planktonic abundance have been identified as having the potential to be affected by this discharge, thus indirect impacts to MNES and other transient fauna species are not expected.

Plankton communities have a naturally patchy distribution in both space and time (ITOPF 2011). Plankton populations have evolved to respond to these environmental perturbations by copious production within short generation times (ITOPF 2011 and UNEP 1985). They are known to have naturally high mortality rates (primarily through predation), however once water quality returns to ambient, plankton populations will return to previous conditions.

As the potential environmental impact has been determined as having an immediate, negligible impact on the environment, the environmental impact severity has been ranked as Level 1 - Negligible.

Location of Potential Impact – Seabed

Smothering, Sedimentation and Toxicity

The sensitivity of environmental receptors to smothering, sedimentation and toxicity associated with drilling fluid discharges was reviewed to understand potential impact thresholds of this release to identified values and sensitivities. A summary of the literature used to inform this assessment is included as Table 5-17.

Table 5-17: Sensitivity of Receptor Exposure to Smothering, Sedimentation and Toxicity

Study	Summary
Smit et al. (2008)	Noted that a 50% hazardous level of sediment burial was 54 mm.
Kjeilen-Eilertsen et al. (2004)	Described that sediment thickness greater than 9.6 mm may cause smothering impacts to benthic ecosystems
IOGP (2016)	A summary of various studies determined that ecological impacts would only be expected when sediment deposition exceeded a thickness greater than 6.5 mm.
Terrens et al. (1998)	• Biological effects were observed within 100 m of the drilling site shortly after drilling; recovery of seabed communities across the area were reported within four months. • SBM was not detectable in sediments after 11 months • Seabed recovery was identified as occurring via a combination of dispersion and biodegradation
Trannum et al. (2009 cited in RPS 2019)	Identified a significant decrease in species count, abundance of individuals, and biomass of marine animals with deposited cuttings 3-24 mm.

For the purpose of conducting a conservative assessment, a highly conservative impact threshold of 1 mm was chosen to evaluate potential impacts from cuttings deposition.

Modelling was commissioned by BP to understand the predicted extent of exposure associated with drilling fluid discharges based on the volumes detailed in Table 2-5. Using a highly conservative impact threshold of 1 mm, modelling predicted that the environment may be affected via deposition of drill cuttings up to 1.24 km away (RPS 2019). The modelling also indicates that deposition thickness to the high exposure threshold of 10 mm is within 400 m of the indicative well location (RPS 2019).

No particular values and sensitivities were identified within 1.24 km of the indicative well location, with the benthic environment limited to soft-sediment communities. Preliminary geophysical data and photographic records from grab samples taken during the surveys suggest that the seabed is devoid of hard seafloor or distinct sediment facies, with only soft sediment observed (Section 3.3.2.1).

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

Although these studies are associated with cold, deepwater environments, the recovery processes associated with the drilling program are expected to be similar as species present in soft sediment (characteristic of the Operational Area) are well adapted to changes in substrate, especially burrowing species (Kjeilen-Eilertsen et. al. 2004); thus a 1 year recovery period is considered suitable for providing a conservative indication of habitat recovery from this activity (Manoukian et al 2010; IOGP 2016).

As the potential environmental impact has been determined as having a localised and minor negative impact on non-sensitive habitat well-represented within the region, the environmental impact severity has been ranked as Level 2 - Minor.

Inherent / Design Control Measures (Validated Control Measures) and Good Practice Control Measures	
Control Measure	**Context of Control Measures**
Chemical selection process	A sub-point of WBG Guidance Number 59 recommends that: • operators carefully select drilling fluid additives, taking into account their concentration, toxicity, bioavailability, and bioaccumulation potential. BP will apply the chemical selection process to drilling fluid additives.
Use of seawater and viscous sweeps whilst drilling the 42" and 26" hole sections	Environmental, Health, and Safety Guidelines: Offshore Oil and Gas Development (World Bank Group (WBG) 2015) – Drilling Fluids and Drilled Cuttings Guidance (WBG Guidance) Number 53 recommends that: • 'The direct loss system is to be considered an interim solution for the first drilling phase and applied only when the chemical content is low and water-based drilling mud is used.'
Use of SBM limited to 12-1/4" and 8-1/2" sections	A sub-point of WBG Guidance Number 59 recommends that: • Water based drilling fluid be used wherever appropriate Due to the inert / PLONOR nature of its components, water based drilling fluids have been shown to have little or no toxicity to marine organisms (Jones et al., 1996). Therefore, use of SBM has been limited to intervals where it is anticipated that SBM will be required to meet the technical challenges posed by the downhole conditions.
No overboard discharge of whole SBM	WBG Guidance Number 55 and Table 1 recommends that: • disposing used whole SBM by discharge to the sea must be avoided.

Reduce toxicity in SBM by limiting heavy metal concentrations in barite	WBG Guidance Number 57 and Table 1 recommends that:
	• mercury (Hg) and cadmium (Cd) concentrations within barite are limited to:
	  ○ Hg: maximum 1 mg/kg dry weight in stock barite,
	  ○ Cd: maximum 3 mg/kg dry weight in stock barite.

Use of solids control equipment	A sub-point of WBG Guidance Number 59 recommends that operators use high-efficiency solids removal and treatment equipment to reduce and minimise the amount of residual fluid contained in drilled cuttings.
Monitor % Synthetic on Cuttings (SOC)	The industry-standard cuttings treatment technology for use with non-aqueous drilling fluids comprises shakers, cuttings dryers, and centrifuges. Shakers separate fluids from solids, thus reducing the overall volume of adhered drilling fluids discharged. Centrifuges separate cuttings from drilling fluids and the cuttings dryer minimises base fluid from adhering to the cuttings. The equipment together dramatically reduce drilling solids waste discharge and help maximise the recovery of drilling fluids. This technology is commonly used throughout the industry to achieve stringent discharge limits. Fluid discharges will be monitored to verify that SBM on cuttings is <6.9% (wet), averaged over the well sections drilled with SBM.
Submerged caisson	WBG Guidance Number 60 and Table 1 recommends that: • WBM and treated drilled cuttings discharge should be made via a caisson submerged at an appropriate depth to ensure suitable dispersion of the effluent.
Monitor % residual hydrocarbon in tank wash before discharge	USEPA Guidelines and Standards for Synthetic-Based Drilling Fluids and other Non-Aqueous Drilling Fluids (2000) detail the limitations for discharging fluids comprising residual hydrocarbons (expected to be those sections of the well drilled with SBM in the production reservoir). These guidelines were used to derive a limitation for tank-wash discharges for the drilling program—tank wash will be sampled to confirm the residual hydrocarbon in SBM tanks does not exceed 1% before discharge.

Impact Severity Level (Table 4-2)
2 Minor

ALARP Decision Context (Table 4-5)	**Type**
Planned release of drilling fluid cuttings and discharges is a common occurrence associated with both offshore exploration and production drilling activities nationally and internationally. Within the area to be exposed, there are limited values and sensitivities with the potential to be impacted. There is limited uncertainty associated with the presence of hard substrate, however uncertainty will be reduced using seabed surveys to determine presence / absence of hard substrate prior to activities commencing. Preliminary results indicate the absence of hard substrate (Section 3.3.2.1). The risk matrix presented within the Conservation Management Plan for the Blue Whale (DoE 2015) provides a risk rating of low to moderate associated with acute chemical discharge. Given inherent controls and relevant industry standards are applied, controls align with the priority for action recommended in this management plan. No objections or concerns were raised during stakeholder consultation regarding this activity or its potential impacts and risks. ALARP Decision Context Type A applies. Inherent controls are good practice and no control measures beyond good practice are required.	A

Acceptability Assessment
Potential impacts associated with planned drilling fluids and cuttings discharges are ranked as Decision Context Type A, therefore the existing controls are considered inherently acceptable and no further evaluation is required.

Performance Management

Environmental Performance Outcomes	**Performance Standards**	**Measurement Criteria**	**Responsibility**
Undertake the activity in a way that does: • not result in a change that may have a substantial adverse effect on a population of marine fauna, including its life cycle and spatial distribution, or • not result in a change that may modify, destroy or isolate an area of important habitat for a migratory species, or • not result in a change that may seriously disrupt the lifecycle	**Chemical selection process** All planned chemical discharges must be assessed and deemed acceptable before use, in accordance with BP's chemical selection process.	Records demonstrate chemical selection, assessment and approval process for selected chemicals is followed.	Drilling Engineering Team Lead (Planning) Well Site Leader (Operations)
	Use of seawater and viscous sweeps whilst drilling the 42" and 26" hole sections During riserless top-hole drilling operations seawater and viscous sweeps will be used to limit the volume of drilling chemicals discharged directly to sea. A simple water based spud mud consisting of bentonite, barite and water will be used to support the borehole prior to running the steel casing strings.	Daily drilling report confirms fluids used whilst drilling top-hole sections.	Drilling Engineering Team Lead (Planning) Well Site Leader (Operations)
	No overboard discharge of whole SBM BP will not discharge whole SBM to the environment. Recovered SBM and SBM chemicals are to be	Daily reports will include: • SBM transferred onto/off MODU • SBM on location • SBM in use • SBM losses and loss process	Well Site Leader

(breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species. • not result in a substantial change in water quality, sediment quality or air quality which may adversely impact on biodiversity, ecological integrity, social amenity or human health. • not result in a substantial change that may modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results.	recycled or sent to the mainland for treatment and/or disposal.		
	Solids control equipment / operator The solids control equipment operator will monitor solids control equipment when drilling with SBM. Responsiblities include: • functioning of equipment • appropriate shaker screen size and centrifuge speed for cuttings processing to manage %SOC	Records to show %SOC for discharged fluid is aligned with <6.9% requirement. Shaker screen sizes to be reported on the daily report.	Solids Control Equipment Operator (3rd Party)
	Monitor %SOC A %SOC <6.9% averaged over the combined well sections drilled with SBM will be verified by completing at least one full SOC test per 12-hour drilling period and recorded in accordance with API Recommended Practice 13B-2 Recommended Practice for Field Testing Oil-Based Drilling Fluids.	Records to show %SOC for discharged fluid is aligned with <6.9% requirement.	Solids Control Equipment Operator (3rd Party) Mud Engineer (3rd Party) Well Site Leader
	Submerged caisson MODU Piping and Instrumentation Drawings (P&IDs) show that the caisson is submerged below sea level. Where this is not achieved, an evaluation is to be undertaken to demonstrate that the impacts and risks are ALARP.	MODU P&IDs verify that the cuttings discharge outlet (caisson) is submerged.	Well Superintendent
	Monitor % residual hydrocarbon in tank wash before discharge Before discharge, waste water will be sampled to confirm that the concentration of residual hydrocarbon is <1%.	Records confirm discharges to sea meet <1% residual hydrocarbon content.	Mud Engineer (3rd Party)

5.7.2 Cement and Spacer Fluids

The potential impacts associated with cement discharges are evaluated in Table 5-18.

Table 5-18: Impact Assessment: Cement

Activity
The following activities were identified as having the potential to result in a planned release of cement or spacer fluids: • Exploration drilling operations (Section 2.3.6). • Contingency drilling operations (Section 2.3.4). A planned release of cement and spacer fluid has the potential to result in an impact to values and sensitivities in the water column through: • Turbidity, and

- Chemical toxicity,

and values and sensitivities associated with the seabed through:

- Smothering and alteration of habitat.

Potential Impact Associated with Cement Discharges

Location of Potential Impact - Water Column

Turbidity

Cement and spacer fluid discharges at the seabed will occur prior to installation of the marine riser. Once the riser is installed any excess cementor spacer fluid returns at surface and will be discharged via the caisson, causing a turbid plume. Other planned but non-routine cement discharges below the surface water line include incorrect cement slurry mix, cement unit testing slurry, and unused excess bulk dry cement-water mix.

Sensitivity of environmental receptors to changes in Total Suspended Solids (TSS) was reviewed to understand potential impact thresholds of this release to identified values and sensitivities. A summary of the studies used to inform this assessment is included as Table 5-15 thus is not duplicated here.

For the purpose of conducting a conservative assessment, an impact threshold of 10 mg/L based upon Nelson et al. (2016 cited in RPS 2019) was selected to be evaluated (refer to Section 5.7.1).

Modelling of cement discharges for another BP offshore drilling project (BP 2013) was used because it provides a conservative assessment of the potential extent of exposure from this activity's potential discharge of 3 m^3 per cement activity (Table 2-5). The modelling considered cement discharged directly to the seabed of 200 T per well at a rate of 1.3 m3/hour. Two hours after the start of discharge, plume concentrations were determined to be between 5 and 50 mg/L with the horizontal and vertical extents of the plume approximately 150 m and 10 m, respectively (BP 2013). Five hours after ceasing the discharge, modelling indicated that the plume had dispersed to concentrations below 5 mg/L (BP 2013).

Along with plankton and transient marine fauna that are present within the marine environment, the particular values and sensitivities with the potential to be exposed to this discharge include:

- Blue whale (migration and presence).

Chosen impact thresholds are based upon species that are more sensitive to changes in turbidity (plankton and fish larvae) rather than identified particular values and sensitivities (Blue Whales). Modelling indicates that exposures above these concentrations are expected to be limited to within 10 m of the well location.

Given the rapid dilution (and limited exposure to TSS concentrations above impact thresholds), direct impacts to matters of NES and transient marine fauna are not expected, with direct impacts limited to planktonic organisms that are unable to avoid or move through the discharge plume. Indirect impacts to transient fauna may be experienced where those species rely on planktonic organisms as a food source.

No particular values or sensitivities linked to planktonic foraging or increased planktonic abundance have been identified as having the potential to be affected by this discharge (within 10 m of the well location), thus indirect impacts to matters of NES and other transient fauna species are not expected.

Plankton communities have a naturally patchy distribution in both space and time (ITOPF 2011). Plankton populations have evolved to respond to these environmental perturbations by copious production within short generation times (ITOPF 2011 and UNEP 1985). They are known to have naturally high mortality rates (primarily through predation), however once water quality returns to ambient, plankton populations will return to previous conditions.

As the potential environmental impact has been determined as having an immediate negative impact on the environment, the environmental impact severity has been ranked as Level 1 - Negligible.

Chemical Toxicity

The sensitivity of environmental receptors to changes in water quality associated with cementing chemicals was reviewed to understand potential impact thresholds of this release to identified values and sensitivities. A summary of the references used to inform this assessment is included as Table 5-19.

Table 5-19: Sensitivity of Water Column Receptor Exposure to Cementing Chemicals

Reference	Summary
CEFAS 2019	A review of cementing products assessed under the Offshore Chemical Notification Scheme that are generally used in offshore drilling activities (Portland Cement / Class G Cement) determined products are often considered non-charmable products with an OCNS listing of E (CEFAS 2019) which is considered to have aquatic toxicity where concentrations greater than 1000 ppm are experienced.

For the purposes of conducting an assessment to receptors with the potential to be impacted by this activity, an impact threshold of 1000 ppm was selected.

As described for turbidity above, modelling of cement discharges for another BP offshore drilling project indicates that two hours after the start of discharge, plume concentrations were determined to be between 5ppm and 50 ppm with the horizontal and vertical extents of the plume ~150 m and 10 m, respectively (BP 2013). Five hours after ceasing the discharge, modelling indicates that the plume will have dispersed to concentrations below 5 ppm (BP 2013).

Along with plankton and transient marine fauna that are present within the marine environment, the particular values and sensitivities with the potential to be exposed to this discharge include:

- Blue Whale (migration and presence).

Chosen impact thresholds (1000 mg/L) are based upon species that are more sensitive to changes in water quality (micro-algae / phytoplankton). Modelling indicates that exposures above these concentrations are expected to be limited to within 10 m of the well location.

Given the rapid dilution (and limited exposure to concentrations above impact thresholds), direct impacts to matters of NES and transient marine fauna are not expected, with direct impacts limited to planktonic organisms that are unable to avoid or move through the discharge plume. Indirect impacts transient fauna may be experienced where those species rely on planktonic organisms as a food source.

No particular values or sensitivities linked to planktonic foraging or increased planktonic abundance have been identified as having the potential to be affected by this discharge (within 10 m of the well location), thus indirect impacts to matters of NES and other transient fauna species are not expected.

Plankton communities have a naturally patchy distribution in both space and time (ITOPF 2011). Plankton populations have evolved to respond to these environmental perturbations by copious production within short generation times (ITOPF 2011 and UNEP 1985). They are known to have naturally high mortality rates (primarily through predation), however once water quality returns to ambient, plankton populations will return to previous conditions.

As the potential environmental impact has been determined as having a localised and minor negative impact on the environment, the environmental impact severity has been ranked as Level 1 - Negligible.

Location of Potential Impact - Seabed

Smothering and Alteration of Habitat

Cement discharges will occur at the seabed during cementing operations for the conductor and the 22” casing string. The potential impacts of smothering from a surface release are expected to be significantly less, due to small volumes, intermittent nature of these discharges, and high potential for dispersal by ocean currents. As such the focus of this evaluation is on the seabed discharges.

Sensitivity of environmental receptors to smothering and alteration of habitat with these discharges was reviewed to understand the extent of potential impact from this release. A summary of the studies used to inform this assessment is included as Table 5-20.

Table 5-20: Sensitivity of Receptor Exposure to Smothering / Alteration of Habitat

Study	Summary
Terrens *et al.* (1998)	Suggest that once the cement has hardened, the chemical additives are then locked into the hardened cement.
BP 2013	Seabed modelling of 200 T cement discharge estimated the maximum radius where cement would extend to be 30 cm deep would be about 10 m.

Based upon conservative seabed modelling of 200 T cement discharge undertaken by BP (2013), the extent of potential impact from this discharge is expected to be limited to 10 m of the seabed discharge point.

On the basis that this discharge can be expected to alter an area of approximately 100 m^2 and given soft sediment communities that are homogenous and well represented in the region as indicated by preliminary geophysical and geotechnical survey results, any impacts are evaluated to be localised to an area of habitat that is not protected nor overly sensitive, based on the result of the site survey undertaken in 2019. The impact of cement discharge on the seabed is considered within the immediate area of the Ironbark well and would lie within the area previously impacted by cuttings discharge (refer to Section 5.7.2).

As the potential environmental impact has been determined as having an immediate and negligible impact on the environment, the environmental impact severity has been ranked as Level 1 - Negligible.

Inherent / Design Control Measures (validated control measures) and Good Practice Control Measures

Control Measure	Context of Control Measures
Chemical selection process	BP will apply the chemical selection process to cement products, cementing additivities and spacer fluids.
Drilling and cementing procedures	It is standard industry practice for drilling and cementing procedures to be developed, which detail the specific spacer and slurry designs as well as the exact volumes required during operations. The cement procedure details the exact chemical composition and concentrations of specific cement additives to allow a controlled hardening time. A specific volume will be pumped, so that the cement can be positioned at the desired elevation in the well annulus. Excess cement is pumped as part of the procedure to mitigate the risk of an enlarged hole as a result of bore hole wash out. The volume of cement pumped is carefully managed and optimised in order to meet the well barrier requirements.

Impact Severity Level (Table 4-2)

1 Negligible

ALARP Decision Context (Table 4-5)	Type
Planned release of cement is a common occurrence associated with both offshore drilling activities nationally and internationally. Within the area to be exposed, there are limited values and sensitivities with the potential to be impacted. There is limited uncertainty associated with the presence of hard substrate, however uncertainty will be significantly reduced using seabed surveys to verify absence of hard substrate at the indicative well location. Preliminary results indicate the absence of hard substrate (see Section 3.3.2.1). The risk matrix presented within the Conservation Management Plan for the Blue Whale (DoE 2015) provides a risk rating of low to moderate associated with acute chemical discharge. Given inherent controls and relevant industry standards are applied, controls align with the priority for action recommended in this management plan. No objections or concerns were raised during stakeholder consultation regarding this activity or its potential impacts and risks. ALARP Decision Context Type A applies. Inherent controls are good practice and no control measures beyond good practice are required.	A

Acceptability Assessment			
Potential impacts associated with planned cement discharges are ranked as Decision Context A, therefore the existing controls are considered inherently acceptable and no further evaluation is required.			
Performance Management			
Environmental Performance Outcomes	**Performance Standards**	**Measurement Criteria**	**Responsibility**
Undertake the activity in a way that does: • not result in a change that may have a substantial adverse effect on a population of marine fauna, including its life cycle and spatial distribution, or • not result in a change that may modify, destroy or isolate an area of important habitat for a migratory species, or • not result in a change that may seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species. • not result in a substantial change in water quality, sediment quality or air quality which may adversely impact on biodiversity, ecological integrity, social amenity or human health. • not result in a substantial change that may modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results.	**Chemical selection process** All planned chemical discharges must be assessed and deemed acceptable before use, in accordance with BP's chemical selection process.	Records demonstrate chemical selection, assessment and approval process for selected chemicals is followed.	Drilling Engineering Team Lead (Planning) Well Site Leader (Operations)
	Drilling and cementing procedures Detailed cementing procedures will be developed before cementing activities commence	Cementing Program developed for all cementing operations based upon actual borehole conditions as drilled. This will include estimates of the actual borehole size, updated temperature modelling based upon drilled data. Pilot testing performed on representative cement and chemical samples by the cement contractor.	Wells Superintendent

5.7.3 BOP Control Fluids

The potential impacts associated with BOP control fluids are evaluated in Table 5-21.

Table 5-21: Impact Assessment: BOP Control Fluids

Activity
The following activities were identified as having the potential to result in a planned release of BOP fluids: • Exploration drilling – BOP function testing (Section 2.3.5). A planned release of BOP fluids has the potential to result in an impact to values and sensitivities in the water column through: • Chemical toxicity.
Potential Impact associated with BOP Control Fluids Discharges
Location of Potential Impact - Water Column

Chemical Toxicity

BOP control fluids such as Stack Magic Eco-F (planned) or similar are used to provide a medium in which the BOP can be hydraulically controlled and operated from the MODU. BOP function testing is anticipated to be completed within 15 minutes every 7 days for the duration of the activity. The sensitivity of environmental receptors to changes in water quality associated with BOP fluids was reviewed to understand potential impact thresholds of this release to identified values and sensitivities (Table 5-22).

Table 5-22: Sensitivity of Water Column Receptor Exposure to BOP fluids

Reference	Summary
CEFAS 2019	Stack Magic Eco-F is considered a non-CHARMable product with an OCNS listing of D (CEFAS 2019) which is considered to have aquatic toxicity where concentrations between 100 and 1000 ppm are experienced.

For the purpose of conducting a conservative assessment to receptors with the potential to be impacted by this activity, an impact threshold of 100 mg/l (100 ppm), was selected to determine the extent to which the environment may be exposed to concentrations above impact concentrations

Modelling undertaken for another one of BP's offshore drilling projects indicate that a release of 654 litres over 3 minutes of BOP fluids during function testing under different current regimes is expected to reach a dilution of 3000 times within a maximum distance of 98 m (BP 2013). This modelled prediction is conservative in comparison to the anticipated BOP fluid discharge of 4.6 m^3 for the Ironbark drilling program (Table 2-5). On the understanding that BOP fluids are used at low concentrations in the system (5% which equates to ~50,000 ppm), it is expected concentrations of BOP fluid would be reduced to ~16 ppm within 100 m of the BOP following release. Using a conservative ocean current speed of 0.17 m/s (Note: Currents in the region can be up to 1m/s (Chassignet et al., 2007), fluids would be expected to travel 100 m (and thus reach concentrations of 10 ppm) in ~10 minutes.

Along with plankton and transient marine fauna that are present within the marine environment, the particular values and sensitivities with the potential to be exposed to this discharge include:

- Blue Whale (migration and presence).

Chosen impact thresholds are based upon species that are more sensitive to changes in water quality (plankton and fish larvae) rather than identified particular values and sensitivities (Blue whales).

Given the rapid dilution, direct impacts to matters of NES and transient marine fauna are not expected, with direct impacts limited to planktonic organisms that are unable to avoid or move through the discharge plume. Indirect impacts to transient fauna may be experienced where those species rely on planktonic organisms as a food source.

No particular values or sensitivities linked to planktonic foraging or increased planktonic abundance have been identified as having the potential to be affected by this discharge, thus indirect impacts to matters of NES and other transient fauna species are not expected.

Plankton communities have a naturally patchy distribution in both space and time (ITOPF 2011). Plankton populations have evolved to respond to these environmental perturbations by copious production within short generation times (ITOPF 2011 and UNEP 1985). They are known to have naturally high mortality rates (primarily through predation), however once water quality returns to ambient, plankton populations will return to previous conditions.

As the potential environmental impact has been determined as having a localised and minor negative impact on the environment, the environmental impact severity has been ranked as Level 1 - Negligible.

Inherent / Design Control Measures (validated control measures) and Good Practice Control Measures

Control Measure	Context of Control Measures
Chemical selection process	BP will apply the chemical selection process to BOP and function test control fluids.

Impact Severity Level (Table 4-2)

1 Negligible

ALARP Decision Context (Table 4-5)			Type
Planned release of BOP fluids is a common discharge associated with offshore drilling activities nationally and internationally. Within the area to be exposed, there are limited values and sensitivities with the potential to be impacted. The risk matrix presented within the Conservation Management Plan for the Blue Whale (DoE 2015) provides a risk rating of low to moderate associated with acute chemical discharge. Given inherent controls and relevant industry standards are applied, controls align with the priority for action recommended in this management plan. No objections or concerns were raised during stakeholder consultation regarding this activity or its potential impacts and risks. ALARP Decision Context Type A applies. Inherent controls are good practice and no control measures beyond good practice are required.			A
Acceptability Assessment			
Potential impacts associated with planned BOP discharges are ranked as Decision Context A, therefore the existing controls are considered inherently acceptable and no further evaluation is required.			
Performance Management			
Environmental Performance Outcomes	**Performance Standards**	**Measurement Criteria**	**Responsibility**
Undertake the activity in a way that does: • not result in a change that may have a substantial adverse effect on a population of marine fauna, including its life cycle and spatial distribution, or • not result in a change that may modify, destroy or isolate an area of important habitat for a migratory species, or • not result in a change that may seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species. • not result in a substantial change in water quality, sediment quality or air quality which may adversely impact on biodiversity, ecological integrity, social amenity or human health.	**Chemical selection process** All planned chemical discharges must be assessed and deemed acceptable before use, in accordance with BP's chemical selection process.	Records demonstrate chemical selection, assessment and approval process for selected chemicals is followed.	Offshore Installation Manager (3rd party)

5.7.4 Cooling Water and Brine

The potential impacts associated with cooling water and brine are evaluated in Table 5-23. Cooling water will be used on the MODU and support vessel as the medium in heat exchangers to manage temperature in the engines. Brine is a by-product of fresh water generation onboard the vessel using reverse osmosis (or RO) plants onboard.

Table 5-23: Impact Assessment: Cooling Water and Brine

Planned Activity

The following activities were identified as having the potential to result in a planned release of cooling water and brine:

- MODU / vessel operations (Section 2.3.2/ Section 2.4)

Planned discharge of cooling and brine waters has the potential to result in effects to fauna through:

- Increased water temperature,
- Increased water salinity,
- Potential chemical toxicity in the water column.

Potential Impact Associated with Cooling Water and Brine Discharges

Location of Potential Impact - Water surface

Increased Temperature

The sensitivity of environmental receptors to changes in water temperature associated with cooling water discharges was reviewed to understand potential impact thresholds of this release to identified values and sensitivities (Table 5-24).

Table 5-24: Sensitivity of Water Column Receptor Exposure to Changes in Temperature

Reference	Summary
Langford 1990 cited in Santos 2019	Suggest that marine reptiles, cetaceans and fish passing through the area will be able to actively avoid entrainment in any heated plume
Huertas et al. 2011	Studies into the sensitivity of plankton to changes in temperature indicates that phytoplankton species of open ocean waters offer limited resistance to increased temperatures.

Modelling of continuous wastewater discharges (including cooling water) undertaken by Woodside for its Torosa South-1 drilling program found that discharge water temperature decreases quickly as it mixes with the receiving waters, with the discharge water temperature being less than 1°C above ambient within 100 m (horizontally) of the discharge point, and 10 m vertically (Woodside 2014 cited in Woodside 2019). Given the water depth (300 m) for the Ironbark drilling program is similar to Torosa South-1 (~350 m) and cooling water volumes are anticipated to be similar given both are offshore drilling activities; modelling predictions for Torosa South-1 is considered relevant for comparison to the Ironbark drilling program and considered to provide a suitable indication of the extent of exposure from this activity.

The environmental receptors with the potential to be exposed to an increase in temperature include plankton and transient pelagic marine fauna including whales, sharks, fish, and reptiles. The potential values and sensitivities with the potential to be exposed to this discharge include:

- Blue Whale (migration and presence).

Whales are not considered to be overly sensitive to changes in ambient temperature as they are not poikilothermic, thus any impacts would be limited to avoidance of the heated water plume. Larger pelagic species are mobile; at worst, it is expected they would be subjected to changes in ambient temperature for a very short time if they swim near the discharge plume. As transient species, they are not expected to remain long enough within the discharge plume to experience thermal stress. Given the rapid dilution (and limited exposure to changes in temperature), direct impacts to matters of NES and transient marine fauna are not expected, with direct impacts limited to planktonic organisms that are unable to avoid or move through the discharge plume. Indirect impacts transient fauna may be experienced where those species rely on planktonic organisms as a food source.

No particular values or sensitivities linked to planktonic foraging or increased planktonic abundance have been identified as having the potential to be affected by this discharge (within 100 m of the well location), thus indirect impacts to matters of NES and other transient fauna species are not expected.

Given the sensitivity of plankton to changes in temperature (Table 5-24), it is expected that this release may cause localised impacts to plankton populations within 100 m of the well location. However, plankton communities have a naturally patchy distribution in both space and time (ITOPF 2011) and populations have evolved to respond to these environmental perturbations by copious production within short generation times (ITOPF 2011 and UNEP 1985). As such, they are known to have naturally high mortality rates (primarily through predation) and once water quality returns to ambient, plankton populations will return to previous conditions.

As the potential environmental impact has been determined as having a localised and minor negative impact on the environment, the environmental impact severity has been ranked as Level 1 - Negligible.

Increased Salinity

It is expected that brine discharges could result in an increased salinity level ranging between 10-50% (Shell, 2009; Woodside, 2014) depending on the efficiency of the desalination system available onboard the MODU and support vessels.

The sensitivity of environmental receptors to changes in water salinity associated with freshwater maker brine discharges was reviewed to understand potential impact thresholds of this release to identified values and sensitivities (Table 5-25).

Table 5-25: Sensitivity of Water Column Receptor Exposure to Changes in Salinity

Reference	Summary
Gunter et al. 1974	Stenohaline marine animals (including marine fishes) generally react to salinity changes by exhibiting avoidance behaviours.
Kultz 2015	Euryhaline marine animals (marine turtles) are able to adapt to a wide range of salinities from estuarine, brackish to marine water
Azis et al 2003	Studies into the effect of increased salinity on planktonic communities in areas of high mixing and dispersion suggest impacts are generally limited to the point of discharge only.

Upon release, brine water will sink through the water column where it will be rapidly mixed with receiving waters and dispersed by ocean currents. Therefore, any potential impacts are expected to be limited to the area surrounding the source of the discharge where concentrations are highest.

Along with plankton and transient marine fauna that are present within the marine environment, the particular values and sensitivities with the potential to be exposed to increased salinity from this discharge include:

- Blue Whale (migration and presence).

The salinity profile of the east Indian Ocean in terms of range (from Indonesian waters to Antarctic Waters) show high spatial variability of salinity (Purba et al. 2018). Salinity tends to decrease towards Indonesian Seas and increases towards Antarctic waters ranging from 25-34 PSU (Purba et al. 2018). Thus it is understood that migratory species (such as the Blue whale) can tolerate changes in salinity of approximately 25%. Given rapid dispersion upon release, impacts to matters of NES and other transient fauna species are not expected.

This release is expected to cause localised impacts to plankton within proximity of the well location, and as no particular values or sensitivities linked to planktonic foraging or increased planktonic abundance have been identified as having the potential to be affected by this discharge, indirect impacts to matters of NES and other transient fauna species are not expected.

As the potential environmental impact has been determined as having a localised and minor negative impact on the environment, the environmental impact severity has been ranked as Level 1 - Negligible.

Potential Chemical Toxicity

Scale inhibitors and biocide used in the heat exchange and desalination process to avoid fouling of pipework are inherently safe at the low dosages used, because they are usually consumed in the inhibition process with little or no residual chemical concentration remaining upon discharge (Xuejun et al. 2017).

The sensitivity of environmental receptors to changes in water quality associated with scale inhibitors and biocides within cooling water discharges was reviewed to understand potential impact thresholds of this release to identified values and sensitivities (Table 5-26).

Table 5-26: Sensitivity of Water Column Receptor Exposure to Changes in Water Quality

Reference	Summary
CEFAS (2019)	Common biocides used in offshore vessel cooling water systems (Sodium Hypochlorite) are non-CHARMable with an OCNS listing of E which is considered to have aquatic toxicity where concentrations of greater than 1000 ppm are experienced.

For the purpose of conducting a conservative assessment to receptors with the potential to be impacted by this activity, an impact threshold of 1000 ppm, was selected to determine the extent to which the environment may be exposed to chemical concentrations above impact concentrations.

Far-field modelling of cooling water discharge undertaken by RPS for Woodside's Scarborough FPU found that discharge water residual chlorine concentration for a discharge rate of 64,800 m^3/day reached threshold level of 5 ppb (highly conservative threshold compared to 1000 ppm) 630 m (horizontally) of the discharge point (Woodside 2019). Cooling water discharge rate for a drilling rig is approximately 16,560 m^3/day (BP 2013), thus RPS modelling is considered to provide a highly conservative indication of the extent of exposure from this activity.

Along with plankton and transient marine fauna that are present within the marine environment, the particular values and sensitivities with the potential to be exposed to this chemical toxicity from this discharge include:

- Blue Whale (migration and presence).

Larger transient species are mobile and at worst, are expected to be subjected to very low levels of chemicals for a very short time as they swim near the cooling water plume. As transient species, they are not expected to remain long enough within the discharge plume to experience any chronic or acute effects.

Given the open nature of the receiving environment, the intermittent nature of the described petroleum activity, and the lack of sensitive features that would result in sedentary behaviour, the environmental impact severity of this planned impact was assessed to be Level 1 - Negligible.

Inherent / Design Control Measures (validated control measures) and Good Practice Control Measures

Control Measure	Context of Control Measures
No control identified	N/A

Impact Severity Level (Table 4-2)

1 Negligible

ALARP Decision Context (Table 4-5)	Ranking
Planned discharges of cooling water and brine by MODUs and vessels are common both nationally and internationally. Temperature and salinity changes in the vicinity of the surface discharge will be quick to dissipate, and rapidly recover on completion of the activity. There is potential for chemical discharges to result in localised impacts to surface marine fauna, however any impacts will be short term and negligible. No objections or concerns were raised during stakeholder consultation regarding this activity or its potential impacts and risks. The risk matrix presented within the Conservation Management Plan for the Blue Whale (DoE 2015) provides a risk rating of low to moderate associated with acute chemical discharge. Given inherent controls and relevant industry standards are applied, controls align with the priority for action recommended in this management plan. ALARP Decision Context Type A applies. Inherent controls are good practice and no control measures beyond good practice are required.	A

Acceptability Assessment

Potential impacts associated with planned cooling water and brine discharges are ranked as Decision Context A, therefore the existing controls are considered inherently acceptable and no further evaluation is required.

Performance Management

Environmental Performance Outcomes	Performance Standards	Measurement Criteria	Responsibility
N/A – no control identified			

5.7.5 Sewage, Greywater and Putrescible Waste

The potential impacts associated with sewage, greywater and putrescible waste discharges are evaluated in Table 5-27.

Table 5-27: Impact Assessment: Sewage, Greywater and Putrescible Waste

Planned Activity

The following activities were identified as having the potential to result in a planned release of sewage, greywater and putrescible waste:

- MODU / vessel operations (Section 2.3.2/ Section 2.4)

Discharge of food waste and sewage results in potential impacts to marine fauna via:

- Changes to the water quality through nutrient enrichment and increased biological oxygen demand (BOD),
- Impact to predator–prey dynamics.

Potential Impact Associated with Sewage, Greywater and Putrescible Waste Discharges

Location of Potential Impact - Water surface

Changes to Water Quality through Nutrient Enrichment and Increased BOD

The sensitivity of environmental receptors to changes in water quality associated with Sewage, Greywater and Putrescible Waste discharges was reviewed to understand potential impact thresholds of this release to identified values and sensitivities (Table 5-28).

Table 5-28: Sensitivity of Water Column Receptor Exposure to Changes in Water Quality

Reference	Summary
McIntyre and Johnson 1975	Studies into the effects of nutrient enrichment from offshore sewage discharges indicate that the influence of nutrients in open marine areas is much less significant than that experienced in enclosed areas and suggest that zooplankton composition and distribution in areas associated with sewage dumping grounds are not affected.
Black et al 1994	Regardless of receptor sensitivity to BOD, the BOD of treated effluent is not expected to lead to oxygen depletion of the receiving waters.
Parnell, 2003	Any potential change in phytoplankton or zooplankton abundance and composition is expected to be localised, typically returning to background conditions within tens to a few hundred metres of the discharge location.

Monitoring of sewage discharges for an offshore Floating Liquefied Natural Gas (FLNG) project (Woodside 2014) determined that a 10 m^3 sewage discharge reduced to approximately 1% of its original concentration within 50 m of the discharge location. Further, monitoring at distances 50, 100, and 200 m downstream of the discharge location and at five different water depths confirmed that discharges were rapidly diluted and no elevations in water quality monitoring parameters (e.g. total nitrogen, total phosphorous, and selected metals) were recorded above background levels at any station. Because the volumes of sewage from an FLNG facility are expected to be similar to those generated by the MODU (due to the number of people on-board), and given the water depths associated with discharge location are comparable to this survey (and subsequent dilution and dispersion efficacy is expected to be similar) the modelling is considered to provide a suitable indication of the extent of exposure from this activity.

Along with plankton and transient marine fauna that are present within the marine environment, the particular values and sensitivities with the potential to be exposed to this discharge include:

- Blue Whale (migration and presence).

Transient marine fauna (including Blue whales) are mobile. Due to the rapid mixing and dispersion rates identified during modelling of sewage releases (Woodside 2014), no values or sensitivities are expected to be impacted by this activity and consequently the environmental impact severity was assessed to be Level 1 - Negligible.

Impact to Predator-Prey Dynamics

The overboard discharge of sewage and macerated food wastes creates a localised and temporary food source for scavenging marine fauna including seabirds, whose numbers may temporarily increase as a result. The sensitivity of environmental receptors attraction to Sewage, Greywater and Putrescible Waste discharges was reviewed (Table 5-29).

Table 5-29: Sensitivity of Water Column Receptor Attraction to Sewage, Greywater and Putrescible Waste

Reference	Summary
Karris et al. 2018	Discards constitute a food source for several groups of species (e.g. seabirds and benthic scavengers) and cause alteration of trophic interactions, which affect ecosystem function and structure. This alternative food supply can be characterised as normally unavailable due to foraging pelagic seabirds.
NERA 2017:1001	The main environmental impact associated with ocean disposal of sewage and grey water is eutrophication. Eutrophication occurs when the addition of nutrients, such as nitrates and phosphates, causes adverse changes to the ecosystem, such as increased growth of primary producers such as phytoplankton and benthic algae and oxygen depletion. Any potential change in phytoplankton or zooplankton abundance and composition is expected to be localised, typically returning to background conditions within tens to a few hundred metres of the discharge location. Effects on environmental receptors along the food chain, namely, fish, reptiles, birds and cetaceans are therefore not expected beyond the immediate vicinity of the discharge in deep open waters.

Monitoring of sewage discharges (Woodside 2014) suggest that sewage concentrations reduced to approximately 1% of its original concentration within 50 m of the discharge location. On the assumption that increased predation is to occur within 50 m of the Ironbark-1 exploration well, along with plankton and transient marine fauna that are present within the marine environment (e.g. marine mammals, fish and seabirds), the particular values and sensitivities with the potential to be exposed to this discharge include:

- Blue Whale (migration and presence).

The rapid consumption of this waste by scavenging fauna, and physical and microbial breakdown, ensures that the impacts of waste would not lead to effects on environmental receptors along the food chain (cetaceans). Potential impacts are anticipated to be temporary and insignificant. Migration behaviours of the Blue whale are therefore not expected to be influenced by a temporary increased predation thus impacts to this particular value and sensitivity are not considered further.

Although fish are likely to be attracted to these discharges, any attraction and consequent change to predator–prey dynamics is expected to be limited to within 50 m of the release and thus would only result in localised impacts to species. Because it is not expected that any increased predation would result in more than a short-term localised impact on species, the environmental impact severity was assessed as Level 1 - Negligible.

Inherent / Design Control Measures (validated control measures) and Good Practice Control Measures

Control Measure	Context of Control Measures
MARPOL sewage discharge conditions	AMSA Marine Order Part 96 (Sewage) gives effect to MARPOL Annex IV. MARPOL is the International Convention for the Prevention of Pollution from Ships and is aimed at preventing accidental pollution and pollution from routine operations. The AMSA Marine Order Part 96 (Sewage) provides specific conditions relating to sewage discharge from vessels.
Food waste macerated	AMSA Marine Order Part 95 (Marine pollution prevention — garbage) gives effect to MARPOL Annex V. MARPOL Annex V requires that food waste is macerated or ground to particle size < 25 mm.

Impact Severity Level (Table 4-2)

1 Negligible

ALARP Decision Context (Table 4-5)	Type
The discharge of sewage, greywater, and putrescible food wastes from a MODU / vessel is commonly practised. The potential impacts and risks are well regulated via various treaties and legislation, both	A

nationally and internationally. Based on previous offshore monitoring programs, there is limited uncertainty associated with this aspect and the potential impact associated with these discharges. No objections or concerns were raised during stakeholder consultation regarding this activity or its potential impacts and risks. The risk matrix presented within the Conservation Management Plan for the Blue Whale (DoE 2015) provides a risk rating of low to moderate associated with acute chemical discharge. Given inherent controls and relevant industry standards are applied, controls align with the priority for action recommended in this management plan. ALARP Decision Context Type A applies. Inherent controls are good practice and no control measures beyond good practice are required.	

Acceptability Assessment

Potential impacts associated with planned sewage, greywater and putrescible waste discharges are ranked as Decision Context Type A, therefore the existing controls are considered inherently acceptable and no further evaluation is required.

Performance Management

Environmental Performance Outcomes	Performance Standards	Measurement Criteria	Responsibility
Undertake the activity in a way that does not modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results.	**MARPOL-discharge conditions** Sewage will be discharged in accordance with the following MARPOL conditions: • Sewage is treated via a Sewage Treatment Plant (before discharge (>3 nautical miles from land), • Proceeding en-route at a speed not less than 4 knots. or • Sewage remains untreated (>12 nautical miles from land), • Proceeding en-route at a speed not less than 4 knots.	Inspection records confirm Sewage Treatment Plant is installed and operational aboard the MODU and support vessels as per equipment maintenance schedules	Offshore Installation Manager, Vessel Master
	Food waste macerated Discharge of food waste shall be controlled by macerating galley waste to ≤25 mm (using an on-board food macerator) before discharge	Garbage Record Book details the food macerated	Offshore Installation Manager, Vessel Master

5.7.6 Firefighting Foam

The potential impacts associated with firefighting foam are evaluated in Table 5-30.

Table 5-30: Impact Assessment: Firefighting Foam

Planned Activity

The following activities were identified as having the potential to result in a planned release of firefighting foam:

- MODU / vessel operations – fire fighting system test (Section 2.3.2/ Section 2.4).

Planned discharge of firefighting foam has the potential to result in effects to fauna through:

- potential chemical toxicity in the water column.

Potential Impact Associated with Firefighting Foam

Location of Potential Impact - Water column and surface

The sensitivity of environmental receptors to changes in water quality associated with firefighting foam was reviewed to understand potential impact thresholds of this release to identified values and sensitivities (Table 5-31).

Table 5-31: Sensitivity of Water Column Receptor Exposure to Changes in water quality (Fire Fighting Foam)

Reference	Summary
Schaefer 2013, in INPEX, 2018 IFSEC Global 2014	In their diluted form (as applied in the event of a fire or test), firefighting foams are generally considered to have a relatively low toxicity to aquatic species
McDonald et al. 1996; Moody and Field 2000	Toxicological effects from these types of foams are typically only associated with prolonged or frequent exposures, such as on land and in watercourses near firefighting training areas
Schaefer 2013, in INPEX 2018; ANSUL 2007; IFSEC Global 2014)	Firefighting foams such as AR-AFFF and FFFP contain organic and fluorinated surfactants, which can deplete dissolved oxygen in water
ANSUL 2007	Dilution of foam mixtures in dispersive aquatic environments may then occur before there is any substantial demand for dissolved oxygen
CHEMGUARD 3% AFFF C-303 MSDS	MSDSs for Chemguard 3% AFFF (which is used to provide an indication as to the toxicity of these types of chemicals) indicate: LC50 (96 hour pimephales promelas) 233 ppm (concentrate) - 7767 ppm (solution) LC50 (48 hour daphnia magna) 1110 ppm (concentrate) - 37,000 ppm (solution)

The foam systems mix comprises a small portion of foam concentrates (in the order of 3%) mixed with water that upon release comprise chemical concentrations in the order of 30,000 ppm prior to further dilution.

Using the Chemguard LC50 ecotoxicity information, the foam system mix will be below the LC50 for daphnia prior to release (given its 3% concentration) and below the LC50 for fish (marine equivalent) within 4 dilutions upon release.

Given the rapid dilution and dispersion described for other planned discharges, and on the understanding that the Ironbark-1 marine environment is an open water dispersive environment, it is expected that such a release in the marine environment will dilute rapidly. Consequently, any impacts from this release would be limited to proximity of the well location.

Along with plankton and transient marine fauna that are present within the marine environment, the particular values and sensitivities with the potential to be exposed to this discharge include:

- Blue Whale (migration and presence).

Described toxicity thresholds are based upon species that are more sensitive to changes in water quality (plankton and fish) rather than identified particular values and sensitivities (Blue whales).

Given the rapid dilution (and limited exposure to foam chemicals above impact thresholds), direct impacts to matters of NES and transient marine fauna are not expected, with direct impacts limited to planktonic organisms that are unable to avoid or move through the discharge plume. Indirect impacts to transient fauna may be experienced where those species rely on planktonic organisms as a food source.

No particular values or sensitivities linked to planktonic foraging or increased planktonic abundance have been identified as having the potential to be affected by this discharge, thus indirect impacts to matters of NES and other transient fauna species are not expected.

Plankton communities have a naturally patchy distribution in both space and time (ITOPF 2011). Plankton populations have evolved to respond to these environmental perturbations by copious production within short generation times (ITOPF 2011 and UNEP 1985). They are known to have naturally high mortality rates (primarily through predation), however once water quality returns to ambient, plankton populations will return to previous conditions.

As the potential environmental impact has been determined as having a localised negative impact on the environment, the environmental impact severity has been ranked as Level 1 - Negligible. The impact of fire fighting foam on the environment

provides a net environmental benefit that would be achieved through mitigating the potential for a fire resulting in harm to people and the environment.			
Inherent / Design Control Measures (validated control measures) and Good Practice Control Measures			
Control Measure	**Context of Control Measures**		
Use and maintenance of firefighting foam equipment and chemicals	The use and maintenance of foam equipment and chemicals follows CAAP 92-4(0): Guidelines for the development and operation of off-shore helicopter landing sites, including vessels.		
Impact Severity Level (Table 4-2)			
1 Negligible			
ALARP Decision Context (Table 4-5)			**Type**
Planned discharge of fire foam systems during system testing, though not frequent, is a well understood activity. The potential impacts and risks are well regulated and good practice control measures are well understood and implemented by the industry. The significance of impact from this type of event was evaluated as Low. No objections or concerns were raised during stakeholder consultation regarding this activity or its potential impacts and risks. The risk matrix presented within the Conservation Management Plan for the Blue Whale (DoE 2015) provides a risk rating of low to moderate associated with acute chemical discharge. Given inherent controls and relevant industry standards are applied, controls align with the priority for action recommended in this management plan. ALARP Decision Context Type A applies. Inherent controls are good practice and no control measures beyond good practice are required.			A
Acceptability Assessment			
Potential impacts associated with a release of fire fighting foam during system testing are ranked as Decision Context Type A, therefore the existing controls are considered inherently acceptable and no further evaluation is required.			
Performance Management			
Environmental Performance Outcomes	**Performance Standards**	**Measurement Criteria**	**Responsibility**
Undertake the activity in a way that does not result in a substantial change in water quality, sediment quality or air quality which may adversely impact on biodiversity, ecological integrity, social amenity or human health.	**Use and Maintenance of Foam Equipment and Chemicals** Foam equipment and chemicals will be used and maintained ib accordance with CAAP 92-4(0): Guidelines for the development and operation of off-shore helicopter landing sites, including vessels	Inspection records confirm that foam equipment is maintained in accordance with CAAP 92-4(0): Guidelines for the development and operation of off-shore helicopter landing sites, including vessels	Wells Superintendent

5.7.7 Bilge

The potential impacts associated with bilge are evaluated in Table 5-32.

Table 5-32: Impact Assessment: Bilge

Planned Activity
The following activities were identified as having the potential to result in a planned release of bilge water: • MODU / vessel operations (Section 2.3.2 / Section 2.4). Planned discharge of bilge water has the potential to result in effects to fauna through: • Potential chemical toxicity in the water column.
Potential Impact Associated with Bilge Discharges
Location of Potential Impact - Water surface
Bilge water consists of water, oily fluids, lubricants, cleaning fluids, and other similar wastes that have accumulated in the lowest part of the MODU or vessel typically from closed deck drainage and machinery spaces. The sensitivity of environmental receptors to changes in water quality associated with oily water discharges was reviewed to understand potential impact thresholds of this release to identified values and sensitivities (Table 5-33).

Table 5-33: Sensitivity of Water Column Receptor Exposure to Changes in water quality (Oily Water Discharge)

Reference	Summary
OSPAR (2014)	Indicates that the predicted no effect concentration (PNEC) for marine organisms exposed to dispersed oil is 70.5 ppb. It should be noted that this PNEC is based upon no observed effect concentrations (NOEC) after exposure to certain concentrations for an extended period that was greater than 7 days.
Cowles and Remillard 1983	Reported that copepods exposed to sublethal concentrations of hydrocarbons displayed decreased ingestion rates and decreased egg viability; however egg production rates were not significantly affected.

A discharge of treated bilge at sea is non-continuous and infrequent, being driven by the holding capacity of the bilge space onboard the MODU or vessel. In the absence of published literature on the potential range of predicted change in ambient water concentrations as a result of bilge discharges for drilling activities, treated bilge and drainage (slops) discharge plumes modelled for Prelude FLNG is used as a highly conservative estimate for the Ironbark drilling program. Modelling by Shell (2009) indicates that upon release, hydrocarbon and other chemical concentrations are rapidly diluted and expected to be below PNEC within a relatively short period of time, within less than 100 m of the discharge.

Along with plankton and transient marine fauna that are present within the marine environment, the particular values and sensitivities with the potential to be exposed to this discharge include:

- Blue Whale (migration and presence).

Chosen impact thresholds are based upon species that are more sensitive to changes in turbidity (plankton and fish larvae) rather than identified particular values and sensitivities (Blue whales).

Given the rapid dilution (and limited exposure to hydrocarbon concentrations above impact thresholds), direct impacts to matters of NES and transient marine fauna are not expected, with direct impacts limited to planktonic organisms that are unable to avoid or move through the discharge plume. Indirect impacts to transient fauna may be experienced where those species rely on planktonic organisms as a food source.

No particular values or sensitivities linked to planktonic foraging or increased planktonic abundance have been identified as having the potential to be affected by this discharge (within 100 m of the well location), thus indirect impacts to matters of NES and other transient fauna species are not expected.

Plankton communities have a naturally patchy distribution in both space and time (ITOPF 2011). Plankton populations have evolved to respond to these environmental perturbations by copious production within short generation times (ITOPF 2011 and UNEP 1985). They are known to have naturally high mortality rates (primarily through predation), however once water quality returns to ambient, plankton populations will return to previous conditions.

As the potential environmental impact has been determined as having a localised and minor negative impact on the environment, the environmental impact severity has been ranked as Level 1 - Negligible.

Inherent / Design Control Measures (validated control measures) and Good Practice Control Measures	
Control Measure	**Context of Control Measures**
MARPOL-approved oil water separator	AMSA Marine Order Part 91 (Marine Pollution Prevention - Oil) gives effect to parts of MARPOL Annex I. MARPOL is the International Convention for the Prevention of Pollution from Ships and is aimed at preventing both accidental pollution and pollution from routine operations.

Impact Severity Level (Table 4-2)
1 Negligible

ALARP Decision Context (Table 4-5)	Type
Discharge of bilge water offshore (from vessels, MODUs and other facilities) is commonplace. The potential impacts and risks are well regulated via various treaties and legislation, both nationally and internationally, which specify industry best practice control measures. These are well understood and implemented by the industry. The significance of impact from this type of event was evaluated as Low. No objections or concerns were raised during stakeholder consultation regarding this activity or its potential impacts and risks. The risk matrix presented within the Conservation Management Plan for the Blue Whale (DoE 2015) provides a risk rating of low to moderate associated with acute chemical discharge. Given inherent controls and relevant industry standards are applied, controls align with the priority for action recommended in this management plan. ALARP Decision Context Type A applies. Inherent controls are good practice and no control measures beyond good practice are required.	A

Acceptability Assessment
Potential impacts associated with planned bilge discharge are ranked as Decision Context Type A, therefore the existing controls are considered inherently acceptable and no further evaluation is required.

Performance Management			
Environmental Performance Outcomes	**Performance Standards**	**Measurement Criteria**	**Responsibility**
• Undertake the activity in a way that will not modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results.	**MARPOL-approved oil water separator** For vessels > 400 tonnes, bilge water passes through a MARPOL approved Oily Water Separator (OWS).	OWS International Oil Pollution Prevention (IOPP) certificate or equivalent documentation appropriate to vessel class.	Offshore Installation Manager Vessel Master
	MARPOL-approved oil water separator For vessels < 400 tonnes treated bilge is discharged if: • Vessel is proceeding en-route; and • Approved treatment equipment ensures oil content less than 15 ppm. If the above is not met the oil residue must be retained in on-board storage tanks for onshore disposal or further treatment.	Oil record book verifies bilge discharges were compliant with these requirements	Offshore Installation Manager Vessel Master
	MARPOL-approved oil water separator OWS and Oil Discharge Monitoring Equipment (ODME) (appropriate to vessel size) are routinely maintained and	PMS records confirm OWS and ODME are routinely calibrated and maintained	Offshore Installation Manager Vessel Master

	system elements calibrated to ensure reliable discharge concentrations are being met.		
	MARPOL-approved oil water separator The residual oil from the OWS is pumped to tote tanks and disposed of onshore.	The Oil Record Book verifies that bulk oil is transferred to shore.	Offshore Installation Manager Vessel Master

6 Risk Assessment – Unplanned Events

6.1 Risk Assessment Summary

A summary of the risk assessment for all unplanned events that have the potential to occur during the undertaking of drilling activities as detailed in Section 2.3 is provided in Table 6-1.

Table 6-1:Risk assessment summary: unplanned events

Activity	EP section	Environmental Aspect	Impact Severity Level (Table 4-2)	Likelihood	Risk Level	ALARP Decision Context (Table 4-5)	ALARP Statement	Acceptability Assessment Statement
Physical Presence – Interaction with the Wellhead	6.2.1	• MODU operations (Section 2.3.2)	Level 1 - Negligible	Level B - Unlikely	Low	Type A	Good Practice control measures are well defined and therefore the impact is to ALARP managed in accordance with Good Practice.	In accordance with Section 4.1.6, proposed approach is aligned with recognised 'Good Practice' therefore inherently acceptable and no further evaluation is required.
Physical Presence - Dropped Objects	6.2.2	• MODU operations (Section 2.3.2) • Vessel operations (Section 2.4)	Level 1 - Negligible	Level B - Unlikely	Low	Type A	Good Practice control measures are well defined and therefore the impact is to ALARP managed in accordance with Good Practice.	In accordance with Section 4.1.6, proposed approach is aligned with recognised 'Good Practice' therefore inherently acceptable and no further evaluation is required. • The risks associated with dropped objects are well understood. • The inherent controls are requirements of Commonwealth legislation and generally well implemented by industry. • No objections or concerns were raised during stakeholder consultation regarding this activity or its potential impacts and risks.
Physical Presence - Interaction	6.2.3	• MODU operations – vessel movement (Section 2.3.2)	Level 2 - Minor	Level B - Unlikely	Low	Type A	Good Practice control measures are well defined	In accordance with Section 4.1.6, risks are considered inherently acceptable given that ALARP has been achieved and no further evaluation is required.

with Marine Fauna		• Vessel operations (Section 2.4)					and therefore the impact is to ALARP managed in accordance with Good Practice.	
Introduction of an Invasive Marine Species	6.3	• MODU operations - hull fouling / ballast water discharges (Section 2.3.2) • Vessel operations - hull fouling / ballast water discharges (Section 2.4).	Level 3 - Moderate	Level B - Unlikely	High	Type C	Consideration has been given to control measures beyond good practice. Additional measures have been adopted and the risk has been assessed to be reduced to ALARP.	This activity is considered acceptable as it is below the defined levels of acceptable impact, and is not inconsistent with relevant recovery plans, conservation advice or bioregional plans (Section 6.3). However, in accordance with Section 4.1.6 further evaluation is required: <u>Principles of Ecologically Sustainable Development</u> • Activity is not expected to have potential to affect biological diversity and ecological integrity of habitats of ecological importance (i.e. hard substrate communities). • Precautionary principle has not been applied given little scientific uncertainty is associated with this aspect, given; - The activities are well known, the pathways for introducing an IMP are well understood, well regulated and managed. - Seabed surveys prior to the drilling activity commencing will confirm additional uncertainty. - Preliminary geophysical data and photographic records captured during prior surveys have been undertaken (see Section 3.3.2.1). <u>Relevant legislation and other industry standards</u> Adherence to the following legislation and industry standards is considered a relevant control measure for this program: • Biosecurity Act 2015,

								• Protection of the Sea (Harmful Anti-fouling Systems) Act 2006 (enacted by AMSA Marine Order Part 98 [Marine pollution – anti-fouling systems]), and • Australian Ballast Water Management Requirements (DAWR 2017). <u>Internal Context</u> No BP environmental performance standards were deemed relevant. <u>External Context</u> DPIRD was a stakeholder who identified an interest in this aspect. DPIRD were provided sufficient information from the above assessment with no specific objections or claims identified upon receipt of this information.
Accidental Release - Solid Waste	6.4.1	• MODU operations - inappropriate waste storage and human error (Section 2.3.2) • Vessel operations - inappropriate waste storage and human error (Section 2.4)	Level 2 - Minor	Level B - Unlikely	Low	Type A	Good Practice control measures are well defined and therefore the impact is to ALARP managed in accordance with Good Practice.	In accordance with Section 4.1.6, existing controls are considered inherently acceptable and no further evaluation is required.
Accidental Release - Loss of Containment (Small Hydrocarbon or Chemical Spill)	6.4.2	• MODU / vessel operations - general (Section 2.3.2/ Section 2.4) • MODU operations – crane transfers and bunkering operations (Section 2.3.2)	Level 1 - Negligible	Level B - Unlikely	Low	Type A	Good Practice control measures are well defined and therefore the impact is to ALARP managed in	In accordance with Section 4.1.6, existing controls are considered inherently acceptable and no further evaluation is required.

		• ROV operations (Section 2.3.9 • Support vessel operations – crane transfers and bunkering operations (Section 2.4)					accordance with Good Practice.	
Accidental Release - Failure of Slip Joint Packer / Unplanned Riser Disconnect	6.4.3	• Exploration drilling - riser on drilling (Section 2.3)	Level 2 - Minor	Level B - Unlikely	Low	Type A	Good Practice control measures are well defined and therefore the impact is to ALARP managed in accordance with Good Practice.	In accordance with Section 4.1.6, existing controls are considered inherently acceptable and no further evaluation is required.
Vessel Collision	6.4.4	• MODU operations (Section 2.3.2) • Vessel operations (Section 2.4)	Level 2 - Minor	Level B - Unlikely	Low	Type A	Good Practice control measures are well defined and therefore the impact is to ALARP managed in accordance with Good Practice.	In accordance with Section 4.1.6, existing controls are considered inherently acceptable and no further evaluation is required.
Loss of Well Control	6.4.5	• MODU operation – general (section 2.3)	Level 3 - Moderate	Level B - Unlikely	High	Type C		This activity is considered acceptable as it is below the defined levels of acceptable impact, and is not inconsistent with relevant recovery plans, conservation advice or bioregional plans. However, in accordance with Section 4.1.6 further evaluation is required:

								<u>Principles of Ecologically Sustainable Development</u> • Precautionary principle has been applied given scientific uncertainty associated with this aspect exists: - Consideration of worst-case credible scenarios (Section 6.4.5); - Extensive modelling of oil spill fate and trajectory modelling has been undertaken to better understand the extent of potential environmental risks and impacts; - Development of the OPEP and OSMP has been based upon worst credible spill scenarios so to mitigate potential risks of such events, even though likelihood is low. <u>Relevant legislation and other industry standards</u> Adherence to the following legislation and industry standards is considered a relevant control measure for this program: • Minimum requirements listed in API Standard 53, • OPGGS (Resource Management and Administration) Regulations 2011, • OPGGS(E)R 2009 – OPEP, and • OPGGS(E)R 2009 – OSMP. <u>Internal Context</u> Loss of well control is a recognised risk in BP. BP's well design and well integrity requirements are documented in BP Practices, Procedures and Specifications which are based on extensive operational experience and are mandated for use to manage risk to levels considered ALARP. These requirements are incorporated into the well specific design documents and operational procedures, as outlined in the WOMP.

								<u>External Context</u> DPIRD was a stakeholder with identified interest in this aspect. DPIRD had no specific objections or claims identified in relation to assessment.

6.2 Physical Presence

6.2.1 Interaction with the Wellhead

The risks of an interaction with the wellhead are evaluated in Table 6-2.

Table 6-2: Risk Assessment: Interaction with the Wellhead

Activity		
In the event the wellhead is unable to be removed during the abandonment process, the physical presence of the wellhead above the seabed has the potential to result in: • Damage to fishing equipment.		
Potential Impact Severity associated with Interaction with the Wellhead		
Location of Unplanned Event - Seabed		
Commercial fisheries that utilise bottom trawling fishing methods are most at risk from this hazard and thus are the focus of this evaluation. Given the nature of this risk, the extent of exposure is limited to a small area associated with the wellhead itself which is approximately 1-2 m^2 As identified in Section 5.1, although several commercial fisheries have licenses that overlap the well location, only two of the fisheries potentially active in the Operational Area are known to utilise trawl method, namely the Commonwealth North West Slope Trawl Fishery and the State Pilbara Fish Trawl (Interim) Managed Fishery. Patterson et al. (2018) and historical FishCube data indicate that fishing effort has been recorded by these fisheries in the Operational Area between 2014-2018. Ongoing stakeholder engagement with commercial fishers including the provision of updated marine charts showing the wellhead as a subsea hazard will ensure commercial fishers have the information necessary to avoid the wellhead. With these measures in place, BP does not expect to cause a significant impact to commercial operations (via loss of catches or damage to fishing equipment) as a result of the physical presence of the wellhead. As such the impact severity is deemed to be Level 1 - Negligible.		
Inherent / Design Control Measures (validated control measures) and Good Practice Control Measures		
Control Measure	**Context of Control Measures**	
Removal of well head	In accordance with Section 572 of the OPGGS Act a titleholder must remove all equipment and other property in their title area that is neither used, nor to be used, for operations authorised by their title..	
Coordinates for any abandoned wells provided to the AHS	Under the Navigation Act 2012, AHS is responsible for maintaining and disseminating hydrographic and other nautical information and nautical publications. Specifically, subsea infrastructure is identified as a potential subsea hazard to commercial shipping activities (such as fisheries) and thus locations are included on appropriate marine charts.	
Ongoing consultation	In accordance with Regulation 13 (4) of the OPGGS(E)R, the Environment Plan must describe the requirements, including legislative requirements, that apply to the activity and are relevant to the environmental management of the activity; and demonstrate how those requirements will be met. BP has identified that the *Environment Protection (Sea Dumping) Act 1981* may apply to these activities. In the event that the well head is not successfully removed, BP will consult with the Department of Agriculture, Water and Environment regarding the applicability of that legislation to this activity to ensure that all obligations are met. In accordance with the OPGGS(E)R, additional consultation as requested by relevant stakeholders will be implemented to ensure they are aware of the activity in advance.	
Risk Evaluation		
Impact Severity Level (Table 4-2)	**Likelihood**	**Risk Level**

1 Negligible	The likelihood of the wellhead remaining in-situ permanently thus causing impacts to other marine users is low given that BP plan to remove the wellhead upon abandonment. However, in the low likelihood that it remains in-situ or temporarily wet stored, Level - 1 Negligible impacts will be experienced based on the control measures in place for trawl fishers to be able to actively avoid the wellhead. Consequently, the likelihood of the impact severity level occurring was evaluated to be a Level B such that the event is not expected but there is a slight possibility it may occur some time.	Low
ALARP Decision Context (Table 4-5)		**Type**
Leaving subsea infrastructure in place for an extended duration is common-place in offshore environments although leaving in-situ permanently is not as common. Given the limited sensitivities that have the potential to be impacted by leaving the wellhead in situ, BP has ranked the impact severity as Level 1. Managing the risks from this type of event is well understood with control measures that are understood and generally well implemented by the industry. No objections or claims regarding leaving the wellhead in-situ were made during stakeholder consultation. ALARP Decision Context Type A applies. Inherent controls are good practice and no control measures beyond good practice are required.		A
Acceptability Assessment		
The risk associated with interaction with the wellhead during well suspension or post abandonment have been ranked as Decision Context A, therefore the existing controls are considered inherently acceptable and no further evaluation is required.		
Performance Management		

Environmental Performance Outcomes	Performance Standards	Measurement Criteria	Responsibility
Undertake the activity in a way that will not interfere with other marine uses to a greater extent than is necessary for the exercise of right conferred by the titles granted.	**Removal of wellhead** Upon completion of well abandonment, BP will remove the wellhead from the well and recover to the MODU	End of Well Report confirms the removal of the wellhead	Wells Superintendent
	Coordinates for any abandoned wells provided to the AHS BP will provide the coordinates for any abandoned wells provided to the AHS.	Records confirm coordinates for any / all abandoned wells provided to AHS.	Wells Superintendent
	Ongoing consultation In accordance with requests from relevant stakeholders during the consultation period, BP will implement the requirements as described in Section 7.11.	Consultation records confirm BP has implemented ongoing consultation with relevant stakeholders as listed in Section 7.11.	Communications and External Affairs Lead
	Ongoing consultation Where the removal of a wellhead is not successful, BP will commence engagement with Department of Agriculture, Water and Environment regarding the applicability of the Environment Protection (Sea Dumping) Act 1981 to these activities to ensure	Where the removal of a wellhead is not successful, records demonstrate that BP has commenced engagement with the Department of Agriculture, Water and Environment regarding the applicability of the Environment Protection (Sea Dumping) Act 1981 to these activities to ensure any	Communication and External Affairs Lead

	any obligations under this act are met as directed by DAWE.	obligations under this act are met as directed by DAWE.	

6.2.2 Dropped Objects

The risk associated with dropped objects is evaluated in Table 6-3.

Table 6-3: Risk Assessment: Dropped Objects

Activity		
These activities were identified as having the potential to result in dropped objects within the Operational Area: • MODU / vessel operations (Section 2.3.2/ Section 2.4). Dropped objects have the potential to result in: • Seabed disturbance.		
Potential Impact Severity Associated with Dropped Objects		
Location of Unplanned Event - Water Surface		
For the purposes of this EP, the extent of this risk is limited to the Operational Area (within 10.5 km of the indicative well location). In the unlikely event of loss of equipment or materials to the marine environment, potential environmental effects would be limited to localised physical impacts on benthic communities. The loss of dropped objects into the marine environment is not likely to have a significant environmental impact, as the benthic communities associated with the Operational Area have been confirmed to be of low sensitivity and widely represented throughout the region. Preliminary geophysical data and photographic records from grab samples taken during a site specific survey suggest that the seabed is devoid of hard seafloor or distinct sediment facies, with only soft sediment observed (see Section 3.3.2.1). The extent of the impact is limited to the size of the dropped object and given the size of standard materials transferred, any impact would be very small. Consequently, this event would result in a limited effect to low sensitivity benthic communities, thus the environmental impact severity level for this unplanned event was assessed to be Level 1 - Negligible.		
Inherent / Design Control Measures (validated control measures) and Good Practice Control Measures		
Control Measure	**Context of Control Measures**	
Lifting management procedures for MODU and support vessels	MODU and support vessel lifting management procedures procedures with the intent of minimising risk of dropped objects. Such procedures are standard industry safety practice for MODU operations and support vessels.	
MODU/ vessel inductions include control measures and training for crew in dropped object prevention.	Inductions for all vessel crew provide an opportunity to make personnel aware of the requirements for dropped objects prevention and housekeeping provisions during the implementation of the activity.	
Risk Evaluation		
Impact Severity Level (Table 4-2)	**Likelihood**	**Risk Level**
1 Negligible	Dropped objects, the likelihood of this aspect causing seabed disturbance is low. Consequently, the likelihood of the impact severity level occurring was evaluated to be a Level B such that the event is not expected but there is a slight possibility it may occur some time.	Low
ALARP Decision Context (Table 4-5)		**Type**
The risks associated with dropped objects are well understood. The inherent controls are requirements of Commonwealth legislation and generally well implemented by industry.		A

No objections or concerns were raised during stakeholder consultation regarding this activity or its potential impacts and risks. ALARP Decision Context Type A applies. Inherent controls are good practice and no control measures beyond good practice are required.	

Acceptability Assessment
The risk associated with dropped objects is ranked as Decision Context A, therefore is considered inherently acceptable given that ALARP has been achieved and no further evaluation is required.

Performance Management			
Environmental Performance Outcomes	**Performance Standards**	**Measurement Criteria**	**Responsibility**
Undertake the activity in a way that will not modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results.	Lifting management procedures for MODU and support vessels	Records show all lifts conducted in accordance with applicable MODU/ support vessel lifting management procedures.	Offshore Installation Manager Vessel Master
	MODU/ vessel inductions include control measures and training for crew in dropped object prevention.	Presentation and attendance sheets verify that personnel attended the induction.	Offshore Installation Manager Vessel Master

6.2.3 Interaction with Marine Fauna

The risk associated with interacting with marine fauna is evaluated in Table 6-4.

Table 6-4: Risk Assessment: Interaction with marine fauna

Activity
These activities were identified as having the potential to result in an interaction with marine fauna within the Operational Area: • MODU / vessel operations (vessel movement) (Section 2.3.2/ Section 2.4). An interaction with marine fauna has the potential to result in: • Injury or death of marine fauna.
Interaction with Marine Fauna -
Location of Unplanned Event - Water Surface
The sensitivity of various surface-dwelling species to interactions with vessels was reviewed to understand those species most at risk from this activity. A summary of the literature used to inform this assessment is included as Table 6-5.

Table 6-5: Sensitivity of Marine Fauna to Vessel Interactions

Reference	Summary
Peel et al. 2016	Limited data exists on potential ‘at risk’ fauna such as turtles and whale sharks, possibly due to lack of collisions being noticed and lack of reporting; however, marks observed on animals show that strikes have occurred.
Commonwealth of Australia 2017	Vessel strikes are known to be fatal for individual turtles
Richardson 1995	The reaction of whales to the approach of a vessel varies—some species remain motionless when close to a vessel, while others are known to be curious and often approach ships that have stopped or are slow moving; however, they generally do not approach, and sometimes avoid, faster moving ships.

Laist et al. 2001	There were recorded instances of cetacean deaths in Australian waters (e.g. a Bryde's Whale in Bass Strait in 1992), though data indicates these deaths are more likely to be associated with container ships and fast ferries.
WDCS 2006	Collisions between larger vessels with reduced manoeuvrability and large, slow-moving cetaceans occur more frequently where high vessel traffic and cetacean habitat overlap.
NMFS 2013	The Australian National Marine Safety Committee reports that during 2009, there was one report of a vessel collision with an animal (species not defined)
Mackay et al. (2015)	Report that four fatal and three non-fatal collisions with Southern Right Whales have been recorded in Australian waters between 1950 and 2006, with one fatal and one non-fatal collisions reported between 2007 and 2014.
DoE. 2015	This Conservation Management Plan is specific to blue whales. It states that increasing shipping activities in Australian waters suggests the probability of vessel strike involving blue whales may increase. However due to limited information on the abundance and population trend of blue whales in Australian waters and the overlay between shipping lanes and migratory routes and/or biologically important areas for blue whales it is difficult to determine the level of impact of vessel strike on this species. Collisions with calves may be more likely because they spend more time at the surface, are slower, or may need to learn to avoid vessels. Between 2006 and 2015, there have been two records of likely ship strikes of blue whales in Australia. Consequently, the plan presents high risk associated with vessel Collision based on possible likelihood of occurrence and moderate consequence for both pygmy and Antarctic blue whales.

For the purposes of this EP, the extent of this risk is limited to the Operational Area (within 10.5 km of the indicative well location). In addition to transient marine reptiles, marine mammals and fish (including sharks and rays) that have the potential to be present within surface waters; the following values / biologically important areas were identified as being present thus indicate a higher likelihood of presence in the Operational Area:

- Blue Whale (migration and distribution).

No known feeding, calving or resting areas exist within the Operational Area, and consequently, fauna are not expected to be sedentary but transiting through the area. Any interaction with cetaceans is expected to result in avoidance of fauna or a recoverable injury, not death, because vessel speeds within the operational area are inherently slow.

However, if an interaction with marine fauna (either via suction through water intakes or fauna strike) resulted in death, it is expected that impacts will be limited to individuals, not local populations. The recovery plan for marine turtles in Australia (Commonwealth of Australia, 2017) confirm that this is the likely outcome noting that although vessel strikes can be fatal for individual turtles, it has not been shown to cause population-level declines. The conservation management plan for blue whales (DoE 2015) similarly suggests vessel collision will not cause population decline.

Consequently, this event is expected to result in a limited short-term effect (expected impacts on an individual of a species listed as threatened and/or migratory under the EPBC Act) and not affect any populations, thus the environmental impact severity level for this unplanned event was assessed to be Level 2 - Minor.

Inherent / Design Control Measures (validated control measures) and Good Practice Control Measures

Control Measure	**Context of Control Measures**
EPBC Regulations 2000 – Part 8 Division 8.1	EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans describes strategies to ensure whales and dolphins are not harmed during offshore interactions with people.
Incident reporting	The EPBC Act and Conservation Management Plan for the Blue Whale (DoE 2015) specify reporting requirements for fauna strikes with cetaceans. Collisions with cetaceans are reported to the DAWE via the online National Ship Strike database.

Risk Evaluation

Impact Severity Level (Table 4-2)	**Likelihood**	**Risk Level**
2 Minor	Many marine vessels operate within Australian waters. The risks associated with marine fauna interaction is well understood, and industry good practice control	Low

	measures are in place. Due to the nature and scale of this petroleum activity, the slow-moving nature of vessels within the Operational Area, the limited area of exposure and duration of operation, the likelihood of this unplanned event was assessed as Level B.	

ALARP Decision Context (Table 4-5)	**Type**
Although shipping activity within the Operational Area is low, vessel operations are not considered to be an unusual activity in this area and the risks of fauna interaction are well understood. The inherent controls are requirements of Commonwealth legislation and generally well implemented by industry. The risk matrix presented within the Conservation Management Plan for Blue Whales (DoE 2015) provides a risk rating of high associated with vessel collision. Given inherent controls, application of precautionary EPBC marine fauna interaction procedure recommendations and low vessel speeds, these controls align with the priority for action recommended in this management plan. No objections or concerns were raised during stakeholder consultation regarding this activity or its potential impacts and risks. ALARP Decision Context Type A applies. Inherent controls are good practice and no control measures beyond good practice are required.	A

Acceptability Assessment
The risk associated with an interaction with marine fauna is ranked as Decision Context A, therefore is considered inherently acceptable given that ALARP has been achieved and no further evaluation is required.

Performance Management

Environmental Performance Outcomes	**Performance Standards**	**Measurement Criteria**	**Responsibility**
Undertake the activity in a way that will not have a substantial adverse effect on the population of, or the spatial distribution of a MNES	**EPBC Regulations 2000 – Part 8 Division 8.1** Vessel masters will be briefed on the requirements of EPBC Regulations 2000 – Part 8 Division 8.1; specifically, caution, 'no approach zones' and interaction management actions	Training records confirm vessel masters were briefed on caution and 'no approach zones' and interaction management actions as defined in the EPBC Regulations 2000 – Part 8 Division 8.1.	Vessel Master
	Incident reporting Any injury to, or mortality of, an EPBC Act Listed Threatened or Migratory species (including those from a vessel strike) will be reported to the DAWE within seven business days	Reporting records confirm any injury to, or mortality of, an EPBC Act Listed Threatened or Migratory species (including those from a vessel strike) was reported to DAWE within seven business day	Vessel Master

6.3 Introduction of an Invasive Marine Species

The risk associated with the introduction of an invasive marine species (IMS) are evaluated in Table 6-6.

Table 6-6: Risk Assessment: Introduction of an Invasive Marine Species

Activity
The following activities were identified as having the potential to result in the introduction of an IMS: • MODU / vessel operations (hull fouling / ballast water discharges) (Section 2.3.2/ Section 2.4). Introduction of an Invasive Marine Species has the potential to result in:

- Change in ecosystem dynamics.

Potential Impact associated with Introduction of an Invasive Marine Species

Location of Unplanned Event - Seabed

The sensitivity of seabed habitats to the introduction of an IMS was reviewed. A summary of the literature used to inform this assessment is included in Table 6-7.

Table 6-7: Sensitivity of Seabed Habitats to the Introduction of an IMS

Reference	Summary
Paulay et al. 2002	Describes that highly disturbed nearshore environments containing hard substrates and artificial structures (such as marinas) are more susceptible to colonisation than open-water environments, where the number of dilutions and the degree of dispersal are high.
Forrest et al. 2009	Natural dispersal barriers such as water currents and upwellings, extensive tracts of deep water, soft sediment or severe wave exposure limit successful reproduction and establishment of founder IMS populations.
Ruiz et al. 1997; Reise et al. 2002; Nehring 2002	Various studies describe that compared with open coasts, a much higher number and proportion of exotic species are found in embayments, marshes, and estuaries.

The introduction of an IMS has the potential to impact the ecology of marine habitats by outcompeting native species. IMS are marine plants or animals that have been introduced into a region beyond their natural range and can survive, reproduce and establish founder populations.

IMSs are likely to face little or no natural competition or predation and can potentially outcompete native species for food or space, prey on native species, or change the nature of the environment. The introduction of an IMS can potentially alter the ecosystem dynamics of an area. Predicting impacts associated with an IMS are difficult because of the complexity of ecosystems and interactions amongst biotic and abiotic receptors.

However successful implementation of IMS is dependent on several factors, including water temperature, salinity and habitat suitable for the establishment of the non native species. Due to the water depths of the Operational Area, it is assumed that light penetration will be a limiting factor in the potential establishment of any IMS.

Values and sensitivities within the Operational Area are limited to soft sediment benthic habitats that are widespread and homogenous in the NWMR. Preliminary geophysical data and photographic records from grab samples taken during a site specific survey suggest that the seabed is devoid of hard seafloor or distinct sediment facies, with only soft sediment observed (see Section 3.3.2.1).

Due to the nature of the marine habitats near the Operational Area, establishment would be difficult due to the water depths and dominant presence of soft sediment communities. Natural dispersal barriers such as water currents and upwellings, extensive tracts of deep water, soft sediment or severe wave exposure; reduce densities of IMS larvae or algal spores whereby settlement is prevented by limiting successful reproduction and establishment of founder populations i.e. IMS is dispersed too far apart for successful reproduction and establishment of a population (Forrest et al. 2009). If IMS were introduced and established founder populations, it could potentially result in widespread colonisation and subsequent alteration of marine habitat ecology, therefore the environmental impact severity level was assessed as Level 3 - Moderate.

Inherent / Design Control Measures (validated control measures) and Good Practice Control Measures

Control Measure	Context of Control Measures
Maritime Arrivals Reporting System (MARS)	Under the Biosecurity Act 2015, pre-arrival information must be reported through MARS before arriving in Australian waters.
Ballast water management	The Australian Ballast Water Management Requirements (2017) describes the management requirements for ballast water exchange.

<table>
<tr><td>Antifouling certificate</td><td colspan="3">The Protection of the Sea (Harmful Anti-fouling Systems) Act 2006 enacts the Marine Order Part 98 (Marine pollution – anti-fouling systems). This marine order requires that an antifouling certificate is in place for vessels.</td></tr>
<tr><td>Biofouling management plan & record book</td><td colspan="3">The guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species (Biofouling Guidelines) (2011) specifically require a biofouling management plan and record book to be available and maintained.</td></tr>
<tr><td>Biofouling risk assessment</td><td colspan="3">In accordance with the National Biofouling Management Guidance for the Petroleum Production and Exploration Industry (2008), a biofouling risk assessment be undertaken for all support vessels and MODUs covered under this plan. The risk assessment will consider evidence of recent wetsides cleaning, application of anti-foul coating (and its status if present) and recent transit history including consideration of time in known high risk waters. Where there is history uncertainty or moderate risk of IMP presence (for either MODU / support vessels) and in accordance with National Biofouling Management Guidance for the Petroleum Production and Exploration Industry, an inspection will be undertaken and additional actions undertaken (such as dry dock / hull cleaning) if risk is considered high.</td></tr>
<tr><td>Use only local vessels to reduce the potential for introducing IMS during planned activities</td><td colspan="3">For planned drilling activities it is intended that vessels currently active in Commonwealth waters will be used to mitigate unplanned introduction of IMS as well as limit the time and costs associated with initiating and completing the Ironbark Exploration Drilling Program.</td></tr>
<tr><td colspan="4">Risk Evaluation</td></tr>
<tr><td>Impact Severity Level (Table 4-2)</td><td colspan="2">Likelihood</td><td>Risk Level</td></tr>
<tr><td>3 Moderate</td><td colspan="2">There is no documented evidence of IMS establishing in deep offshore waters. Given the nature and scale of this activity, expected absence of sensitive benthic habitats, water depth and dispersive capacity of the Operational Area, the likelihood of this event causing an impact with a severity of Level 3 - Moderate was ranked as Level B - Unlikely.</td><td>High</td></tr>
<tr><td colspan="3">ALARP Decision Context (Table 4-5)</td><td>Type</td></tr>
<tr><td colspan="3">The pathways for introducing IMS (e.g. planned release of ballast water or biofouling) are well understood and managed by both nationally and international regulations and industry guidance. This risk has the potential for future impact with widespread damage to a non-sensitive environment and has been assessed as High.
The Department of Primary Industries and Regional Development (DPIRD) was a stakeholder who identified an interest in this aspect. DPIRD were provided sufficient information from the above assessment with no specific objections or claims identified upon receipt of this information.
Given the potential for a High potential risk, and interest from a relevant stakeholder, BP believes that ALARP Decision Context C should apply and therefore control measures beyond good practice are required.</td><td>C</td></tr>
<tr><td colspan="4">ALARP Decision Context C – Further Assessment</td></tr>
<tr><td>Control Measure</td><td>Benefit</td><td>Cost</td><td>Outcome</td></tr>
<tr><td>Use only local vessels to reduce the potential for introducing IMS during planned activities</td><td>By using vessels already working in Commonwealth waters, the likelihood of introducing an IMS can be reduced.</td><td>For planned drilling activities it is intended that vessels currently active in Commonwealth waters will be used to mitigate unplanned introduction of IMS as well as limit the time and costs associated with initiating and completing the Ironbark Exploration Drilling Program.</td><td>Selected</td></tr>
</table>

Eliminate vessel use durimg planned activities	Avoid the risk of introducing IMS to the Operational Area	The MODU is required to be supported and resupplied through the drilling program. Vessels are the only form of transport that can supply and support the MODU that is practicable and cost efficient.	Not Selected
Use a MODU already operating in Australian waters during planned activities	By using a MODU already working in Commonwealth waters, the likelihood of introducing an IMS can be reduced.	Selecting a MODU operating in Commonwealth waters would result in delays when sourcing a MODU that is appropriate to undertake the drlling activities specific to the Ironbark well. The potential cost and time needed to source a capable MODU locally is disproportionate to the minor environmental gain potentially achieved.	Not Selected

Acceptability Assessment	
Principles of Ecologically Sustainable Development	The potential impact associated with this aspect is a widespread and persistent change to soft sediment communities. Given the absence of hard substrate, this activity is not expected to result in any impacts to ecologically important hard substrate communities, and thus is not considered as having the potential to affect biological diversity and ecological integrity of those habitats. The environmental impact severity level for this planned impact is Level 3 – Moderate. Consequently, further evaluation against the remaining principles of ESD is required. Little scientific uncertainty is associated with this aspect. The activities are well known, the pathways for introducing an IMP are well understood, well regulated, and managed. Seabed surveys prior to the drilling activity commencing will remove any uncertainty associated with benthic habitat communities. Preliminary geophysical data and photographic records from grab samples taken during the surveys suggest that the seabed is devoid of hard seafloor or distinct sediment facies, with only soft sediment observed (see Section 3.3.2.1). within the operational area. Consequently, the precautionary principle (Section 4.1.5) has not been applied.
Relevant legislation and other industry standards	Adherence to the following legislation and industry standards is considered a relevant control measure for this program: • Biosecurity Act 2015, • Protection of the Sea (Harmful Anti-fouling Systems) Act 2006 (enacted by AMSA Marine Order Part 98 [Marine pollution – anti-fouling systems]), and • Australian Ballast Water Management Requirements (DAWR, 2017).
Internal Context	No BP environmental performance standards were deemed relevant.
External Context	DPIRD was a stakeholder who identified an interest in this aspect. DPIRD were provided sufficient information from the above assessment with no specific objections or claims identified upon receipt of this information.
Defined Acceptable Level	Relevant to this aspect, BP defined acceptable levels, based upon the EPBC Act Significant Impact Guidelines, as a level to a situation where there is a: • Substantial change that may modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results. Given the impacts to habitat from the introduction of an IMS would be limited to soft sediment communities (that are not associated with any particular value and sensitivity), and given the widespread homogenous nature of these habitats in the region, this event would not be expected to cause changes that modify, destroy, fragment, isolate or disturb an important area, nor modify, destroy, fragment, isolate or disturb a substantial area that results in adverse impacts to the functioning or integrity of marine ecosystems. Although identified as a key pressure on marine biodiversity in the NWMR (DEWHA 2008a), with the control measures in place, management of this risk is not inconsistent with the North-west Marine Bioregional Plan which describes management requirements for the region to include compliance with the Convention for the Prevention of Pollution from Ships 1973 (MARPOL) through the

	Protection of the Sea (Prevention of Pollution from Ships) Act 1983 and the Australian Ballast Water Management requirements. The potential risk is below the level BP has defined as being unacceptable as: • The evaluation above does not identify any inconsistencies with recovery plans, conservation advice or bioregional plans, and does not have the potential to result in a persistent reduction in ecosystem function on a landscape scale; and • The likelihood of the event occurring in the first place (and subsequent likelihood of exposing sensitive receptors) resulted in an unlikely likelihood ranking of Level B. This activity is considered acceptable as it is below the defined levels of impact, and is not inconsistent with relevant recovery plans, conservation advice or bioregional plans.

Performance Management

Environmental Performance Outcomes	Performance Standards	Measurement Criteria	Responsibility
Undertake the activity in a way that will not modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results.	**MARS** Commonwealth Department of Agriculture, Water and Resources (DAWR) clearance is obtained to enter Australian waters through pre-arrival information reported through MARS	Records confirm pre-arrival report submitted to DAWR	Offshore installation manager
	Report ballast water discharges All ballast water discharges from the MODU will be reported	Records confirm all ballast water discharges were reported.	Offshore installation manager
	Maintain a ballast water record system A ballast water record system will be maintained by the MODU and each support vessel	Ballast water record system completed	Offshore installation manager, Vessel Master
	Ballast Water Management Certificate International vessels entering Australian waters have a Ballast Water Management Certificate	Records confirm Ballast Water Management Certificate is in place, where required.	Offshore installation manager Vessel Master
	Exchange of MODU ballast water outside Australian waters Ballast water exchange has been undertaken by the MODU in accordance with the requirements of the Australian Ballast Water Management Requirements before entry into Commonwealth waters	Reports of ballast water discharges and the ballast water record system demonstrate that the Australian Ballast Water Management Requirements were met	Offshore installation manager
	Antifouling certificate Support vessel antifouling system certification is current in accordance with AMSA Marine Order Part 98 (Anti-fouling systems)	The support vessels' antifouling system certificates are valid	Vessel Master

	Biofouling management plan and record book A biofouling management plan and record book will be available for the MODU and each support vessel	Review of the biofouling management plan and record books confirm they are in place and maintained.	Offshore installation manager Vessel Master
	Biofouling Risk Assessment BP undertakes an IMS Risk Assessment for each MODU / support vessel to ensure biofouling related risks are managed to a low/acceptable level prior to entering the Operational Area.	Records verify that an IMS risk assessment has been undertaken for each MODU / support vessel and that additional management requirements have been completed	Offshore Installation Manager, Vessel Master

6.4 Accidental Release

The activities described in this plan have been evaluated to identify potential spill sources and their causes. This evaluation identified any activities involving the potential use, transfer, or storage of hydrocarbons and other materials. Following this assessment, spill sources were grouped to identify the credible spill scenarios for the program; resulting in four credible spill scenarios identified for the drilling program:

- loss of containment (small hydrocarbon or chemical spill),
- failure of slip joint packer / unplanned riser disconnect,
- vessel collision, and
- loss of well control (LOWC).

In addition to these liquid spill scenarios, an additional scenario was included—the accidental release of solid objects (including hazardous or non-hazardous waste) due to human error or inappropriate waste storage.

Spill response strategies for vessel collision and loss of well control scenarios are detailed further in the Oil Pollution Emergency Plan (OPEP; Document Reference AU001-HS-PLN-600-00002) (Appendix D).

6.4.1 Accidental Release of Solid Waste

The risk associated with an accidental release of solid waste is evaluated in Table 6-8.

Table 6-8: Risk Assessment: Accidental Release of Solid Waste

Activity
The following activities were identified as having the potential to result in an accidental release of solid objects: • MODU / vessel operations (inappropriate waste storage) (Section 2.3.2/ Section 2.4), • MODU / vessel operations (human error) (Section 2.3.2 / Section 2.4).
Impact Severity Associated With An Accidental Release of Solid Waste
Location of Unplanned Event - Water Column / Surface
Discharged overboard, non-hazardous solid wastes can cause injury or death to marine fauna or seabirds through ingestion or entanglement (e.g., plastics caught around the necks of sea turtles or ingested by seabirds, sea turtles, marine mammals and

fish). For example, DSEWPaC (2015) reported that there had been 104 records of cetaceans in Australian waters impacted by plastic debris through entanglement or ingestion since 1998 (humpback whales being the main species).

Fauna most at risk from marine debris through ingestion or entanglement include marine reptiles and seabirds. The ingestion or entanglement of marine fauna has the potential to limit feeding / foraging behaviours and thus can result in individual deaths.

In addition to transient marine reptiles, marine mammals and seabirds and shorebirds that have the potential to present within surface waters; the following values / biologically important areas were identified as being present thus indicate a higher likelihood of presence in the Operational Area:

- Blue Whale (migration and distribution).

Given the restricted exposures and limited quantity of marine debris expected from the Ironbark Exploration Drilling Program, impacts are expected to be localised short-term impact to species/habitats of recognised conservation value but not affecting local ecosystem functioning. Therefore, the impact severity level associated with an accidental release of solid wastes has been evaluated as Level 2 - Minor.

Inherent / Design Control Measures (validated control measures) and Good Practice Control Measures

Control Measure	Context of Control Measures
Garbage / waste management plan Garbage record book	AMSA Marine Order Part 95 (Marine pollution prevention — garbage) and Marine Order Part 94, (Packaged harmful substance) gives effect to MARPOL Annex V. MARPOL Annex V requires that a garbage / waste management plan and garbage record book are in place and implemented.
Accidental release / waste management training / induction	AMSA Marine Order Part 95 highlights that placards (or stickers) advise the crew and passengers of the rules related to the discharge of garbage into the sea and should be displayed on the vessel where they are visible for both crew and passengers. Inductions for all vessel crew provide an opportunity to make personnel aware of the requirements of the Garbage Management Plan and housekeeping provisions during the implementation of the activity.

Risk Evaluation

Impact Severity Level (Table 4-2)	Likelihood	Risk Level
2 Minor	Accidental release of solid wastes from other activities has occurred previously in the industry, that is an accidental release of waste that caused death to individual fauna species. However, it is not expected to occur during these activities with the control measures in place. In the event that it did occur, the likelihood that values and sensitivities are impacted is also low. Consequently, the likelihood has been ranked as a Level B – Unlikely.	Low

ALARP Decision Context (Table 4-5)	Type
Suitable management practices exist to managing waste that is generated offshore and are commonly implemented. The release pathways and control measures required to manage these, are well understood. There is little uncertainty associated with the potential environmental impacts and risks, which were evaluated to have an impact severity Level 2 - Minor. The risk matrix presented within the conservation Management Plan for Blue Whales (DoE 2015) provides a risk rating of low associated with marine debris. Given inherent controls and relevant industry standards are applied, controls align with the priority for action recommended in this management plan. No objections or claims raised by relevant stakeholders during consultation for the program. ALARP Decision Context Type A applies. Inherent controls are good practice and no control measures beyond good practice are required.	A

Acceptability Assessment

The risks associated with an accidental release of solid waste has been ranked as Decision Context Type A, therefore the existing controls are considered inherently acceptable and no further evaluation is required.

Performance Management			
Environmental Performance Outcomes	**Performance Standards**	**Measurement Criteria**	**Responsibility**
• Undertake the activity in a way that will not result in a substantial adverse effect on a population of marine fauna, including its life cycle and spatial distribution. • Undertake the activity in a way that will not seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	**Garbage / waste management plan** A Garbage Management Plan will be in place and implemented for the MODU and support vessels	Review of the Garbage Management Plan confirms it is in place and maintained	Offshore Installation Manager Vessel Master
	Garbage record book A garbage record book / log will be in place and maintained for the MODU and support vessels	Review of the garbage record book confirms it is in place and maintained	Offshore Installation Manager Vessel Master
	Garbage Placards Placards (or stickers) advise the crew and passengers of the rules related to the discharge of garbage into the sea and should be displayed on the vessel where they are visible for both crew and passengers.	MODU and support vessel inspection confirms garbage placards are in place and visible.	Offshore Installation Manager Vessel Master
	Waste management training / induction All crew will undertake site inductions that include a component on storing and handling hazardous materials and wastes	Presentation and attendance sheets verify that personnel attended the induction	Offshore Installation Manager Vessel Master
	Accidental release / waste management training / induction Prevent overboard discharge of hazardous liquid spills by storing hydrocarbons and hazardous liquids within secondary containment or purpose-built bulk tanks aboard the MODU and support vessels	HSE inspection confirm hydrocarbons and hazardous liquids are stored within secondary containment or purpose-built bulk tanks	Offshore Installation Manager Vessel Master

6.4.2 Loss of Containment (Small Hydrocarbon or Chemical Spill)

The risks associated with an accidental release – loss of containment (small hydrocarbon or chemical spill) are evaluated in Table 6-9.

Table 6-9: Risk Assessment: Accidental release - Loss of Containment (Small Hydrocarbon or Chemical Spill)

Activity
The following activities were identified as having the potential to result in a Loss of Containment (Small Hydrocarbon or Chemical Spill): • MODU / vessel operations (general) (Section 2.3.2/ Section 2.4), • MODU operations – crane transfers and bunkering operations (Section 2.3.2) [a], • ROV operations (Section 2.3.9), and • Support vessel operations – crane transfers and bunkering operations (Section 2.4).

<table>
<tr><td colspan="2">Causes of spills overboard include:
• Failure or mechanical breakdown of equipment used to store or transfer hydrocarbons or hydraulic fluid,
• Hose or connection failure (due to equipment condition or failure of the vessel to keep stationary),
• Incorrect storage and/or absence of bunding around hydrocarbons,
• Human error,
• Failure to align valves correctly during transfer to tanks,
• Overfilling tanks on MODU,
• Overfilling aviation fuel tank on fuel unit or bulk storage tank of the MODU, and
• Dropped objects from crane transfers.
[a] A range of hydrocarbons are likely to be present during the drilling program; however, the maximum credible volume associated with this group of spill events is associated with a bunkering incident. AMSA (2015) suggests the maximum credible spill volume from a bunkering / refueling incident with continuous supervision is approximately the transfer rate × 15 minutes. Assuming failure of dry-break couplings and a ~200 m^3/h transfer rate (based on previous operations in North-western Australia), this equates to an instantaneous spill of ~50 m^3. This could comprise any hydrocarbon or chemical that is transferred from the support vessel to the MODU and includes SBM or diesel (MDO) etc.</td></tr>
<tr><td colspan="2">Impact Severity Associated With A Loss of Containment (Small Hydrocarbon or Chemical Spill) Event</td></tr>
<tr><td colspan="2">Location of Unplanned Event - Water Column / Surface</td></tr>
<tr><td colspan="2">The impact severity level associated with water column / surface hydrocarbon exposures from this type of event are expected to be much less than those evaluated in Section 6.4.4, which are based upon a surface release of 250 m^3 of MDO at the indicative well location, thus the assessment has not been duplicated. The environmental impact severity level (in line with that described in Section 6.4.4) was assessed to be Level 1 - Negligible.
The impact severity associated with water column exposures to SBM from this type of event are expected to be much less than those evaluated in Section 6.4.3, which are based upon a release of SBM in the order of 60 m3 at the well location, thus the assessment has not been duplicated. The environmental impact severity level (in line with that described in Section 6.4.3) was assessed to be Level 1 - Negligible.</td></tr>
<tr><td colspan="2">Inherent / Design Control Measures (validated control measures) and Good Practice Control Measures</td></tr>
<tr><td>Control Measure</td><td>Context of Control Measures</td></tr>
<tr><td>Bunded storage</td><td>Storage containers are managed in a manner that provides for secondary containment in the event of a spill or leak.</td></tr>
<tr><td>Shipboard Oil Pollution Emergency Plan (SOPEP)</td><td>MARPOL Annex I and AMSA's Marine Order Part 91, Marine pollution prevention – oil requires that each support vessel has an AMSA-approved SOPEP in place. To prepare for a spill event, the SOPEP details:
• Response equipment available to control a spill event,
• Review cycle to ensure that the SOPEP is kept up to date, and
• Testing requirements, including the frequency and nature of these tests.
In the event of a spill, the SOPEP details:
• Reporting requirements and a list of authorities to be contacted,
• Activities to be undertaken to control the discharge of oil, and
• Procedures for coordinating with local officials.</td></tr>
<tr><td>Accidental release / waste management training / induction</td><td>Inductions for all MODU and vessel crew make personnel aware of the requirements of the housekeeping provisions during the implementation of the activity.</td></tr>
<tr><td>Bulk transfer process

Hoses and connections</td><td>GOMO 0611-1401 (2013) provides guidance on best practices that should be adopted to ensure the safety of personnel on board all vessels servicing and supporting offshore facilities, and to reduce the risks associated with such operations. Specifically, this guideline recommends:</td></tr>
</table>

PMS	• An appropriate procedure is in place for the discharging operation, • Hoses must remain afloat at all times by using sufficient floating devices, • Using self-sealing weak-link couplings in the mid-section of the hose string, and • Hoses must be maintained and sections changed out in accordance manufacturer guidance (PMS).
Fuel Oil and Hazardous Fluids Transfer procedure	Rig contractor will follow a procedure for bulk transfer of SBM. Specifically, this requires that before SBM can be transferred in bulk: • Designation of personnel in charge of transfer operations. • Personnel will complete a number of visual checks to ensure safe transfer conditions. • Job Safety Analysis must be completed before transferring SBM.

Risk Evaluation

Impact Severity Level (Table 4-2)	Frequency/Duration	Risk Level
1 Negligible	An accidental release of a small volume of hydrocarbons or chemicals to the marine environment has occurred previously in the industry. However, it is not expected to occur during these activities with the control measures in place. In the event that it did occur, the likelihood that values and sensitivities are impacted is also low. Consequently, the likelihood has been ranked as a Level B - Unlikely.	Low

ALARP Decision Context (Table 4-5)	Type
Despite the safety risks, handling, storage and transfer of chemicals and hydrocarbons is well-practised for offshore marine activities. There is a good understanding of potential spill sources and the control measures required to manage these. There is little uncertainty associated with this risk, which was evaluated as Level 1 - Negligible. ALARP Decision Context Type A applies. Inherent controls are good practice and no control measures beyond good practice are required.	A

Acceptability Assessment

The risks associated with a loss of containment (small hydrocarbon or chemical spill) has been ranked as Decision Context Type A, therefore the existing controls are considered inherently acceptable and no further evaluation is required.

Performance Management

Environmental Performance Outcomes	Performance Standards	Measurement Criteria	Responsibility
• Undertake the activity in a way that will not have a substantial adverse effect on a population of marine fauna, including its life cycle and spatial distribution. • Undertake the activity in a way that will not seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion	**SOPEP** Emergency response activities will be implemented in accordance with the vessel SOPEP	Records confirm that emergency response activities were implemented in accordance with the vessel SOPEP.	Vessel Master
	Accidental release / waste management training / induction All MODU an vessel crew will undertake site inductions that include a component on storing and handling hazardous materials and wastes	Presentation and attendance sheets verify that MODU and vessel personnel attended the induction	Offshore Installation Manager Vessel Master
	Hoses and connections Transfer hoses shall comprise sufficient floating devices and self-sealing weak-link couplings in	Records demonstrate transfer hoses meet GOMO 0611-1401 requirements (2013)	Offshore Installation Manager

of the population of a migratory species.	the mid-section of the hose string, in accordance with GOMO 0611-1401 (2013)		
	PMS Maintain bulk fluid transfer hoses, in accordance with the MODU PMS	Records confirm bulk fluid transfer hoses have been maintained in accordance with the MODU PMS	Offshore Installation Manager
	Bunded storage Storage areas or containers areprovided with secondary containment capacity in the event of a spill	Inspection records confirm that secondary containment of storage areas or containers is maintained.	Well Site Leader Mud Engineer Vessel Master
	Fuel Oil and Hazardous Fluids Transfer Implement the Fuel Oil and Hazardous Fluids Transfer procedure inclusive of intake valve alignment and overboard discharge point inspections	Records are maintained for all transfer inspection checklists, in alignment with Fuel Oil and Hazardous Fluids Transfer procedure	Wells Superintendent

6.4.3 Failure of Slip Joint Packer / Unplanned Riser Disconnect

The risks associated with an accidental release of drilling fluids from a failure of the slip joint packer or an unplanned riser disconnect are evaluated in Table 6-10.

Table 6-10: Risk Assessment: Accidental release - Failure of Slip Joint Packer / Unplanned Riser Disconnect

Activity
The following activities were identified as having the potential to result in a Failure of Slip Joint Packer / Unplanned Riser Disconnect: • Exploration drilling (riser on drilling) (Section 2.3) If the riser is disconnected accidentally, there is the potential for the drilling fluid volume from the drill floor level down to the top of the subsea BOP stack (comprised of the riser and drill string) to be lost to the environment – estimated to be in the order of 60 m3 of SBM. If the slip joint packer failed, the volume lost is expected to be ~4 m3 (or ~30 bbl), which would be slowly released at the sea surface. An accidental release of drilling fluid has the potential to result in an impact to values and sensitivities in the water column through: • Chemical toxicity, and values and sensitivities associated with the seabed through: • Smothering and sedimentation, and • Chemical toxicity.
Impact Severity Associated with a Failure of Slip Joint Packer / Unplanned Riser Disconnect
Location of Unplanned Event - Water Column
Chemical Toxicity The American Chemistry Council (2006) evaluated toxicity data for water and sediment dwelling organisms against SBM. Toxicity tests found SBM are non-toxic to water dwelling organisms but have toxicity effects to sediment-dwelling organisms similar to diesel oil. Details on potential impacts from sediment (seabed) toxicity is provided in the next section.

<table>
<tr><td colspan="3">Seabed</td></tr>
<tr><td colspan="3">Smothering, Sedimentation and Toxicity
In the event of an emergency riser disconnect, SBM will be released at the top of the BOP, within tens of metres above the seabed. Due to the density of SBM, SBM would exit the from the bottom of the lower marine riser package, thereby directly blanketing the seabed. If the riser is disconnected in an emergency, there is the potential for the riser volume estimated to be in the order of 60m^3 of SBM to be lost to the environment.
Modelling for a subsurface SBM release from the marine riser, during an emergency BOP disconnect event was undertaken for Nexen Energy ULC for drilling operations in water depth of 378 m (Amec Foster Wheeler 2018). Based on a release of total SBM volume of 89 m^3 over 2 hours located 15 m above the seafloor, the model predicted a maximum distance of 57 m from site for SBM dispersion (Amec Foster Wheeler 2018). The SBM volume modelled for Nexen Energy ULC is greater than the estimated volume of 60m^3 of SBM to be lost to the environment, thus the predictions of this model is considered to provide a conservative indication of the extent of seabed exposure from this activity.
Given the extent of seafloor exposure associated with this scenario (57 m) is expected to be less than the seafloor exposure for planned surface release of drill fluids and cuttings (1.24 km), the impact severity level associated with seabed smothering, sedimentation and toxicity from this type of event are expected to be much less to those evaluated in Section 5.7.1 and therefore not discussed further. The environmental impact severity level (per Section 5.7.1) was assessed to be Level of 2 – Minor.</td></tr>
<tr><td colspan="3">Inherent / Design Control Measures (validated control measures) and Good Practice Control Measures</td></tr>
<tr><td>Control Measure</td><td colspan="2">Context of Control Measures</td></tr>
<tr><td>Chemical selection process</td><td colspan="2">A sub-point of WBG Guidance Number 59 recommends that:
• Operators carefully select drilling fluid additives, taking into account their concentration, toxicity, bioavailability, and bioaccumulation potential.
BP will apply the chemical selection process to drilling fluid additives to meet the above recommendation.</td></tr>
<tr><td>Riser analysis conducted</td><td colspan="2">A riser analysis will be conducted to ensure that its design is suitable for the Ironbark-1 exploration well.</td></tr>
<tr><td>Wells monitoring program</td><td colspan="2">A leak at the slip joint packer would be identified via a discrepancy of the drilling fluid volumes, which is closely monitored. Drilling fluid volume control is a fundamental component of well control. A complete understanding of drilling fluid volumes at all stages of drilling and abandonment allows the monitoring of any losses / leaks or gains.</td></tr>
<tr><td>Design of riser disconnect system</td><td colspan="2">Initiating a riser disconnect is a multi-stage process, which is only executed by trained, competent personnel. Therefore the likelihood of an accidental riser disconnect is considered low.</td></tr>
<tr><td>PMS</td><td colspan="2">PMS ensure that critical equipment (such as risers and seals) is maintained in accordance with manufacturer specifications to enable optimal performance.</td></tr>
<tr><td colspan="3">Risk Evaluation</td></tr>
<tr><td>Impact Severity Level (Table 4-2)</td><td>Frequency/Duration</td><td>Risk Level</td></tr>
<tr><td>2 Minor</td><td>Failure of the slip joint packer and unplanned riser disconnect has occurred previously in the industry. However, it is not expected to occur during these activities with the control measures in place. In the event that it did occur, the likelihood that values and sensitivities are impacted is also low. Consequently, the likelihood has been ranked as a Level B – Unlikely.</td><td>Low</td></tr>
<tr><td colspan="2">ALARP Decision Context (Table 4-5)</td><td>Type</td></tr>
<tr><td colspan="2">Use of slip joint packers and risers in offshore drilling activities is common place, with spill causes well understood and managed. There is little uncertainty associated with the potential</td><td>A</td></tr>
</table>

environmental impacts associated with this activity, which were evaluated to be conservatively as a Low risk event. No concerns were raised during stakeholder consultation regarding this activity or its potential impacts and risks. ALARP Decision Context Type A applies. Inherent controls are good practice and no control measures beyond good practice are required.			
Acceptability Assessment			
The risk associated with failure of slip joint packer / riser disconnect has been ranked as Decision Context Type A, therefore the existing controls are considered inherently acceptable and no further evaluation is required.			
Performance Management			
Environmental Performance Outcomes	**Performance Standards**	**Measurement Criteria**	**Responsibility**
Undertake the activity in a way that will: • Not have a substantial adverse effect on a population of marine fauna, including its life cycle and spatial distribution. • Not seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species. • Not result in a substantial change that may modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results.	**Chemical selection process** All drilling fluids and additives must be assessed and deemed acceptable before use, in accordance with BP's chemical selection process	Records demonstrate chemical selection, assessment and approval process for selected chemicals is followed.	Drilling Engineering Team Lead
	Riser analysis Conduct a riser analysis before commencing the Ironbark-1 exploration drilling activities	Records confirm riser analysis was completed before drilling activities commenced	Wells Superintendent
	Wells Monitoring Program Conduct continuous wells monitoring during drilling and abandonment operations. This includes continuous monitoring of mud return, total mud volume and mud additives	Daily reports show real time alarms on the rig triggered by changing trends exceeding preset limits.	Wells Superintendent
	Design of riser disconnect system The existing rig equipment will be used, and only operated by trained, competent personnel.	Equipment maintenance records show equipment is maintained as per OEM recommendations. Training records demonstrate competence of personnel permitted to operate riser disconnect equipment.	Offshore Installation Manager
	PMS Prevent SBM spills by maintaining slip joint packer and marine riser seals in accordance with the MODU PMS	Records confirm slip joint packer and marine riser seals were maintained in accordance with the MODU PMS	Offshore Installation Manager

6.4.4 Vessel Collision

After evaluating threats associated with the activities covered under this EP, a vessel collision event is considered a credible (but unlikely) event. The major causes of a vessel collision were identified as:

- Loss of DP, or
- Navigational error.

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, poor weather and failure to implement the 500 m petroleum safety buffer. A tank rupture as a result of vessel grounding is not considered a credible scenario as the water depth is approximately 300 m and there are no emergent features within the Operational Area.

Review of several potential vessel collision scenarios for the Ironbark-1 exploration drilling program have identified one possibility where a breach of a fuel tank may occur within the Operational Area. BP considers the potential vessel collision between a support vessel and a passing third party vessel (such as commercial shipping/fishing vessel) within the Operational Area as the only credible scenario which would result in release of hydrocarbons from a ruptured fuel tank. This credible scenario assumes the third-party vessel to be travelling at a speed which will have enough force to penetrate the support vessel hull, with the collision penetrating the location of the support vessel's fuel tank, and the support vessel's fuel tank is full.

Vessel collisions between the MODU and a support vessel are not considered credible scenarios for accidental release of hydrocarbons. Potential collisions between the slow moving MODU and support vessels within the Operational Area would not result in sufficient force to penetrate the support vessel's fuel tank. In addition, MODU fuel tanks are located within the MODU pontoons and can be over 10 m below the waterline; therefore, the penetration of a MODU fuel tank from a vessel collision is not considered credible.

A maximum credible spill volume has been determined based on technical guidance provided by AMSA (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 typical support vessels in the North West Shelf, isolated MDO tanks of support vessels are typically located mid-ship and can range in typical size from 22 to 105 m^3. As a conservative approach, BP has assessed the maximum credible spill from a vessel collision as 250 m^3 which represents more than double the typical maximum tank size.

6.4.4.1 Modelling inputs

RPS were engaged to assess and quantify the extent of hydrocarbon exposure from a potential offshore spill event associated with this activity. A three-dimensional oil spill trajectory and weathering model, SIMAP (Spill Impact Mapping and Analysis Program), was used. This model is designed to simulate the transport, spread, and weathering of specific oil components (e.g. surface, entrained, dissolved) under the influence of changing meteorological and oceanographic forces. RPS warrants that this modelling approach meets and exceeds the American Society for Testing and Materials (ASTM) Standard F2067-13

"Standard Practice for Development and Use of Oil Spill Models". Table 6-11 provides a summary of the model inputs and parameters.

The modelling did not take into consideration any spill prevention, mitigation, and response capabilities that BP proposes to have in place during the production drilling program. The modelling makes no allowance for intervention following a spill to reduce volumes and/or prevent hydrocarbons from reaching sensitive areas. This enables BP to conservatively understand the extent to which the environment may be affected or impacted by an unmitigated spill.

Table 6-11:Vessel Collision Credible Spill Scenario Inputs

Parameter	Details			
Release location	Ironbark Exploration Well (Table 2-1)			
Oil type	Marine Diesel Oil (Section 2.2)			
Total volume released	250 m^3			
Release duration	6 hours			
Model simulation duration	30 days			
Hydrocarbon Exposure Values[a]	**Surface**	**Entrained**	**Dissolved**	**Shoreline**
Socioeconomic Values	1 g/m^2	100 ppb	50 ppb	10 g/m^2
Ecological Values	10 g/m^2	100 ppb	50 ppb	100 g/m^2
Water depth (m)	approx. 300 m			
Number of randomly selected spill simulations per season	100			
Seasons assessed	Summer (October to March); Transitional (April and September); Winter (May to August)			

[a]The sea surface, shoreline and water column exposure thresholds used to assess and present the oil spill modelling results correspond to those exposure values for oil spill modelling published by NOPSEMA (2019).

MDO has an API of 37.6, a density of 829.1 kg/m^3 with a low pour point of -14°C and a viscosity of 4 cP), classifying it as a Group II non-persistent oil (ITOPF 2014). The low viscosity (4 cP) indicates that this oil will spread quickly when released and will form a thin to low thickness film on the sea surface, increasing the rate of evaporation.

A surface release of MDO was modelled to confirm this expected behaviour; the tests were run under three wind conditions (5, 10 and 15 knots; RPS 2019). The fates and weathering graph (Figure 6-1) illustrates rapid evaporation under all three wind speeds and that a proportion of the released oil will likely entrain in the water column under higher (e.g. 10 and 15 knot simulations) wind speeds.

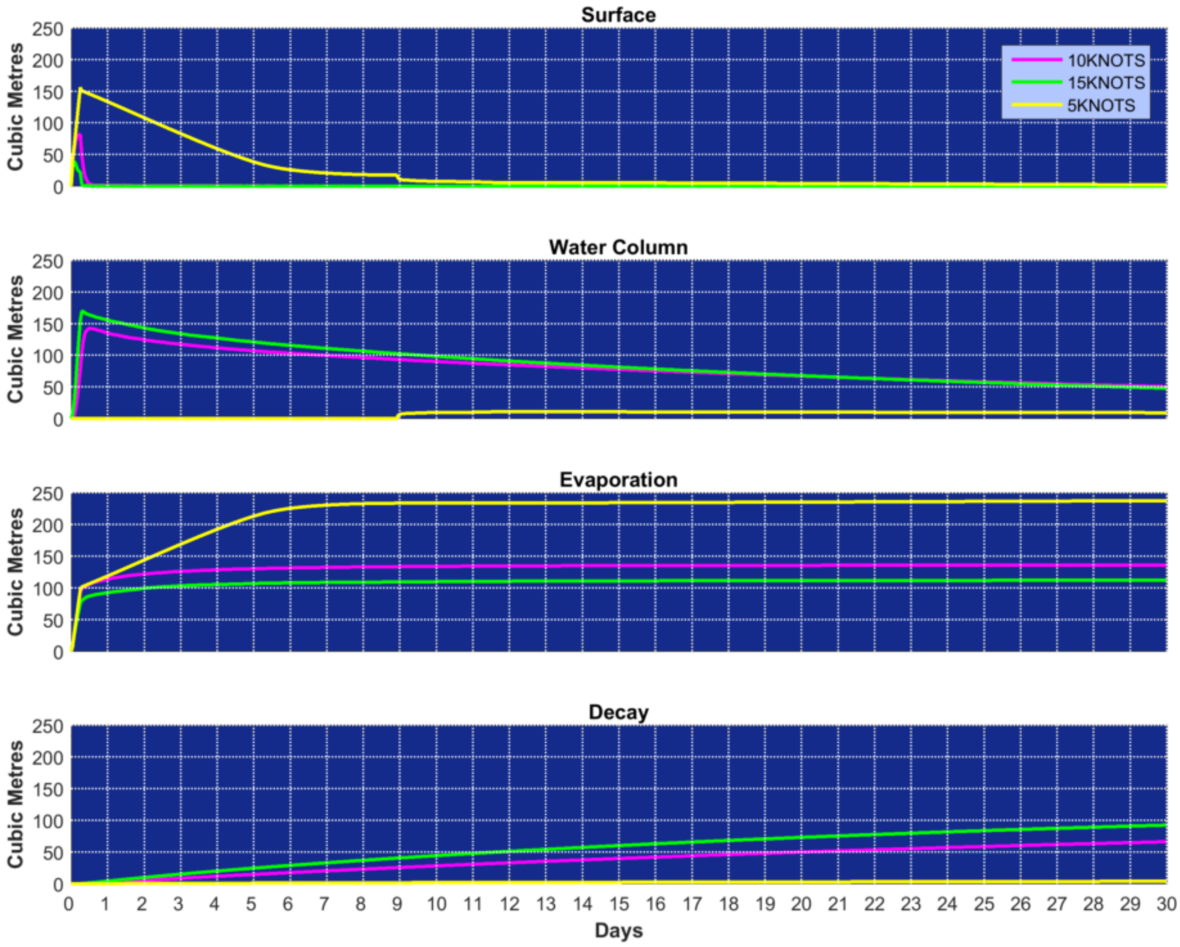


Figure 6-1: Predicted Weathering and Fate of the released MDO based on a 250 m^3 surface release of MDO over 6 hours and tracked for 30 days

6.4.4.2 Modelling outputs

Key results from the stochastic modelling outputs, obtained from a total of 100 spill simulation per season over the 3 seasons characteristic of the region, include:

- No shoreline accumulation above the minimum threshold (>10 g/m^2) was predicted for any of the seasons modelled.
- The maximum distance from the release site for surface oil at >1 g/m^2 ranged from 97 km (winter) and 153 km (transitional); and at >10 g/m^2 ranged from 45 km (summer) to 54 km (transitional).
- Entrained and dissolved oil remained in surface layers, typically from surface down to 10 m depth.

6.4.4.3 Risk Assessment

The risks associated with an accidental release - Vessel Collision are evaluated in Table 6-12.

Table 6-12: Risk Assessment: Accidental Release - Vessel Collision

Activity

The following activities were identified as having the potential to result in a vessel collision event:

- MODU / vessel operations (Section 2.3.2/ Section 2.4).

The major causes of a vessel collision were identified as:

- Loss of engine power causing a vessel to drift, or
- Navigational error.

An accidental release of hydrocarbons has the potential to result in an impact to values and sensitivities associated with the water surface and water column through:

- Physical ingestion or smothering, and
- Chemical toxicity

Impact Severity associated with an accidental release from Vessel Collision

Water Column / Surface

Marine fauna with the potential to be exposed to hydrocarbons from this event include plankton and transient marine fauna and BIAs associated with the migrating Blue Whale, migrating Humpback Whales, breeding Wedge-tailed Shearwaters and foraging Whale Shark were identified as being present more than 150 km from the Ironbark-1 exploration well.

The spatial boundary of in-water hydrocarbons within the 0-10 m depth surface layer, intersects two KEFs. The KEFs are deeper water and/or benthic features, they are not considered further:

- Ancient coastline at 125 m depth contour
- Continental slope demersal fish communities

The spatial boundary of in-water entrained hydrocarbons within the 0-10 m depth surface layer, intersects three AMPs, one State Marine Park:

- Mermaid Reef AMP (1% probability of entrained hydrocarbons at 10 ppb)
- Montebello AMP (1% probability of entrained hydrocarbons at 10 ppb)
- Gascoyne AMP (2% probability of entrained hydrocarbons at 10 ppb)
- Ningaloo Marine Park (2% probability of entrained hydrocarbons at 10 ppb)

Surface Exposure

The extent of surface water hydrocarbon exposure has the potential to cause injury and mortality through toxicity poisoning to an intersecting individual marine receptor (such as seabirds, marine turtles or marine mammals):

- Seabirds dive in ocean waters to feed or rest at the surface. In the event that seabirds are exposed to hydrocarbons, these behaviours will oil feathers breaking down thermal insulation and buoyancy properties of seabird plumage which prevents them from feeding or flying (Crawford et al. 2000). Seabird preening of oiled feathers will result in oil ingestion and resultant gut damage (Crawford et al. 2000). Oiling of seabird feathers may result in mortal injury through starvation, cold and poisoning. Breeding BIA for the Wedge-tailed Shearwater is present within 153 km of the Ironbark-1 exploration well, however, it is noted that it is the edge of the buffer zone around a breeding island (i.e. not the breeding location itself). A study tracking movements of wedge-tailed shearwaters indicate that birds forage on average 85 km away and up to a maximum of approx. 185 km from their nesting site, over short trips of 1-3 day duration (Cecere et al 2013).
- Marine turtles have the potential to ingest oil by surface breathing within the slick or consuming contaminated prey species. Ingestion of oil may result in mortal injury from damaged digestive function (Milton and Lutz 2003). No BIAs are present within 153 km of the Ironbark-1 exploration well indicating that no known aggregation areas are present / nor have the potential to be exposed to hydrocarbons from this event.
- Surfacing marine mammals such as Blue Whales and Humpback Whales migrating through surface hydrocarbon exposures are susceptible to fume inhalation and oil absorption through the skin (Helm et al. 2015). Physical contact by individual whales of MDO is unlikely to lead to any long-term impacts (Fraker, 2013). Given the mobility and wide geographical distribution of whales on the NWS, only a small proportion of the population would be expected to surface in an area exposed to surface hydrocarbons, resulting in short-term and localised consequences, with no long-term population viability effects (Helm et al. 2015). Geraci (1988) found little evidence of cetacean mortality from

hydrocarbon spills; however, some behaviour disturbance (including avoidance of the area) may occur. While this reduces the potential for physiological impacts from contact with hydrocarbons, active avoidance of an area may disrupt behaviours such as migration. **In-water Exposure** The extent of in-water hydrocarbon exposure has the potential to cause chronic impacts to planktonic organisms, pelagic fish and marine mammals that might move within the plume. • Plankton are drifting organisms which includes eggs and larvae of fish and other animals. Plankton species are sensitive to toxic effects of oil at low concentrations and large numbers of planktonic organisms may be affected (ITOPF, 2011). Plankton are numerous and widespread but do act as the basis for the marine food web. However, any impact is expected to be localised and temporary, meaning that an oil spill in any one location is unlikely to have long-lasting impacts on plankton populations at a regional level. Once background water quality conditions have re-established, the plankton community may take weeks to months to recover (ITOPF, 2011). The potential impacts to plankton are expected to be short-term, localised, and not affecting local ecosystem functioning. • Pelagic free-swimming fish and sharks are unlikely to suffer long-term damage from oil spill exposure because dissolved/entrained hydrocarbons in water are not expected to be sufficient to cause harm (ITOPF, 2011). Subsurface hydrocarbons could potentially result in acute exposure to marine biota such as juvenile fish, larvae, and planktonic organisms, although impacts are not expected cause population-level impacts. A proportion of the foraging population of Whale Sharks could be affected, which could result in temporary and localised consequences. • Cetacean exposure to in-water hydrocarbons can occur via ingestion or physical coating (Geraci and St Aubin, 1988). The potential for environmental impacts would be limited to a relatively short period following the release and would need to coincide with a migration or aggregation event to result in exposure of a large number of individuals. However, such exposure is not anticipated to result in long-term population viability effects. A proportion of the migrating population of whales could be affected for a single migration event, which could result in temporary and localised consequences. • Tainting of seafood can occur rapidly with even very low concentrations of hydrocarbons in the water. Tainting is where fish/shellfish absorb hydrocarbon from the water and its flesh has an oil odour or flavour when eaten. Tainted fish will be unacceptable to the market and may need to be dumped. If left in clean water for a few weeks the tainting will gradually disappear (NERA 2018:1003). Given that the potential for surface hydrocarbon exposure within 153 km of the Ironbark-1 exploration well is relatively short-term (approximately 12 days in accordance with Figure 6-1), and impacts from exposure to in-water hydrocarbons are considered temporary; the potential consequences to receptors that may be exposed to surface and in-water is considered localised and limited. It is unlikely that many marine receptors will be exposed and therefore no receptor populations will be affected. In the event a vessel collision would result in the release of diesel, marine fauna casualties may result however would only occur at a localised level (given the limited duration and transient nature of receptors within the area) and would be unlikely to impact local populations. This event is expected to result in localised, short-term impacts to transient marine receptors. Therefore the impact severity level was assessed to be Level 2 - Minor.	
Inherent / Design Control Measures (validated control measures) and Good Practice Control Measures	
Control Measure	**Context of Control Measures**
Vessel Crew	BP contractual obligations will require vessel contractors to comply with legislated requirements. Including that: Crew meet the minimum standards for safely operating a vessel, including watchkeeping requirements (AMSA Marine Order Part 3 [Seagoing qualifications]).
Navigational Equipment	Navigation, radar equipment, and lighting meets industry standards (AMSA Marine Order Part 30 [Prevention of collisions]).
Shipboard Oil Pollution Emergency Plan (SOPEP).	MARPOL Annex I and AMSA's Marine Order Part 91, Marine pollution prevention – oil requires that each support vessel has an AMSA-approved SOPEP in place. To prepare for a spill event, the SOPEP details: • Response equipment available to control a spill event • Review cycle to ensure that the SOPEP is kept up to date • Testing requirements, including the frequency and nature of these tests.

<table>
<tr><td></td><td colspan="2">In the event of a spill, the SOPEP details:
• Reporting requirements and a list of authorities to be contacted
• Activities to be undertaken to control the discharge of oil procedures for coordinating with local officials.</td></tr>
<tr><td>Pre-start notifications.</td><td colspan="2">Under the Navigation Act 2012, AHS is responsible for maintaining and disseminating hydrographic and other nautical information and nautical publications, including Notices to Mariners.
Through Notices to Mariners, other marine users can plan their activities such that their disruption from these activities are minimised.</td></tr>
<tr><td>OPEP arrangements.</td><td colspan="2">Under the OPGGS(E)R, there is the requirement to describe the oil pollution emergency arrangements and capabilities/control measures necessary for timely response to an emergency that results or may result in oil pollution.
For the purposes of this EP, these are detailed in Section 6.5 of this EP.</td></tr>
<tr><td>Operational and Scientific Monitoring Plan.</td><td colspan="2">The details and capability in place for:
• Operational monitoring of a hydrocarbon spill to inform response activities.
• Scientific monitoring of environmental impacts of the spill and response activities.
Operational monitoring allows adequate information to be provided to aid decision making to ensure response activities are timely, safe and appropriate. Scientific monitoring identifies if potential longer-term remediation activities may be required.</td></tr>
<tr><td colspan="3">Risk Evaluation</td></tr>
<tr><td>Impact Severity Level (Table 4-2)</td><td>Likelihood</td><td>Risk Level</td></tr>
<tr><td>2 Minor</td><td>Between 2005 and 2012 (7 years), 37 vessel collisions and 30 pollution occurrences were reported to the Australian Transport Safety Bureau from a total of 1,200 marine incidents in Australian waters. Of the 30 pollution occurrences across the whole period, 10 involved gas and 10 involved fuel or oil leaks. Furthermore, a review of the shipping traffic and fishing activity reported for the Operational Area indicates that the level of vessel traffic in the Operational is not conducive to an increased collision risk (outside of the shipping fairway). In line with industry statistics, the probability of a vessel collision occurring in the Operational Area during the drilling activity is therefore low.
In 2011-12, one of the five pollution-related occurrences reported involved oil spilled (25 to 50 litres) from a vessel collision which lead to puncturing the hull of one vessel resulting in water ingress and an oil spill. As most vessel collisions involve the loss of containment of a forward tank, which are generally double-lined and smaller than other tanks, the loss of the maximum volume used in the vessel collision scenario (250 m3) is unlikely.
Considering:
• The inherent low likelihood of a collision occurring, further reduced by:
  - the presence of support vessels operating at slow speeds within the Operational Area;
  - the implementation of a petroleum safety zone, and associated notifications issued to other users of the area via AMSA;
• Design features of the vessel inherently limiting exposure of fuel tanks and associated hydrocarbons during a collision scenario (through features such as positioning, tank capacity and double full);
• Timely enactment of the SOPEP/SMPEP and OPEP to limit exposure of environmental receptors to hydrocarbons;</td><td>Low</td></tr>
</table>

	• volatile nature and rapid weathering properties of fuel selected for use in vessels contracted for the drilling program; A vessel collision resulting in adverse effects to the marine environment is therefore considered B – Unlikely**.**	

ALARP Decision Context (Table 4-5)	**Type**
The operation of MODUs and vessels offshore is well practiced and collision risk is well regulated with associated control measures well understood and implemented by the offshore industry. AMSA have advised that heavy vessel traffic, including tanker, cargo, support and passenger vessels, pass in the vicinity of the Operational Area based on the location of the chartered shipping fairway located west of the Operational Area (AMSA, personal communication, 19 March 2019). Although no specific objections or claims were raised by AMSA regarding the activity, they requested that suitable safety control measures be implemented to ensure the risk of interaction is managed. This was verified via consultation with AMSA during consultation undertaken in support of a site survey in WA-359-P. Based upon the location of the Ironbark-1 exploration well, BP determined that there was only the potential for a minor environmental impact from this event. As the causes of this event are well known along with the control measures for managing the risk, there is limited uncertainty associated with this event. The risk matrix presented within the Conservation Management Plan for Blue Whales (DoE 2015) provides a risk rating of moderate associated with chronic chemical pollution. Controls and mitigation actions described, align with the priority for action recommended in the management plan. ALARP Decision Context Type A applies. Inherent controls are good practice and no control measures beyond good practice are required.	A

Acceptability Assessment
Unplanned events associated with an accidental release from a vessel collision event are ranked as Decision Context Type A, therefore the existing controls are considered inherently acceptable and no further evaluation is required.

Performance Management

Environmental Performance Outcomes	**Performance Standards**	**Measurement Criteria**	**Responsibility**
Undertake the activity in a way that will not cause a: • Change that may have a substantial adverse effect on a population of marine fauna, including its life cycle and spatial distribution, or • Change that may modify, destroy or isolate an area of important habitat for a migratory species, or • Change that may seriously disrupt the lifecycle (breeding, feeding,	**Vessel Crew and Navigational Equipment** Vessels and crew will meet AMSA requirements.	Records indicate that contractual arrangements specified minimum requirements for AMSA compliance for both vessel equipment and crew.	Offshore Installation Manager, Vessel Master
	SOPEP Emergency response activities will be implemented in accordance with the vessel SOPEP	Records confirm that emergency response activities were implemented in accordance with the vessel SOPEP.	Offshore Installation Manager, Vessel Master
	Pre-start notifications The AHS will be notified no less than four working weeks before operations commence to enable Notices to Mariners to be published	Information to communicate a Notice to Mariners is provided to AHS via email datacentre@hydro.gov.au	Offshore Installation Manager, Vessel Master
	Pre-start notifications The AHS will be notified no less than four working weeks before	Information to communicate a Notice to Mariners is provided	Offshore Installation Manager, Vessel Master

migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species. • Substantial change in water quality, sediment quality or air quality which may adversely impact on biodiversity, ecological integrity, social amenity or human health.	operations commence to enable Notices to Mariners to be published	to AHS via email datacentre@hydro.gov.au	
	Oil Pollution Emergency Plan (OPEP) Emergency response activities will be implemented in accordance with the OPEP	Records confirm that emergency response activities have been implemented in accordance with the OPEP	Crisis and Continuity Management/Emergency Response Lead
	Operational and Scientific Monitoring Program (OSMP) Operational and scientific monitoring will be implemented in accordance with the OSMP	Records confirm that operational and scientific monitoring was implemented in accordance with the OSMP	Crisis and Continuity Management/Emergency Response Lead
	MODU Safety case The MODU safety case will include specific marine activity compliance procedures detailing how activities with support vessels will be undertaken.	Records confirm NOPSEMA-accepted MODU specific safety case includes specific marine activity compliance procedures	Offshore Installation Manager

6.4.5 Loss of Well Control

After evaluating threats associated with the activities covered under this EP, a total LOWC event (well blowout) is considered a credible (but unlikely) event.

BP's Global Wells Central Team have calculated the potential flow rate based on the Ironbark-1 well design, whereby the credible worst-case risk of loss of well control would occur once the 13 5/8" casing string at the top of the reservoir has been set and the 12 1/4" well section has been drilled. BP estimated that in this scenario, the initial flowrate would be 79,480 bbl/day (condensate rate), 1,236 bbl/day (water rate) and 883 MMscf/day (gas rate), which would result in a total condensate spill volume of 6.267 MMstb (or 996,327.7 m^3) based on a 83-day release duration (corresponding to the time required to complete relief well drilling).

However, for the purpose of predicting the worst case extent of exposure of hydrocarbons in the event of a loss of well control event, BP modelled the dispersion of a spill based on highly conservative flow rates of 91,793bbl/day (condensate rate), 11,504bbl/day (water rate) and 1,541MMscf/day (gas rate). Resulting in a total condensate spill volume of 9.016 MMstb (or 1,433,429 m^3). The predicted exposure areas therefore provide a highly conservative estimate of the potential area that may be exposed to hydrocarbon in the event of loss of well control during the Ironbark exploration drilling program.

6.4.5.1 Modelling inputs

RPS were engaged to assess and quantify the extent of hydrocarbon exposure from a potential offshore spill event associated with this activity (Appendix C). Near-field modelling of the subsea release was undertaken using OILMAPDEEP; this model predicts the near-field behaviour of multi-phase gas-condensate plumes during subsurface releases. Following this near-field modelling, a three-dimensional oil spill trajectory and weathering model, SIMAP, was used. This model is designed to simulate the transport, spread, and weathering of specific oil components (e.g. surface, entrained, dissolved) under the influence of changing meteorological and oceanographic forces. RPS warrants that this modelling approach meets and exceeds the American Society for Testing and Materials (ASTM) Standard F2067-13 “Standard Practice for Development and Use of Oil Spill Models”. Table 6-13 provides a summary of the model inputs and parameters.

The modelling did not take into consideration any spill prevention, mitigation, and response capabilities that BP proposes to have in place during the production drilling program. The modelling makes no allowance for intervention following a spill to reduce volumes and/or prevent hydrocarbons from reaching sensitive areas. This enables BP to conservatively understand the extent to which the environment may be affected or impacted by an unmitigated spill.

Table 6-13: LOWC Credible Spill Scenario Inputs

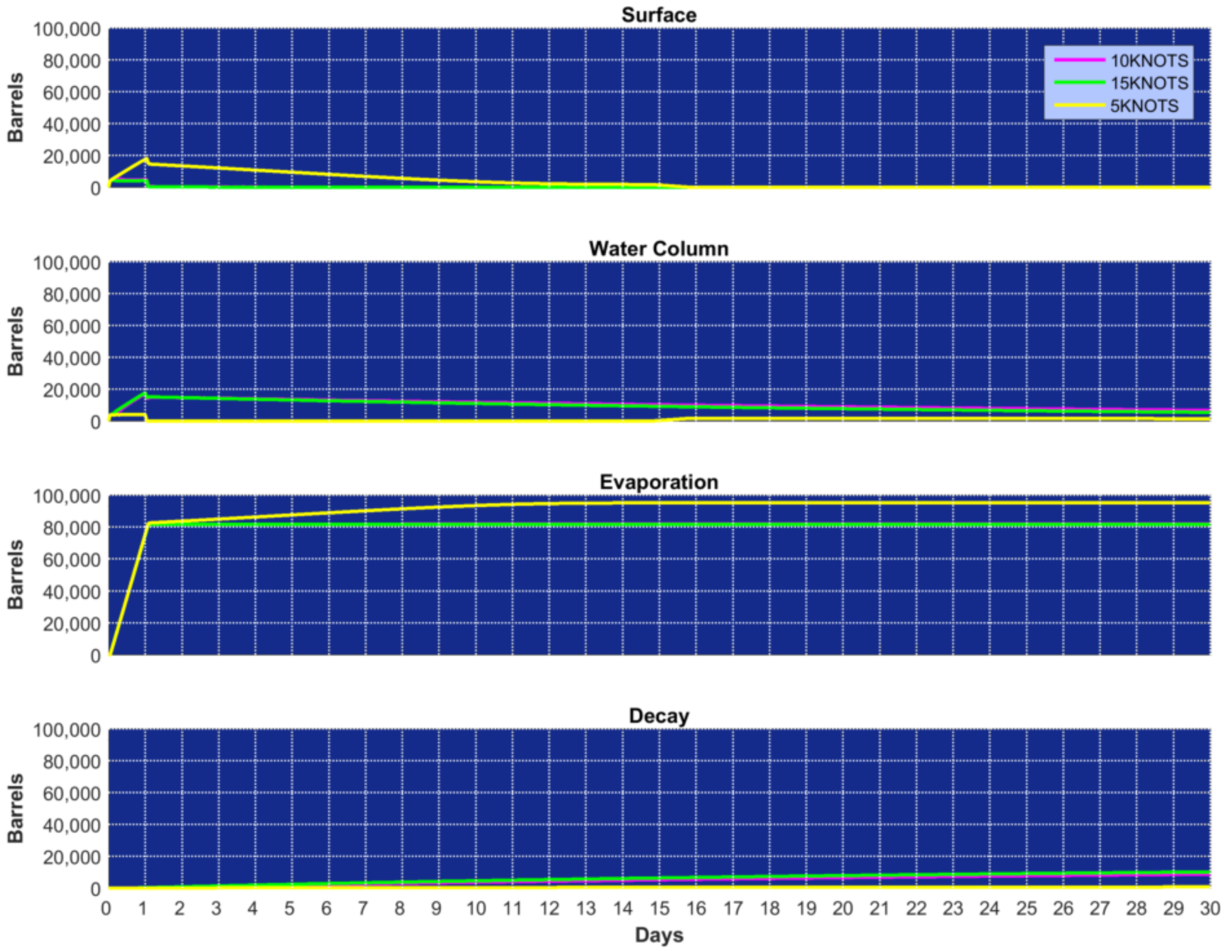
Parameter	Details			
Release location	Ironbark Exploration Well (Table 2-1)			
Oil type	Gas condensate (Section 2.2)			
Total volume of condensate released	9.016 MMstb			
Initial flow rates	91,793bbl/day (condensate rate), 11,504bbl/day (water rate) 1,541MMscf/day (gas rate) (Section 2.2)			
Release duration	103 days			
Model simulation duration	133 days			
Hydrocarbon Exposure Values[a]	**Surface**	**Entrained**	**Dissolved**	**Shoreline**
Socioeconomic Values	1 g/m^2	100 ppb	50 ppb	10 g/m^2
Ecological Values	10 g/m^2	100 ppb	50 ppb	100 g/m^2
Water depth (m)	approx. 300 m			
Number of randomly selected spill simulations per season	100			
Seasons assessed	Summer (October to March); Transitional (April and September); Winter (May to August)			

[a] As described by NOPSEMA (2019).

The estimated 103 day duration is considered to provide a conservative indication of a LOWC.

The condensate has an API of 51.5, a density of 773.1 kg/m^3 (at 25 °C) with a low pour point of -30 °C and a viscosity of 0.912 cP (at 21.1 °C) (Table 2-2), classifying it as a Group I non-persistent oil (ITOPF 2014). The condensate is comprised of a significant portion of volatiles (highly, semi and low volatiles; 97.6% total) and very few residual components (2.4%). This means that the condensate will evaporate readily when on the water surface, with a very small volume of persistent hydrocarbons to remain over time (Section 2.2).

A subsea release of condensate was modelled to confirm this expected behaviour; the tests were run under three wind conditions (5, 10 and 15 knots; RPS 2019). The fates and weathering graph (Figure 6-2) illustrates rapid evaporation under all three wind speeds and that a proportion of the released condensate will likely entrain in the water column under higher (e.g. 10 and 15 knot simulations) wind speeds.



(Source: RPS 2019)

Figure 6-2: Predicted weathering and fate of the released condensate based on a modelled 92,000 bbl subsea release over a 24-hour period

6.4.5.2 Modelling outputs

Modelling results indicate the gas/condensate plume would reach the sea surface and generate oil droplets in the range of 128–442 µm during the initial near-field release. Due to the buoyancy relative to other mixing processes the oil droplets will tend to rise to the surface; no condensate is expected to remain in deep waters. Depending on wind conditions, some of this surface oil may become entrained into the surface layers of water.

Key results from the stochastic modelling outputs, obtained from a total of 100 spill simulation per season over the 3 seasons characteristic of the region, include:

- No shoreline accumulation above the minimum threshold (>10 g/m^2) was predicted for any of the seasons modelled.

- The maximum distance from the release site for surface oil at >1 g/m^2 ranged from 374 km southwest (summer) to 575 km west-southwest (transitional); and at >10 g/m^2 ranged from 174 km west-southwest (transitional) to 180 km north-northeast (winter).
- Entrained and dissolved oil remained in surface layers, typically from the surface down to 30 m depth.

The presence of ecological and social receptors within the predicted exposure areas are summarised Table 6-14 and Table 6-15 respectively.

Table 6-14: Presence of Ecological Receptors within predicted Hydrocarbon Exposure Area for the different types of exposure

Receptor	Surface Exposure	In-water Exposure	Shoreline Exposure
Coastal Habitats and Communities	Not applicable.	Not applicable.	No accumulation of oil on shorelines above the 10 g/m^2 exposure value was predicted; therefore, there is no relevant exposure area.
Benthic Habitats and Communities	Not applicable.	In-water (entrained and dissolved) exposure areas are restricted to the surface water layers (<30 m depth). However, where this area coincides with nearshore/shallow water features there is the possibility that benthic habitats may be contacted. There was negligible (<1%) probability of any nearshore areas being exposed to dissolved oils, therefore they are not considered further. There was typically low, but variable probabilities of entrained exposure with some islands and reef features, including: • Imperieuse Reef, 2–37% • Clerke Reef, 2–16% • Mermaid Reef, 1–28% • Scott Reef, 0–12% • Seringapatam Reef, 0–9% • Ashmore Reef, 0–2% • Barrow (and surrounding) Islands, 0–4% • Muiron, Serrurier (and surrounding) Islands, 3–8%. • Montebello Islands, 0-54% These shallow nearshore areas are known to have variety of benthic habitats and communities including corals, macroalgae, and seagrass.	Not applicable.
Plankton	Not applicable.	Plankton are expected to be present within this area of exposure.	Not applicable.
Seabirds and Shorebirds	Threatened and migratory seabird and shorebird species may occur within this exposure area;	Not applicable.	No accumulation of oil on shorelines above the 10 g/m^2 exposure value was predicted;

Receptor	Surface Exposure	In-water Exposure	Shoreline Exposure
	however, any activity is expected to be of a transient nature only given the offshore location. There is a breeding BIA for the Wedge-tailed Shearwater that partially intersects with this area of exposure; however, it is noted that it is the edge of the buffer zone around a breeding island (i.e. not the breeding location itself).		therefore, there is no relevant exposure area.
Fish and Sharks	Threatened and migratory shark species may occur within this exposure area; however, any activity is expected to be of a transient nature. There is a foraging BIA for the Whale Shark that partially intersects with this area of exposure.	Threatened and migratory shark species may occur within this exposure area. There is a foraging BIA for the Whale Shark that intersects with this area of exposure.	Not applicable.
Marine Reptiles	Threatened and migratory marine reptile species may occur within this exposure area; however, any activity is expected to be of a transient nature. There is an internesting BIA for the Flatback Turtle that intersects with this area of exposure; however it is noted that it only intersects a small proportion of the northern extent of the BIA.	Threatened and migratory marine reptile species may occur within this exposure area. The following BIAs intersect with this exposure area: • Nesting, internesting, aggregation and foraging BIAs for the Flatback Turtle • Nesting, internesting, aggregation, basking and foraging BIAs for the Green Turtle • Nesting, internesting and foraging BIAs for the Hawksbill Turtle • Nesting and internesting BIAs for the Loggerhead Turtle.	No accumulation of oil on shorelines above the 10 g/m^2 exposure value was predicted; therefore, there is no relevant exposure area.
Marine Mammals	Threatened and migratory marine mammal species may occur within this exposure area; however, any activity is expected to be of a transient nature. There is a migration BIA for the Pygmy Blue Whale that intersects with this area of exposure.	Threatened and migratory marine mammal species may occur within this exposure area. The following BIAs intersect with this exposure area: • Migration and foraging BIAs for the Pygmy Blue Whale • Migration and resting BIAs for the Humpback Whale	Not applicable.

Table 6-15: Presence of Social Receptors within predicted Hydrocarbon Exposure Area for the different oil components

Receptor	Surface Exposure	In-water Exposure	Shoreline Exposure
Australian Marine Parks (Commonwealth Marine Reserves)	One AMP occur within this exposure area: • Argo-Rowley Terrace (0–19% probability of contact >10 g/m²). Note: Three AMPs may be within the exposure area at the lower surface threshold (>1 g/m2): • Argo-Rowley Terrace (15–43% probability) • Montebello (10–19% probability) • Gascoyne (3–16% probability). Surface oil at this level is expected to be visually detectable but not have biological effects.	Nine AMPs occur within this exposure area: • Ashmore Reef (0–2% probability of entrained) • Kimberley (5–40% probability of entrained • Argo-Rowley Terrace (68–99% probability of entrained; 3–6% probability of dissolved) • Mermaid Reef (6–35% probability of entrained) • Montebello (43–54% probability of entrained; 2–5% probability of dissolved) • Ningaloo (14–32% probability of entrained) • Gascoyne (65–100% probability of entrained; 0–1% probability of dissolved) • Carnarvon Canyon (10–21% probability of entrained) • Abrolhos (0–1% probability of entrained).	Not applicable.
Key Ecological Features	There are no KEFS associated within the ocean surface within this exposure area. The spatial boundary of an additional two KEFs intersect with this exposure area, however as they are deeper water and/or benthic features, they are not considered further: • Ancient coastline at 125 m depth contour • Continental slope demersal fish communities.	Four KEFs that may be associated with surface water layers (<30 m depth) occur within this exposure area: • Commonwealth waters adjacent to Ningaloo Reef (14–32% probability of entrained; 0–1% probability of dissolved) • Mermaid Reef and Commonwealth waters surrounding Rowley Shoals (15–76% probability of entrained) • Seringapatam Reef and Commonwealth waters in the Scott Reef complex (1–12% probability of entrained) • Ashmore Reef and Cartier Island and surrounding Commonwealth waters (2% probability of entrained). The spatial boundary of an additional eight KEFs also intersect with this exposure area, however	Not applicable.

Receptor	Surface Exposure	In-water Exposure	Shoreline Exposure
		as they are deeper water and/or benthic features, they are not considered further: • Ancient coastline at 125 m depth contour • Canyons linking the Argo Abyssal Plan with the Scott Plateau • Canyons linking the Cuvier Abyssal Plan and the Cape Range Peninsula • Continental slope demersal fish communities • Exmouth Plateau • Glomar Shoals • Wallaby Saddle • Western demersal slope and associated fish communities.	
State Protected Areas – Marine	There are no State marine protected areas within this exposure area.	Six State marine protected areas occur within this exposure area: • Rowley Shoals Marine Park (8–50% probability of entrained) • Montebello Islands Marine Park (2–16% probability of entrained) • Barrow Island Marine Park (0–4% probability of entrained) • Barrow Island Marine Management Area (0–16% probability of entrained) • Muiron Islands Marine Management Area (6–11% probability of entrained; 0–1% probability of dissolved) • Ningaloo Marine Park (4–14% probability of entrained; 0–1% probability of dissolved).	No accumulation of oil on shorelines above the 10 g/m^2 exposure value was predicted; therefore, there is no relevant exposure area.
Heritage and Cultural Features	There are no heritage or cultural features within this exposure area.	There is one World and National Heritage Properties within this exposure area: • The Ningaloo Coast There are four Commonwealth Heritage Place within this exposure area: • Ashmore Reef National Nature Reserve	No accumulation of oil on shorelines above the 10 g/m^2 exposure value was predicted; therefore, there is no relevant exposure area.

Receptor	Surface Exposure	In-water Exposure	Shoreline Exposure
		• Scott Reef and Surrounds (Commonwealth Area) • Mermaid Reef – Rowley Shoals • Ningaloo Marine Area (Commonwealth Waters). There are also a number of known shipwreck locations that occur within this exposure area, however as they are deeper water and/or benthic features, they are not considered further.	
Commercial Fisheries (Commonwealth, State, Traditional Indonesian)	There are a number of Commonwealth and State fisheries with management areas that intersect with this area of exposure.	There are a number of Commonwealth and State fisheries with management areas that intersect with this area of exposure. The MoU Box for Traditional Indonesian Fishing is also within this exposure area.	Not applicable.
Marine and Coastal Industries	There are other users (e.g. petroleum industry, commercial shipping) that intersect with this area of exposure. No restricted defence areas, or ports/harbours are within the area of exposure.	There are other users (e.g. petroleum industry, commercial shipping, defence) that intersect with this area of exposure. No ports/harbours are within the area of exposure.	No accumulation of oil on shorelines above the 10 g/m^2 exposure value was predicted; therefore, there is no relevant exposure area.
Tourism and Recreation	There are no tourism and recreation activities expected to be undertaken within this exposure area.	Tourism and recreation activities may be undertaken within this exposure area, specifically within areas that may extend into State waters (e.g. around Exmouth and the North West Cape). Activities may include recreational and charter fishing, marine fauna watching and diving.	No accumulation of oil on shorelines above the 10 g/m^2 exposure value was predicted; therefore, there is no relevant exposure area.

6.4.5.3 Use of modelling information in evaluating the level of impact severity

BP utilised the following process to interpret stochastic modelling outputs to enable the potential impact severity to be evaluated and linked to their impact severity level definitions (Table 4-2):

- Modelling outputs were interrogated to understand the presence of ecological and social receptors (Section 3).
- Once identified, literature was reviewed to understand the sensitivity and recovery of these receptors following exposure to hydrocarbons. Where available, the literature review also identified behaviours or life stages that are particularly sensitive to hydrocarbon exposure, along with recovery durations.
- An impact severity level was assigned to exposed receptors that considered:
  - If receptors were considered sensitive (refer to Section 4); and
  - The extent of hydrocarbon exposure to sensitive receptors (based upon modelling outputs).

6.4.5.4 Risk Assessment

Table 6-16: Risk Assessment: Accidental Release – Loss of Well Control

Activity
After evaluating the activities covered under this EP, a LOWC event is considered a credible (but unlikely) event.
Consequence associated with an accidental release from a Loss of Well Control
Seabed
Stochastic modelling indicates that seabed receptors (such as corals, macroalgae and soft sediment communities) have the potential to be exposed to in-water oil (entrained only) above exposure thresholds. A summary of the types of impacts and assessed impact severity level for these receptors associated with this event is considered in Table 6-17.

Table 6-17: Potential Impact Severity to Seabed Receptors from a Loss of Well Control Event

Value and Sensitivity	Descriptor	Impact Severity Level (Table 4-2)
Benthic Habitats and Communities	**Coral** Experimental studies and field observations indicate all coral species are sensitive to the effects of oil, although there are considerable differences in the degree of tolerance between species (e.g. NOAA 2010a). Differences in sensitivities may be due to depth, the ease with which oil adheres to the coral structures, the degree of mucous production and self-cleaning, or simply different physiological tolerances (e.g. branching corals appear to have a higher susceptibility than massive corals or corals with large polyps). Physical oiling of coral tissue can cause a decline in metabolic rate and may cause varying degrees of tissue decomposition and death (Negri & Heyward 2000). Direct contact of coral by oil may also impair respiration and photosynthesis by symbiotic zooanthellae (Peters 1981; Knap et al. 1985). The potential impacts to corals from a LOWC event is considered 3 Moderate, where short-term impacts may occur within a moderate area affected (i.e. sensitive areas such as Rankin Bank, Ningaloo, Montebello known to have coral cover of hard	3 Moderate

or soft corals were predicted to be exposed to moderate levels of dissolved hydrocarbons at probabilities less than 5% for instantaneous exposure over one hour).

Macroalgae

Physical contact with entrained hydrocarbon droplets could cause sub-lethal stress, causing reduced growth rates and reduced tolerance to other stress factors (Zieman et al., 1984). In macroalgae, oil can act as a physical barrier for the diffusion of CO_2 across cell walls (O'Brian & Dixon 1976). The effect of oil however is largely dependent on the degree of direct exposure and how much of the hydrocarbon adheres to algae, which will vary depending on the oils physical state and relative 'stickiness'.

The potential impacts to macroalgae from a LOWC event is considered 3 Moderate, where short-term impacts may occur within a moderate area affected (i.e. sensitive areas such as Barrow Island, Montebello Island, Muiron Island, Glomar Shoal and Rankin Bank known to have cover of macroalgae were predicted to be exposed to high levels of entrained hydrocarbons at probabilities up to 68% for instantaneous exposure over one hour).

Seagrass

Seagrass may be exposed to oil by direct contact (i.e. smothering). When seagrass leaves are exposed to oil, sub-lethal quantities of the soluble fraction can be incorporated into the tissue, causing a reduction in tolerance to other stress factors (Zieman et al. 1984). The toxic components of petroleum oils are thought to be the PAH, which are lipophilic and therefore able to pass through lipid membranes and tend to accumulate in the thylakoid membranes of chloroplasts (Ren et al., 1994).

The potential impacts to seagrass from a LOWC event is considered 3 Moderate, where short-term impacts to species of recognised conservation value may occur within a moderate area affected (i.e. sensitive areas such as Barrow Island, Montebello Island, Ningaloo Reef known to have seagrass habitats were predicted to be exposed to high levels of entrained hydrocarbons at probabilities up to 42% for instantaneous exposure over one hour).

Summary

The condensate is classified as a non-persistent oil and has a high proportion (97.6%) of volatile components and only a small (2.4%) residual component. Due to this volatility, once exposed to the atmosphere (e.g. on the surface) most of this oil is expected to evaporate within several days. Entrained oil components may persist for periods of time greater than this surface oil; however, the duration of exposure is still expected to be limited and short-term.

Recovery of benthic habitats and communities is expected to occur.

Studies undertaken after the Montara incident included diver surveys to assess the status of Ashmore, Cartier and Seringapatam coral reefs. These found that other than a region-wide coral bleaching event caused by thermal stress (i.e. caused by sea water exceeding 32°C), the condition of the reefs was consistent with previous surveys, suggesting that any effects of oil reaching these reefs was minor, transitory or sub-lethal and not detectable (Heyward et al. 2010). This is despite AMSA observations of surface slicks or sheen nears these shallow reefs during the spill (Heyward et al. 2010). Surveys in 2011 indicated that the corals exhibiting bleaching

	in 2010 had largely survived and recovered (Heyward et al. 2012), indicating that potential exposure to hydrocarbons while in an already stressed state did not have any impact on the healthy recovery of the coral. Other studies have indicated that oiled kelp beds had a 90% recovery within 3-4 years of impact, however full recovery to pre-spill diversity may not occur for long periods after the spill (French-McCay 2004). Given the details above and potential extent, the impact severity for benthic habitats has been assessed to be – Level 3 – Moderate.	

Water Surface

Receptors associated with the water surface (such as airbreathing and surface foraging fauna) have the potential to be exposed to surface oil concentrations above exposure values. An accidental release of condensate has the potential to result in:

- injury / mortality to fauna
- change in fauna behaviour.

A summary of the types of impacts and assessed impact severity level for these receptors associated with this event is considered in Table 6-18.

Table 6-18: Potential Impact Severity to Water Surface Receptors from a Loss of Well Control Event

Value and Sensitivity	Descriptor	Impact Severity Level (Table 4-2)
Marine Fauna (Seabirds and Shorebirds, Fish and Sharks, Marine Reptiles, Marine Mammals)	**Seabirds and Shorebirds** Birds at sea (e.g. foraging, resting) of recognised conservation value (BIAs for seabirds and shorebirds listed in the Hydrocarbon Exposure Area in Table 3-7) have the potential to directly interact with surface oils. Seabird species most at risk include those that readily rest on the sea surface (e.g. shearwaters) and surface plunging species (e.g. terns, boobies). Direct contact with oils can foul feathers, which may subsequently result in hypothermia due to a reduction in the ability of the bird to thermo-regulate and impair waterproofing. Direct contact with surface oil may also result in dehydration, drowning and starvation (DSEWPC 2011b; AMSA 2013b). Oiling of birds can also suffer from damage to external tissues, including skin and eyes, as well as internal tissue irritation in their lungs and stomachs. Toxic effects on birds may result where oil is ingested as the bird attempts to preen its feathers, or via consumption of oil-affected prey. Whether this toxicity ultimately results in mortality will depend on the amount consumed and other factors relating to the health and sensitivity of the particular bird species. The potential impacts to seabirds and shorebirds from a LOWC event is considered 4 Major, where short-term impacts to species of recognised conservation value may occur within a large area affected (i.e. given the area of surface hydrocarbon concentrations > 10 g/m^2 was estimated to extend out to a maximum of 180 km from the release location). **Fish and Sharks** Most fish do generally not break the sea surface and are therefore not at risk from surface oil slicks. However, some shark species, such as the whale shark,	4 Major

tend to feed close to the surface. A foraging BIA for the whale shark was identified as intersecting with the surface oil exposure area (Table 3-9). The whale sharks are known to routinely move between surface and to depths or >30 m, and in offshore regions can spend most of their time near the seafloor (DSEWPaC 2012).

The potential impact to fish is considered 1 Negligible given the absence of an interaction between the species and surface hydrocarbons. However, the potential impact to sharks (Whale Sharks specifically) from a LOWC event is considered 4 Major, where short-term impacts to species of recognised conservation value may occur within a large area affected (i.e. given the area of surface hydrocarbon concentrations > 10 g/m^2 was estimated to extend out to a maximum of 180 km from the release location).

Marine Reptiles

Marine reptiles of recognised conservation value (BIAs for marine reptiles listed in the Hydrocarbon Exposure Area in Table 3-14) have the potential to directly interact with surface oils. Marine reptiles (e.g. turtles, sea snakes) can be impacted by surface exposure when they surface to breathe. Marine turtles can be exposed to oil externally (e.g. swimming through oil slicks) or internally (e.g. swallowing the oil, consuming oil affected prey, or inhaling of volatile oil related compounds). Several aspects of turtle biology and behaviour place them at particular risk, including a lack of avoidance (NOAA 2010b) and large pre-dive inhalations (Milton and Lutz 2003).

The potential impacts to marine reptiles from a LOWC event is considered 4 Major, where short-term impacts to species of recognised conservation value may occur within a large area affected (i.e. given the area of surface hydrocarbon concentrations > 10 g/m^2 was estimated to extend out to a maximum of 180 km from the release location).

Marine Mammals

Marine mammals of recognised conservation value (BIAs for marine mammals listed in the Hydrocarbon Exposure Area in Table 3-11) have the potential to directly interact with surface oils. Marine mammals (e.g. cetaceans, dugongs) may be impacted by surface exposure when they surface to breathe. Marine mammals can be exposed to oil externally (e.g. swimming through surface slick) or internally (e.g. swallowing the oil, consuming oil affected prey, or inhaling of volatile oil related compounds). Direct contact with surface oil is considered to have little deleterious effect on whales, possibly due to the skin's effectiveness as a barrier to toxicity. Furthermore, effect of oil on cetacean skin is probably minor and temporary (Geraci & St Aubin 1982).

Impacts from ingested oil and subsequent lethal or sub-lethal toxicity are possible; however, the susceptibility of cetaceans varies with feeding habits (e.g. baleen whales feed by surface skimming; however toothed whales and dolphins gulp feed at depth).

While mammals do not appear to exhibit avoidance behaviours, as highly mobile species, in general it is very unlikely that these animals will be constantly exposed to concentrations of hydrocarbons for continuous durations (e.g. >48–96 hours) that would lead to chronic effects.

	The potential impacts to marine mammals from a LOWC event is considered 4 Major, where short-term impacts to species of recognised conservation value may occur within a large area affected (i.e. given the area of surface hydrocarbon concentrations > 10 g/m^2 was estimated to extend out to a maximum of 180 km from the release location). **Summary** The condensate is classified as a non-persistent oil and has a high proportion (97.6%) of volatile components and only a small (2.4%) residual component. Due to this volatility, once exposed to the atmosphere (e.g. on the surface) most of this oil is expected to evaporate within several days; and therefore, any duration of exposure is expected to be short-term. Recovery of any impacted surface water associated receptors is expected to occur. No confirmed reports of impacts to marine wildlife were received or surveyed during the Montara oil spill scientific monitoring studies (UniQuest 2010). Given the details above, the impact severity for marine fauna has been assessed to be – Level 4 – Major.	

Water Column

An accidental release of hydrocarbons has the potential to result in an impact to values and sensitivities associated with the water column through:

- Chemical toxicity or physical ingestion.

Stochastic modelling indicates that a number of ecological and socio-economic receptors have the potential to be exposed to in-water concentrations above impact thresholds. Based upon receptor sensitivity information summarised in Table 5-33, the impact severity level for these receptors associated with this event is considered in Table 6-19.

Table 6-19: Potential Impact Severity to In-Water Receptors from a Loss of Well Control Event

Value and Sensitivity	Descriptor	Impact Severity Level (Table 4-2)
Marine Fauna (Fish and Sharks, Marine Reptiles, Marine Mammals)	**Fish and Sharks** Exposure to entrained or dissolved oil in the water column can be toxic to fish. Fish can be exposed to oil through a variety of pathways, including direct dermal contact (e.g. swimming through oil); ingestion (e.g. directly or via oil-affected prey/foods); and inhalation (e.g. elevated dissolved contaminant concentrations in water passing over the gills). Studies have shown a range of impacts including changes in abundance, decreased size, inhibited swimming ability, changes to oxygen consumption and respiration, changes to reproduction, immune system responses, DNA damage, visible skin and organ lesions, and increased parasitism. However, many fish species can metabolize toxic hydrocarbons, which reduces the risk of bioaccumulation (NRDA 2012). In addition, very few studies have demonstrated increased mortality of fish as a result of oil spills (Fodrie et al. 2014, Hjermann et al. 2007, IPIECA, 1997). Demersal fish within the hydrocarbon exposure area are not expected to be impacted given the presence of entrained and dissolved oil is predicted in the surface layers (<30 m depth) only. However, pelagic free-swimming fish and sharks are also unlikely to suffer long-term damage from oil spill exposure	4 Major

		because dissolved/entrained hydrocarbons are typically insufficient to cause harm (ITOPF 2011). Pelagic species are also generally highly mobile and as such are not likely to suffer extended exposure (e.g. >40–96 hours) at concentrations that would lead to chronic effects due to their patterns of movement. There is potential for short-term impacts to fish communities and sharks within a moderate extent (i.e. limited to the top 30 m of the water column); therefore, potential impacts to fish and sharks from a LOWC event is considered 3 Moderate. Impacts on eggs and larvae entrained in the upper water column are not expected to be significant given the temporary period of water quality impairment. Egg/larvae dispersal is extensive in the upper layers of the water column and it is expected that current induced drift will rapidly replace any oil affected populations. Impacts are assessed as short-term within a moderate area, and therefore considered 3 Moderate. **Marine Reptiles** Marine reptiles of recognised conservation value (BIAs for marine reptiles listed in the Hydrocarbon Exposure Area in Table 3-14) have the potential to directly interact with in-water hydrocarbons. Marine reptiles (e.g. turtles, seasnakes) can be exposed to oil externally (e.g. swimming through) or internally (e.g. swallowing the oil, consuming oil affected prey, or inhaling of volatile oil related compounds). Effects of oil include increased mortality and developmental defects; and negative impacts to the skin, blood, digestive and immune systems, and salt glands. There are a number of BIAs for turtle species (Loggerhead, Flatback, Green and Hawksbill) that occur within this area of exposure. However, turtles are more susceptible to surface and shoreline oil, than the dissolved and entrained components. The potential impacts to marine reptiles from a LOWC event are considered 4 Major, where short-term impacts to species of recognised conservation value may occur as a result of hydrocarbon exposure to large areas of sensitive environment for marine reptiles (i.e. given the area where entrained hydrocarbons above the high threshold and dissolved hydrocarbons above the moderate threshold – refer to Figure 62 of Appendix C – was predicted to overlap Loggerhead, Flatback, Green and Hawksbill marine turtle internesting BIAs located between North Turtle Island and the Ningaloo and Jurabi Coast). **Marine Mammals** Marine mammals of recognised conservation value (BIAs for marine mammals listed in the Hydrocarbon Exposure Area in Table 3-11) have the potential to directly interact with in-water hydrocarbons. Marine mammals can be exposed to oil externally (e.g. swimming through oil) or internally (e.g. swallowing the oil, consuming oil affected prey, or inhaling of volatile oil related compounds). Impacts from ingested oil and subsequent lethal or sub-lethal toxicity are possible; however, the susceptibility of cetaceans varies with feeding habits. Baleen whales feed by surface skimming; however, toothed whales and dolphins gulp feed at depth (and are therefore less likely to be exposed to	

	entrained/dissolved oil given its presence in surface water layers only). While mammals do not appear to exhibit avoidance behaviours, as highly mobile species, in general it is very unlikely that these animals will be constantly exposed to concentrations of hydrocarbons for continuous durations (e.g. >48–96 hours) that would lead to chronic effects. Some whales, particularly those with coastal migration and reproduction, display strong site fidelity to specific resting, breeding and feeding habitats, as well as to their migratory paths. There are BIAs identified for the Pygmy blue (migration and foraging) and Humpback (migration and resting) whales within this exposure area (Table 3-11). Oil in biologically important habitats may disrupt natural behaviours, displace animals, reduce foraging or reproductive success rates and increase mortality. Dugongs may also ingest oil (directly, or indirectly via oil-affected seagrass), and depending on the amount and type of oil, the effects could be short-term to long-term/chronic (e.g. organ damage). However, it is noted that reports on oil pollution damage to dugongs is rare (ITOPF 2014). No exposure of the BIA within Exmouth Gulf was predicted from the stochastic modelling. The potential impacts to marine mammals from a LOWC event are considered 4 Major, where short-term impacts to species of recognised conservation value may occur as a result of hydrocarbon exposure to large areas of sensitive environment for marine mammals (i.e. given the area where entrained hydrocarbons above the high threshold and dissolved hydrocarbons above the moderate threshold – refer to Figure 62 of Appendix C – was predicted to overlap Pygmy blue (migration and foraging) and Humpback (migration and resting) BIAs located within the North-west Marine Region). **Summary** The condensate is classified as a non-persistent oil and has a high proportion (97.6%) of volatile components and only a small (2.4%) residual component. Due to this volatility, once exposed to the atmosphere (e.g. on the surface) most of this oil is expected to evaporate within several days. Entrained and dissolved oil components may persist for periods of time greater than this surface oil; however, the duration of exposure is still expected to be short-term. Given the details above and potential extent, the impact severity for marine fauna has been assessed to be – Level 4 – Major.	
Plankton	While plankton can occur throughout the water column, they are generally more abundant in the surface layers; this coincides with the area predicted to be exposed to entrained and dissolved oils. Surface waters of the NWS are typically low in nutrients and plankton abundance is low; however, in areas of greater vertical mixing (e.g. upwelling along the shelf edge, or around some reefs/shoals) there is likely to be a higher abundance of plankton. Phytoplankton are typically not sensitive to oil, whereas zooplankton are (Hook et al. 2016). Water column organisms may be impacted by oil via exposure through ingestion, inhalation and dermal contact (NRDA 2012), which can cause immediate mortality or declines in reproduction (Hook et al. 2016). Lethal and sublethal effects on zooplankton include narcosis, alterations in feeding, development, and reproduction (Almeda et al. 2013).	3 Moderate

	Plankton populations have evolved to respond to environmental perturbations by copious production within short generation times (ITOPF 2011; UNEP 1985). They are known to have naturally high mortality rates (primarily through predation), however once water quality returns to ambient, plankton populations will return to previous conditions. Impacts to plankton are therefore assessed to result in extensive damage to a non-sensitive environment, which can however be restored to an equivalent capability in a period of around 1 year. Impacts are assessed as short-term within a moderate area, and therefore considered 3 Moderate. Given the details above, the impact severity for plankton has been assessed to be – Level 3 – Moderate.	

Shoreline

Modelling did not predict any shoreline contact above the lowest exposure value (10 g/m^2), thus shoreline impact has not been considered further.

Socio-economic

An accidental release of condensate has the potential to result in an impact to values and sensitivities associated with socio-economic receptors directly through:

- Reduction in aesthetic value, and

indirectly through:

- Impacts to ecological receptors to which Socioeconomic receptors rely upon,

Stochastic modelling indicates that a number of socio-economic receptors have the potential to be exposed to hydrocarbon concentrations above exposure thresholds. A summary of the types of impacts and assessed impact severity level for these receptors associated with this event is considered in Table 6-20.

Table 6-20: Potential Impact Severity to Socio-economic Receptors from a Loss of Well Control Event

Value and Sensitivity	Descriptor	Impact Severity Level (Table 4-2)
Australian Marine Parks State Marine Protected Areas	Marine protected areas may be vulnerable to oil exposure from a spill event. As the values and sensitivities of these protected places are a combination of quality, habitat, marine fauna and flora, and human use, the impact pathways are varied. Refer also to impact assessments for related receptors, including benthic habitats and communities and marine fauna. Australian Marine Parks that may be exposed to surface oil are Argo-Rowley Terrace, Montebello and Gascoyne. These three, plus an additional six (Ashmore Reef, Kimberley, Mermaid Reef, Ningaloo, Carnarvon Canyon and Abrolhos) may also be exposed to in-water oil within the surface (<30 m) water layers. The probability of exposure was variable between the parks (Table 6-15). No surface oil (therefore no aesthetic impact) was predicted to occur for State marine protected areas. Six marine parks (Rowley Shoals MP, Montebello Islands MP, Barrow Islands MP and MMA, Muiron Islands MMA and Ningaloo MP) may be exposed to in-water oil within the surface (<30 m) water layers; probability of exposure was variable between the parks (Table 6-15). Potential impacts range from a temporary decrease in aesthetic values (e.g. from visible surface oil slicks) to physical coating and/or toxicity effects associated with the values of the marine protected area (e.g. marine fauna,	3 Moderate

	benthic habitats etc.). Impacts resulting from in-water oil to pelagic values (e.g. marine fauna) are restricted to those in surface waters only. Given the details above and potential extent, the impact severity for marine protected areas has been assessed to be – Level 3 – Moderate.	
Key Ecological Features	KEFs may be vulnerable to oil exposure from a spill event. As the values and sensitivities of these protected places are often a combination of quality, habitat, marine fauna and flora, the impact pathways are varied. Refer also to impact assessments for related receptors, including benthic habitats and communities and marine fauna. Given the stochastic modelling predicted that all in-water oil exposure would remain in the surface (<30 m) layers, those KEFS associated with deeper water and/or benthic features are not expected to be impacted. Four KEFs were identified as potentially being exposed to in-water oil: • Commonwealth waters adjacent to Ningaloo Reef • Mermaid Reef and Commonwealth waters surrounding Rowley Shoals • Seringapatam Reef and Commonwealth waters in the Scott Reef complex • Ashmore Reef and Cartier Island and surrounding Commonwealth waters. The probability of exposure was variable between the parks (Table 6-15). The actual area of exposure for an individual spill event will be relatively small, with exposure shown to be transient and temporary due to the influence of waves, currents and weathering processes. Given the details above and potential extent, the impact severity for KEFs has been assessed to be – Level 3 – Moderate.	3 Moderate
Commercial Fisheries	Oil spills can damage fishery resources through physical contamination, toxic effects on stock and by disrupting business activities. Refer also to impact assessments for related receptors, including benthic habitats and communities and fish and sharks. Tainting is a change in the characteristic smell or flavour of fish and may be due to oil being taken up by the tissues or contaminating the surface catch (McIntyre et al 1982). Taint in seafood renders it unfit for human consumption or unsellable due to public perception. Tainting may not be a permanent condition but will persist if the organisms are continuously exposed; but when exposure is terminated, depuration will quickly occur (McIntyre et al 1982). A major oil spill may result in the temporary closure of part of fishery management areas. It is unlikely that a complete fishery would be closed due to their large spatial extents, but the partial closure may still displace fishing effort. Oil spills may also foul fishing equipment (e.g. traps and trawl nets) and requiring cleaning or replacement; however due to the volatility of condensate, this is not expected to occur. Given the details above and potential extent, the impact severity for commercial fisheries has been assessed to be – Level 3- Moderate.	3 Moderate
Marine and Coastal Industries	Marine and coastal industries in the area of exposure mainly consist of petroleum activities, commercial shipping and defence activities. Offshore petroleum activities in the vicinity include the North Ranking Complex (~48km south). In the event of a large spill, an exclusion zone may be	3 Moderate

	established within the immediate vicinity of the spill-affected area. However, as the condensate is subject to rapid evaporation the exclusion zone is likely to be temporary, thus minimising the impacts to these developments. There are defence practice and training areas that extend offshore from Learmonth RAAF base. In-water hydrocarbon exposure is not expected to adversely impact the use of these areas. Given the details above and potential extent, the impact severity for other industries has been assessed to be – Level 3 – Moderate.	
Recreation and Tourism	Due to the small spatial extent surface exposure, and its occurrence beyond State waters, direct impacts to the recreation and tourism industry associated with a reduction in aesthetics are not expected. In-water exposure does extend into some State water areas (e.g. around Exmouth and North West Cape), and therefore in-direct impacts may occur. Activities common in the area include recreational and charter fishing, marine fauna watching and diving. Consequently, these impacts are related to any changes in ecological receptors (e.g. marine fauna, benthic habitats and communities) that may occur as a result of in-water oil exposure; refer also to impact assessments for the related receptors. Any disruption to activities such as vessel activities, fishing and diving can have follow-on effects on accommodation, tourism business and other companies who gain their livelihood from tourism. However, given the limited exposure and predicted impact to ecological receptors, this type of impact is not expected to occur. Given the details above and potential extent, the impact severity for recreation and tourism has been assessed to be – Level 3 – Moderate.	3 Moderate

Heritage

An accidental release of condensate has the potential to result in an impact to values and sensitivities associated with heritage receptors directly through:

- Physical oiling / reduction in aesthetic value, and

indirectly through:

- Indirectly through impacts to ecological receptors to which heritage receptors rely upon.

A summary of the types of impacts and assessed impact severity level for these receptors associated with this event is considered in Table 6-21.

Table 6-21: Potential Impact Severity to Heritage Receptors from a Loss of Well Control Event

Value and Sensitivity	Descriptor	Impact Severity Level (Table 4-2)
Heritage and Cultural Features	Heritage listed places may be vulnerable to oil exposure from a spill event. As the values and sensitivities of these protected places are a combination of quality, habitat, marine fauna and flora, and human use, the impact pathways are varied. Refer also to impact assessments for related receptors, including benthic habitats and communities and marine fauna. There are no heritage or cultural features predicted to be exposed to visible surface oil (>1 g/m^2), therefore, no aesthetic impacts are expected to occur.	3 Moderate

	The Ningaloo Coast World and National heritage area, and four Commonwealth heritage areas (Ashmore Reef, Scott Reef, Mermaid Reef and Ningaloo Marine Area) may be exposed to entrained oil components in the event of LOWC event. Potential impacts may include physical coating and/or toxicity effects associated with the values of the respective areas (e.g. marine fauna, coastal habitats etc.). There are also known shipwrecks within the predicted area of entrained and dissolved oil exposure. However, stochastic modelling indicates that in-water oil exposure is limited to surface (<30 m) layers, therefore no impact to known shipwrecks is expected to occur. Given the details above and potential extent, the impact severity for heritage areas has been assessed to be – Level 3 – Moderate.	

Inherent / Design Control Measures (validated control measures) and Good Practice Control Measures	
Control Measure	**Context of Control Measures**
BP rig intake and rig verification process	The BP rig intake and rig verification practice uses a standardised and systematic method for bringing rigs into service to deliver safe, compliant and reliable rig operations. Key equipment is audited to ensure that it is fit for purpose prior to commencement of drilling operations.
Approved Basis of Design and Drilling Program	BP's well design and well integrity requirements are documented in BP Practices, Procedures and Specifications which are based on extensive operational experience and are mandated for use to manage risk to levels considered ALARP. These requirements are incorporated into the well specific design documents and operational procedures. This is managed using BP's New Well Common Process, a stage gate model that is applied to help manage and communicate risk. It provides a decision-making framework to facilitate systematic management with clear accountabilities throughout well planning and well construction activities, as outlined in the WOMP.
GWO Bowtie	GWO Standard Bowties exist for specified risk events in order to identify and manage the risk prevention and risk mitigation barriers. A bowtie for the 'Loss of Well Control – Well Construction' risk on Ironbark will be developed prior to operations. Once barriers are identified, criteria for determining their performance, such as performance standards, can be established. These performance criteria are tested through existing operational processes, e.g. maintenance and inspection programmes. These in turn are supported by self-verification activities, or assurance activities, as described in the WOMP.
WOMP	Under Part 5 of the Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011, a WOMP approved by NOPSEMA is required before well activities can be undertaken. The WOMP includes information on the: • Well design and construction process • Geological prognosis and planned formation evaluation • Barrier philosophy and barrier verification • Source control and capping and containment plan • Relief well plan
OPEP arrangements.	Under the OPGGS(E)R, there is the requirement to describe the oil pollution emergency arrangements and capabilities/control measures necessary for timely response to an emergency that results or may result in oil pollution. A response strategy for this event has been developed based upon IPIECA 2018 and is detailed in Section 5 of the OPEP. Response arrangements to enable implementation of the response strategy are described in Table 5-5 of the OPEP. In the event of a well blowout safety cases acceptable to NOPSEMA will be required for the MODU drilling the relief well and capping deployment vessels involved in the capping stack and offset installation equipment (OIE) installation. Safety case revisions and associated risk assessments would

	be developed and submitted for NOPSEMA consideration, with pre-emptive safety case update work to consider the various work scopes that may form part of relief well drilling or well capping operations, including utilising Ironbark well specific information from the Ocean Apex safety case revision. The NOPSEMA recommendation for collaboration between titleholders to enhance pre-incident Safety Case preparedness is appreciated and, as a new entrant to the region, BP will participate with existing incumbent titleholders as far as reasonably practicable in such regional initiatives.	
Operational and Scientific Monitoring Plan.	This outlines the capability in place for: • Operational monitoring of a hydrocarbon spill to inform response activities. • Scientific monitoring of environmental impacts of the spill and response activities. Operational monitoring allows adequate information to be provided to aid decision making to ensure response activities are timely, safe and appropriate. Scientific monitoring identifies if potential longer-term remediation activities may be required.	
Risk Evaluation		
Impact Severity Level (Table 4-2)	**Likelihood**	**Risk Level**
3 Moderate	IOGP (2019) provided numerical likelihood estimates for exploration well blowouts. Review of likelihood estimates relevant to the Ironbark-1 well identified the potential likelihood to range from 1.5 x 10^{-4} per well drilled for conventional exploration gas wells to 9.12 x 10^{-4} per well drilled for HPHT exploration gas wells. To be conservative, BP has used the higher range of probability (9.12 x 10^{-4} per well drilled) to conduct its risk evaluation. The process for establishing and maintaining well integrity during the well construction process is governed by BP's practices, procedures, specifications and guides. These focus on: • pore pressure prediction; • casing and tubing design; • zonal isolation pressure testing; and • well control. These categories provide the basis for the various well barrier envelopes set for the Ironbark-1 well, namely: • BP's pore pressure prediction modelling for the well has been peer reviewed by company specialists. • A basin model has been created to further constrain the pore pressure model for Ironbark-1. • Casings have been designed based on a series of standard load cases using the well specific pore pressure data to describe the pressure envelope for the well. • The well construction process has been designed to replace any geological seals that have been removed by drilling and trap any formation fluids in situ using a combination of casing and cement, in addition to the wellhead infrastructure. Each of these components form barriers to downhole pressure and fluids, which are built up as the well is drilled deeper. BP also follows processes that provide rigour in implementing and testing of barriers. As barriers are identified, criteria for determining their performance, such as performance standards, are established. These performance criteria are tested through existing operational processes, e.g. maintenance and inspection	High

	programs. These in turn are supported by self-verification activities, or assurance activities, as described in the WOMP. BP's approach to maintaining well integrity has evolved based upon the findings from the Deepwater Horizon incident. This approach combines industry best practice and BP Global experience. This forms the basis for an integrated well design and well construction process involving geologists, pore pressure experts drilling engineers, fluids and cementing experts and the operational staff on the MODU including Drilling Contractor personnel. On this basis, BP deems the likelihood of such an event to be Level B – Unlikely.		
ALARP Decision Context (Table 4-5)			**Type**
Exploration drilling is a standard offshore activity. The activity and causes are well understood; however, if a LOWC event occurs, there is the potential for a High impact. Risk matrix presented within the Conservation Management Plan for Blue Whales (DoE 2015) provides a risk rating of moderate associated with chronic chemical pollution. Controls and mitigation actions described, align with the priority for action recommended in the management plan. BP believes ALARP Decision Context Type C should apply, because: • The level of risk associated with this event is considered High; • Stakeholders are interested in this type of event; • Previous LOWC events have occurred in the industry. Consideration of control measures beyond good practice are required.			C
ALARP Decision Context C – Further Assessment			
Control Measure	**Benefit**	**Cost**	**Outcome**
Source Control Considerations			
Availability of relief well contingency equipment	The availability of contingency well equipment will minimise the response time associated with drilling a relief well. BP maintains a dedicated wellhead and tubular inventory in Houston for immediate deployment globally. Additional contingency tubulars and well equipment will also be held in Perth to supplement/reduce mobilistation time if necessary.	Although this requires significant investment by BP it is considered appropriate for the potential environmental benefit, as the lead time for certain equipment can be in the order of months, resulting in a major impact to the time taken to drill a relief well.	Selected
Additional rig on standby to reduce mobilisation duration for relief well response	Mobilising a second dedicated rig on standby for a relief well response could potentially reduce the hydrocarbon release duration by up to 21 days (using current response estimates), which equates to a potential ~1.6 million bbl reduction in the total volume of condensate released. This potential reduction in hydrocarbons is significant; however, as the condensate is expected to be comprised of only 2.4% persistent hydrocarbons, the majority of this released volume would be expected to	Having an additional rig on standby would result in additional mobilisation costs to the project. At a conservative daily rig cost of $800,000, and given the duration of this activity is anticipated to be in the order of 90-100 days, this control measure could result in an additional cost of AU$72,000,000. Compared to the potential cost to the project, implementing this control measure is considered grossly disproportionate to the reduction in consequence that could be expected (due to the small	Not selected

	quickly evaporate or decay in the water column upon release. As such, the benefit of having an additional MODU on standby can be estimated as a reduction of 38,400 bbl of persistent hydrocarbons entering the environment in the event of a well blowout.	percentage of persistent hydrocarbons associated with the targeted reservoir), for this low likelihood event. As such this control measure has not been selected for use. This is aligned with standard industry practice and partially mitigated by the use and implementation of mutual aid agreements giving access to rigs scheduled to be operating in reasonable proximity to the Ironbark location.	
Pre-drill the top-hole section of the relief well to minimise the relief well drilling response time	Considering the potential volume of release in its entirety, reducing the volume of hydrocarbons released by 10% (based on reducing the time to control the well from 103 days to 93 days) is significant. However, as the condensate is known to comprise only 2.4% persistent hydrocarbons, the majority of the released volume would be expected to quickly evaporate or decay in the water column upon release. As such the estimated benefit of pre-drilling the top-hole section is preventing approximately 21,008 bbl of persistent hydrocarbons entering the environment in the event of a well blowout.	Based on the proposed well design, the top-hole sections of the relief well are estimated to take ~10 days to drill. At a conservative daily rig cost of $800,000, this control measure could result in a cost of $8,000,000. There would also be additional cost associated with the time taken to transit between the relief well and exploration well, as well as the additional environmental discharges associated with drilling two top hole sections and associated casing cementing operations. For a low likelihood event the cost impact associated with implementing this control measure is considered grossly disproportionate to the net potential environmental benefit gained,	Not selected
Reduce capping timeframe by staging a capping stack in Australia to reduce mobilisation time	Logistics studies conducted by BP considered the following scenarios: • OSRL 15kpsi 18 ¾" capping stack rented and stored in Karratha: well capped in 15 days. • OSRL 15kpsi 18 ¾" capping stack fly from Stavanger to Port Hedland: well capping commenced within 20 days. • OSRL 15kpsi 18 ¾" capping stack and OIE equipment by sea from Trieste: well capping commenced within 62 days. The OSRL 15K 18 ¾" capping stack is considered the best option to cap the Ironbark well; however it requires specialist storage and maintenance by OSRL personnel.	Although shorter a deployment than flying the stack from Stavanger, this option would limit availability of equipment and personnel to other OSRL subscribers. Flying the OSRL 15kpsi 18 ¾" capping stack from Stavanger to Port Hedland with onward shipment to the field using the contracted capping deployment vessel is therefore the preferred option. Deploying the capping stack in Karratha prior to a LOWC event would not significantly reduce the capping deployment timeframe i.e. 5 day difference. However, for both vertical access capping only options, modelling of the gas plume resulting from the worst-case credible discharge	Not selected

	There are also a limited number of stacks available to multiple subscribers around the world. Relocating the OSRL stack to Karratha prior to a LOWC event would require specialist storage space in Karratha and mobilisation of OSRL personnel to maintain the equipment for the duration of the drilling program. Once the stack has arrived in Karratha, a minimum of 12 days would be required to source a vessel and update the safety case. In addition, ROV surveying and debris removal would be required before a capping operation could be attempted. BP therefore estimates that a minimum of 15 days would be required before capping could be attempted.	scenario indicates that vertical access cannot be achieved in the event of a LOWC control. Although the worst-case credible discharge predicted would not allow for vertical access, less severe LOWCs resulting in smaller releases may occur. In this situation vertical access may be possible. The OIE is compatible with the OSRL capping stack. The OIE is stored at the Saipem base in Trieste in Italy. It is stored assembled in a specially designed hanger and maintained by Saipem on behalf of OSRL. The OIE equipment is a limited resource shared across multiple subscribers. The equipment was developed by Saipem and is maintained and operated by Saipem personnel. It would be shipped assembled to minimise any reassembly and commissioning time to Australia. The OIE system has never been deployed in a real LOWC event. Due to the water depth at the Ironbark-1 well location and the associated use of a moored MODU, there is a risk that there could be significant debris on the seabed following a LOWC event. While waiting for the arrival of the OIE equipment, extensive well bore monitoring, surveying of the site with ROVs and debris removal would be undertaken while the vessel's safety case is revised to ensure successful deployment of the OIE equipment. Given the indicative timeframes for implementation of capping from its current locations, the additional cost of implementing this control measure is considered grossly disproportionate to the potential environmental benefit achieved.	
Reduce OIE mobilisation timeframes by having transport vessel on standby	OIE is used in conjunction with OSRL's capping stack equipment. The current time frame for mobilising the OIE to the Operational Area is estimated to be 51 days with a further 11 days for loading the cap and transit to incident site	The cost of having a suitable transport vessel on standby is conservatively estimated to be ~AU$5,850,000, assuming a 90 day program, and an indicative daily rate of ~$65,000 (noting this is the could be significantly higher depending on market rates at the time). In addition	Not selected

	One of the ways to reduce this timeframe (and more closely align it with the deployment timeframe of the capping stack) is to source a suitable standby transport vessel. This is estimated to potentially reduce the response time by 3 days.	to this, there would be additional expenses and delays associated with having the vessel stationed in Trieste for the duration of this period, however these have not been estimated here. This control measure poses significant costs, and significant challenges for the estimated reduction in response time. As such, the cost is considered grossly disproportionate to the level of environmental benefit achieved and has not been selected for use.	
Monitor OIE transport and deployment vessel availability to enable a more efficient response to be implemented	The benefit of monitoring vessels suitable for OIE transport and deployment activities has the potential to result in ensuring a more efficient response thus reducing the timeframe for identifying and mobilising vessels to the OSRL Port (currently estimated to be conservatively a total of 8 days). Although the environmental benefit is not specifically measurable, it is possible that this control measures could reduce the overall mobilisation time by a day or two.	The cost of monitoring available vessels to enable identification and mobilisation times to be reduced is not significant, and thus is not considered grossly disproportionate to the level of benefit achieved.	Selected
Reduce ROV emergency BOP intervention mobilisation time (48 hours)	It is best practice within BP that BOP intervention is attempted within 48 hours of a loss of well control incident. This is to ensure prompt intervention to maximise the ROV team's chance of successfully activating the BOP while minimising potential exposure to personnel and the environment. A successful BOP intervention attempted as early as 48 hours post LOWC event would stop the flow of hydrocarbons resulting from a loss of well control event, significantly reducing the environmental footprint of a hydrocarbon spill. The timing of this response is critical to ensure that the BOP can be activated while the BOP's integrity still allows operation.	BP requires the implementation of several control measures to manage the risks associated with the BOP intervention operations to ALARP, namely: • the equipment is mobilised to the nominated BOP intervention vessel prior to the drilling of the critical reservoir sections, so that the equipment is prepared and commissioned prior to any well control event. • the detailed plan for ROV-based BOP activation is prepared, reviewed by BOP specialists and discussed with the ROV crew prior to the drilling of the critical reservoir sections, so that the operational team is ready and prepared to intervene. • A total of 3 vessels are contracted to support the MODU. All vessels contracted will have Search and Rescue capabilities and responsibilities, with one AHTS vessel, certified for firefighting and onboard oil	Selected

		recovery (i.e. designed to operate in proximity to hydrocarbons) duties, will be the nominated BOP intervention vessel. • While drilling the critical reservoir sections, at least one vessel will be at the well location at all times. In the event of a LOWC event, all vessels would participate in search and rescue operations, until such time the nominated BOP intervention vessel is relieved of these duties by the IMT, so it can mobilise personnel to attempt BOP intervention vessel within the 48-hour window. • Gas plume modelling completed by BP specialists indicates a maximum surface plume radius less than 200 m. Through a combination of weather forecasting, current modelling, real time gas monitoring, vessel positioning and use of 1,000m ROV tether, the nominated BOP intervention vessel would be able to maintain a safe distance from the blowing out well and associated gas plume and cloud. • The duration of the BOP intervention operations is short, and optimised to ensure minimum interaction between the ROV and BOP and minimum vessel movement requirements in the vicinity of the blowing out well. BP consider the benefit that could be achieved from the implementation of the 48hr BOP intervention strategy to be considerably higher than the costs associated with implementing those measures.	
Acoustic subsea control system	The 'optional secondary control system' acoustic subsea control of the BOP may increase BOP reliability and effectiveness in both prevention and response functions of the BOP.	BP has selected the Diamond Offshore owned MODU Ocean Apex to drill the Ironbark-1 well. The Ocean Apex has a BOP stack which is compliant with minimum requirements listed in API standard 53 for blowout preventers. BP has assessed that there is sufficient redundancy in place to not warrant	Not selected

		the modification of the BOP control system to include a secondary acoustic subsea control system. Namely, the BOP control system includes: • Two control pods with full operational capability. • An ROV intervention system in compliance with API Standard 53. • Two annular preventers, two shear rams and three pipe rams. • Emergency hydraulic backup system (EHBS) which meets minimum requirements listed in API Standard 53. • Full traceability and maintenance records available from Diamond Offshore. The installation of a secondary acoustic control system to the BOP involves re-engineering of the control system and is a significant modification scope of work. This type of upgrade is normally performed during a scheduled shipyard rig maintenance programme where the work can be performed in a workshop in a controlled environment. There is not a rig maintenance program scheduled for the Ocean Apex MODU prior to drilling the Ironbark-1 well. Therefore, if a control system upgrade were to be performed on the BOP, it would be required to complete the work at the well location during a period of rig standby and will add significant cost. An estimate of the total cost for designing, procuring and installing an acoustic control system during a period of rig standby is US$12.0 million. This option has not been selected because for a low likelihood event the additional cost of implementing this control measure is considered disproportionate to the potential environmental benefit achieved.	
Install conduit low pressure alarm	Installation an additional BOP pressure monitoring system in-line with API	BP has reviewed the Ocean Apex's BOP control system which currently	Selected

(additional real-time pressure monitoring system) on MODU	Standard 53 will increase ability to detect the potential for a LOWC event.	includes pressure monitoring systems fitted with alarms for the low pressure pilot pressure (alarm set at 2500 psi) and low pressure accumulator (alarm set at 4500 psi). "As a learning from a recent drilling program, Diamond Offshore has installed a low pressure gauge in the Drillers Console for the conduit line so pressure can monitored on a continuous basis. The BOP is therefore equipped with three separate pressure monitoring systems, which BP has assessed to be sufficient redundancy to not warrant any further modification	

Acceptability Assessment	
Principles of Ecologically Sustainable Development	The severity of the potential impact associated with this aspect has been evaluated to be a long term impact to a sensitive receptor resulting in a worst-case impact severity - Level 3 - Moderate. Consequently, BP considers that in the unlikely event of a LOWC, there is the potential to impact biological diversity and ecological integrity. The environmental impact severity for this planned impact is Level 3 - Moderate. Consequently, further evaluation against the remaining principles of ESD is required. The Operational Area is located within a region where significant levels of petroleum exploration and production activities have taken place. The environment within which BP is proposing to operate is well understood. However, where scientific uncertainty has been identified, it has been addressed throughout the EP, whereby: • Conservative assumptions regarding hydrocarbon reservoir properties and worst-case discharge scenario have been made in accordance with the precautionary principle. • Detailed modelling studies have been commissioned to improve certainty around oil spill fate and trajectory modelling, drill fluids and cuttings discharge modelling and underwater sound modelling. • BP has based its assessment of impacts and risks on available information using robust scientific literature and government endorsed information sources (e.g. AFMA, DPIRD, MNES search and PMST reports) to ensure impact and risk assessment is appropriate to the nature and scale of the activity. • In line with the precautionary approach, during identification of control measures, BP has explored a wide range of alternatives and opted for preventive actions where significant uncertainty exists. Description of controls measures and supporting justification is provided within the evaluation of impacts from planned activities (section 5) and risks from unplanned events (section 6) demonstrating the thought process for all considered controls. Consequently, the precautionary principle has been applied. Precautionary management has been applied through consideration of unacceptable outcomes such as a LOWC (Section 6.4.5) and the development of the OPEP and OSMP to mitigate such outcomes.
Relevant legislation and other industry standards	Adherence to the following legislation and industry standards is considered a relevant control measure for this program: • Minimum requirements listed in API Standard 53, • OPGGS (Resource Management and Administration) Regulations 2011, • OPGGS(E)R 2009 – OPEP, and • OPGGS(E)R 2009 – OSMP
Internal Context	Loss of well control is a recognised risk in BP. BP's well design and well integrity requirements are documented in BP Practices, Procedures and Specifications which are based on extensive operational

	experience and are mandated for use to manage risk to levels considered ALARP. These requirements are incorporated into the well specific design documents and operational procedures, as outlined in the WOMP.
External Context	DPIRD was a stakeholder who identified an interest in this aspect as part the stakeholder engagement conducted for a site survey in the permit. DPIRD were provided sufficient information from the above assessment with no specific objections or claims identified upon receipt of this information.
Defined Acceptable Level	Relevant to this aspect, BP defined acceptable levels, based upon the EPBC Act Significant Impact as a level up to a situation where there is a: • Substantial change in water quality, sediment quality or air quality which may adversely impact on biodiversity, ecological integrity, social amenity or human health. • Substantial change ambient light or sound levels which may modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results. • Substantial change that may modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results. • Change that may have a substantial adverse effect on a population of marine fauna, including its life cycle and spatial distribution, or • Change that may modify, destroy or isolate an area of important habitat for a migratory species, or • Change that may seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species. • Modification, destruction, fragmentation, isolation or disturbance of an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area, State Parks and Reserves or wetlands of national and international importance results. • Substantial adverse effect on the sustainability of commercial fishing. • Interference with other marine users to a greater extent than is necessary for the exercise of right conferred by the titles granted. • Substantial adverse impact on heritage values of the Commonwealth marine area, including damage or destruction of an historic shipwreck. • Expose social surroundings to significant harm. Given the impacts associated with a LOWC event has been predicted to be limited to small numbers of marine fauna and local areas of sensitive benthic habitat, this event is not be expected to cause changes that permanently modify, destroy, fragment, isolate or disturb an important area, nor modify, destroy, fragment, isolate or disturb a substantial area that results in adverse impacts to the functioning or integrity of marine ecosystems. Oil spill events have been identified as a key threat in the NWMR (DEWHA 2008a), however with the control measures in place, management of this risk is not inconsistent with the North-west Marine Bioregional Plan which requires that an approved environment plan containing an oil spill contingency plan (This document) is in place and accepted by the National Offshore Petroleum Safety and Environmental Management Authority The potential risk is below the level BP has defined as being unacceptable (Table 4-2) as: • The evaluation above does not identify any inconsistencies with recovery plans, conservation advice or bioregional plans, and does not have the potential to result in a persistent reduction in ecosystem function on a landscape scale; and • The likelihood of the event occurring in the first place (and subsequent likelihood of exposing sensitive receptors) resulted in a likelihood ranking of Level B – Unlikely. Undertaking the activity with the assigned residual risk is therefore deemed acceptable. The residual risk of High assigned to this unplanned event is below the defined levels of acceptability for this type

	of event, and the management approach for the activity detailed in this EP that is relevant to this event is consistent with relevant recovery plans, conservation advice or bioregional plans.

Performance Management			
Environmental Performance Outcomes	**Performance Standards**	**Measurement Criteria**	**Responsibility**
Undertake the activity in a way that will not cause a: • Substantial change in water quality, sediment quality or air quality which may adversely impact on biodiversity, ecological integrity, social amenity or human health. • Substantial change ambient light or sound levels which may modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results. • Substantial change that may modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity results. • Change that may have a substantial adverse effect on a population of marine fauna, including its life cycle and spatial distribution, or • Change that may modify, destroy or isolate an area of important habitat for a migratory species, or • Change that may seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species. • Modification, destruction, fragmentation, isolation or disturbance of an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area, State Parks and Reserves or wetlands of national and international importance results. • Substantial adverse effect on the sustainability of commercial fishing. • Interference with other marine users to a greater extent than is	**BP Rig Intake and Verification Process** BP will complete its rig intake process prior to operations commencing.	Records confirm rig intake process has been completed.	Wells Superintendent
	Approved Basis of Design and Drilling Program. The well basis of design and operational drilling program will be technically reviewed and approved as per BP's internal process.	Records confirm Ironbark Basis of Design and Drilling Operations Program are approved prior to commencing operations.	Wells Manager
	GWO Bowtie A GWO bowtie will be completed for the Loss of Well Control risk event prior to drilling operations commencing.	Records confirm LOWC GWO Bowtie completed prior to operations commencing.	Wells Manager
	WOMP A NOPSEMA-accepted WOMP that describes well barriers and integrity testing will be in place prior to drilling operations commencing.	Records confirm a NOPSEMA-accepted WOMP was in place prior to operations commencing.	Wells Manager
	OPEP Arrangements Emergency response capabilities will be implemented in accordance with the OPEP.	Prior to commencing rig operations all planned emergency response training and drills to have been completed and all outstanding actions implemented.	Wells Manager
	OSMP Operational and scientific monitoring will be implemented in accordance with the OSMP.	Pre-operational verification that requirements were implemented in accordance with the OSMP (ensure availability of human resources, logistics and scientific equipment to implement OSMP.)	Wells Manager

necessary for the exercise of right conferred by the titles granted. • Substantial adverse impact on heritage values of the Commonwealth marine area, including damage or destruction of an historic shipwreck. • Expose social surroundings to significant harm.			
Implement BOP to regain control of the well and eliminate the release of hydrocarbon to the environment.	**Subsea BOP specification and function testing** Subsea BOP specification and function testing compliant with minimum requirements listed in API Standard 53 and BP control system configuration requirements: • Two control pods with full operational capability. • A ROV intervention system in compliance with API Standard 53. • Two annular preventers, two shear rams and three pipe rams. • Emergency hydraulic backup system (EHBS) in compliance with API Standard 53. • Conduit low pressure alarm monitoring system.	Records show that BOP function and pressure tests are undertaken as per the agreed testing schedule and approved by BP Wells Manager. Inspection and maintenance records demonstrate that BOP specifications meet minimum requirements listed in API Standard 53 and BP control system configuration requirements Inspection and maintenance records show BOP is maintained in accordance with MODU PMS.	Wells Manager

6.5 Oil Spill Response Overview

6.5.1 Oil Spill Response Strategy

This section presents the risk assessment for oil spill response options as required by the OPGGS(E)R.

Not all response options and tactics are appropriate for every oil spill. Different oil types, spill locations, and volumes require different response options and tactics, or a combination of response options and tactics, to form an effective response strategy.

Specifically, BP's response strategy has been developed following the Spill Impact Mitigation Assessment (SIMA) process (IPIECA 2018) which describes the process and presents the outcomes of selecting feasible response options and developing a proposed response strategy for the spill events identified for this activity (refer to Section 6 and Appendix A of the OPEP).

6.5.2 Protection Prioritisation Process

To support the identification of priority response areas, shoreline sensitivity analysis and mapping was undertaken guided by IPIECA principles and informed by the regional description of the environment and understanding of receptor presence in the region. The Response Priority process is detailed in Section 7 of the OPEP.

6.5.3 Pre-spill SIMA Response Option Feasibility Assessment

Appendix A of the OPEP details the response option feasibility assessment which is part of the SIMA. Outcomes of the planning stage SIMA proposed the following primary response arrangements suitable for the activity and details on feasibility are as follows:

- **Monitoring Evaluation and Surveillance** (refer to Section 5.3.1 of the OPEP)
  MES is important for anticipating resources at risk of exposure, directing response resources, and evaluating the effectiveness of response techniques. MES should be conducted throughout the response duration, potentially along with other response options. The response activity validates trajectory and weathering models providing forecasts of spill trajectory, determines the behaviour of the oil in the marine environment, determines the location and state of the slick, determines the effectiveness of the response options and confirms the impact on receptors.
- **Oiled Wildlife Response** (refer to Section 5.3.2 of the OPEP)
  The oiled wildlife response may lead to the survival of vulnerable wildlife populations. The level of oiled wildlife response required can be scaled based on the predicted number of animals oiled.
- **Waste Management** (refer to Section 5.3.3 of the OPEP)
  The management, classification, manifesting and propoer disposition of wastes generated from spill response activities.

In addition to the above primary response options, the following potential secondary response options were identified through the SIMA process, with the feasibility assessments found in Appendix A of the OPEP:

- Containment and Recovery
- Surface Dispersant Application

Note that Source Control is implemented simultaneously with other spill response options and therefore is not assessed as part of the planning stage SIMA.

6.5.4 Spill Response – Source Control

Well-related source control activities may range from:

- ROV emergency BOP intervention utilising specialist ROV tooling; and/or
- Well capping and containment; and/or
- Relief well drilling.

Source control arrangements from an accidental release from a vessel collision includes:

- Closing water tight doors;
- Checking bulkheads;

- Determining whether vessel separation will increase spillage;
- Isolating penetrated tanks; and
- Tank lightering, etc.

Implementation of source control for vessels is detailed within the below documents, and is not discussed further:

- Vessel-specific Shipboard Oil Pollution Emergency Plan (SOPEP/SMPEP);
- Vessel Specific Safety Cases; and
- National Plan for Maritime Environmental Emergencies (NatPlan).

The potential impacts and risks associated with this is covered under the aspects evaluated in the associated WOMP and Safety Case and thus are not considered further.

The potential impacts and risks and ALARP evaluation associated with source control activities are covered in Section 6.5.4 of this EP whereby failure of activating the BOP or capping the well would result in a continued loss of well control until a relief well is drilled.

The environmental performance outcomes, standards and measurement criteria for response preparedness and implementation of source control activities are detailed in Table 6-22.

Table 6-22: Environmental Performance Outcomes, Standards and Measurement Criteria – Source Control

Performance Management				
Environmental Performance Outcomes	**Control Measure**	**Performance Standards**	**Measurement Criteria**	**Responsibility**
BP maintains capability to implement its OPEP source control activity – BOP Intervention	Timing of BOP intervention	BOP intervention personnel and equipment on site ready to commence intervention within 48 hours of LOWC event.	Response logs confirm that BOP intervention personnel and equipment have been mobilised to site within 48 hours of LOWC event.	Incident Commander
		The BOP rams would be closed manually by the ROV stabbing into the BOP ROV control panel (conforming to API 17H hot stab).		Incident Commander
	Vessels with dedicated BOP intervention and SAR capabilities	All vessels contracted to support the drilling program have SAR capabilities, including one AHTS vessel equipped to attempt BOP intervention, with at least one of these vessels being always on location for the duration of the drilling program.	Vessel logs demonstrate that one vessel with SAR capability is always on site.	Wells Manager
		Vessels are crewed with personnel adequately trained in SAR activities.	Training records or induction records show that crew are competent with undertaking SAR activities.	Vessel Master

Performance Management				
Environmental Performance Outcomes	**Control Measure**	**Performance Standards**	**Measurement Criteria**	**Responsibility**
		Nominated BOP intervention vessel has appropriate fire-fighting and onboard oil recovery certification and is capable of high accuracy positioning (certified IMO Dynamic Positioning Class 2).	Pre-mobilisation inspection records confirm fire-fighting and oil recovery certificates are current for the nominated BOP intervention vessel.	Vessel Master
	Specialist equipment	ROV package including work class ROV with an integral pumping skid rated to the shear rating of the BOP shear rams and 1,000 m tether, is positioned on the vessel and fully commissioned prior to the drilling the critical reservoir sections.	Equipment register show that the ROV package is onboard the vessel prior to the drilling the critical reservoir sections. Maintenance records show that the ROV package is maintained in accordance with manufacturer's specifications. Records of commissioning show that ROV has been tested and is functional prior to the drilling of the critical reservoir sections.	Vessel Master / Wells Manager
		Real time gas monitoring sensors and additional sensors are positioned on the BOP intervention vessel and functional prior to the drilling of the critical reservoir sections.	Equipment register shows that gas monitoring sensors and additional logging equipment are onboard the vessel. Maintenance records show that monitoring and logging sensors are maintained in accordance with manufacturer's specifications.	Vessel Master / Wells Manager
		Sensors are functional prior to the drilling of the critical reservoir sections.	Records of commissioning show that sensors have been tested and are functional prior to the drilling of the critical reservoir sections.	Wells Manager
	BOP intervention Plan	BOP Intervention Plan developed prior to spud.	The BOP Intervention Plan has been approved by BP.	Wells Manager
		Compatibility between ROV, BOP intervention skid and the rig's BOP to be verified prior to the drilling of the critical reservoir sections.	Training records show that operational review of BOP intervention vessel ROV, BOP intervention skid and MODU BOP compatibility carried out prior to the	Wells Manager

Performance Management				
Environmental Performance Outcomes	**Control Measure**	**Performance Standards**	**Measurement Criteria**	**Responsibility**
			drilling of the critical reservoir sections.	
	Training, testing, and drills	Pre-spud tabletop exercise to validate BOP intervention readiness for mobilisation.	Exercise records show that timeframes of BOP intervention attempt can be met.	Wells Manager
		The BOP intervention plan is available onboard the nominated BOP intervention vessel prior to the drilling of the critical reservoir sections.	BOP intervention plan has been reviewed by ROV crew, BP senior ROV technical authority and BP and Diamond Offshore Subsea teams.	Wells Manager
		Video link for remote specialist support tested and functioning effectively prior to the drilling of the critical reservoir sections.	Video link has been tested and is functional prior to the drilling of the critical reservoir sections.	Wells Superintendent
	Specialist personnel	Specialist air monitoring personnel have gas plume monitoring competence.	Training records confirm specialist air monitoring personnel have appropriate gas plume monitoring skills.	HSE Manager
		ROV supervisor on nominated BOP intervention vessel has subsea BOP intervention competence.	Training records confirm ROV supervisor has appropriate subsea BOP intervention skills.	Wells Superintendent
BP maintains capability to implement its OPEP source control activity – Well Capping	Identification and confirmed access to suitable capping stacks	At least one capping stack is suitable for Ironbark-1 well conditions and accessible through valid contractual arrangements.	Notice of commencement of activities from BP to OSRL has been sent.	Wells Manager
		OIE equipment and specialist personnel are accessible in Trieste, prior to and during the drilling program.	Records of pre-mobilisation checks show BP's subscription to the OIE suite of equipment is current.	Wells Manager
	Timing of well capping	Well capping (vertical capping) personnel and equipment on site ready to commence well capping operations within 20 days of incident, contingent on debris clearance requirements, predicted plume size and weather conditions.	Response logs confirm that well capping personnel and equipment have been mobilised to site within 20 days of LOWC event.	Incident Commander
		Well capping (OIE) personnel and equipment on site ready	Response logs confirm that OIE well capping personnel	Incident Commander

Performance Management				
Environmental Performance Outcomes	**Control Measure**	**Performance Standards**	**Measurement Criteria**	**Responsibility**
		to commence well capping operations within 62 days of incident, contingent on debris clearance requirements, predicted plume size and weather conditions.	and equipment have been mobilised to site within 62 days of LOWC event.	
	Capping deployment vessel availability and suitability	Location of suitable vessels will be monitored by BP at a minimum 30 days prior to spud, on a monthly basis for the duration of the drilling program and prior to drilling the critical reservoir sections.	Monitoring records confirm that at least one suitable vessel is located within 15-day sail radius from Dampier prior to commencing of the drilling program and prior to drilling the critical reservoir sections.	Wells Manager
		Well capping deployment vessel availability confirmed within 24 hours of LOWC event and contracting process commenced.	Response logs confirm that vessel provider has been contacted within 24 hours of LOWC event.	Incident Manager
		A suitable vessel will be selected for well capping activities, based on the following minimum requirements: • existing Australian safety case • located within 15-day sail radius from Dampier, and • minimum 250 t crane, with 25 m reach	Monitoring records provide a list of suitable vessels identified.	Wells Manager
	Safety case	Contract between BP and specialist service provider established to support pre-emptive updates of vessel safety cases to consider the various work scopes that may form part of a well capping operation.	Contract between BP and specialist service provider for safety case services is in place.	Wells Manager
		Well capping deployment vessel Safety Case Revision initiated as soon as practicable after LOWC event	Records of meeting with NOPSEMA confirms submission schedule and request all attempts be made to assess Safety Case	Incident Commander

Performance Management				
Environmental Performance Outcomes	**Control Measure**	**Performance Standards**	**Measurement Criteria**	**Responsibility**
			Revision as a matter of priority.	
		Risk review to identify risks of capping operations and mitigation to be applied is undertaken prior to drilling of critical reservoir sections	Risk review report shows that risks have been identified and proposed mitigation has been considered.	Wells Manager
	Capping plan	Capping Plan is developed prior to spud.	The Capping Plan has been approved by BP.	Wells Manager
	Testing and Drills	Pre-spud tabletop exercise to validate process to verify real time vessel availability to meet vertical access capping deployment plans.	Testing records show monitoring process is adequate to identify vessels availability prior to the drilling program commencing.	Wells Manager
		Pre-spud tabletop exercise to validate capping stack readiness for mobilisation.	OSRL's maintenance records show that vertical capping stack has been maintained in accordance with manufacturer's schedule Saipem's maintenance records show that OIE deployment system has been maintained in accordance with manufacturer's schedule	Wells Manager
	Debris clearance	Light duty debris clearance is conducted using the ROV onboard the capping deployment vessel.	Approved safety case for vessels assigned to debris clearance considers this activity. Pre-mobilisation checks confirm that ROV package is onboard contracted vessels assigned to debris clearance activity.	Wells Manager
		Contracts in place for access to heavy duty debris clearance packages prior to spud.	Records show that membership with AMOSC is active. Records show contract in place with Wild Well Control for super shears access. Notice of commencement of activities from BP to OSRL has been sent.	Wells Manager

Performance Management				
Environmental Performance Outcomes	**Control Measure**	**Performance Standards**	**Measurement Criteria**	**Responsibility**
			Notice of commencement of activities from BP to AMOSC has been sent.	
BP maintains capability to implement its OPEP source control activity – Relief Well Drilling	Access to relief well drilling rigs and associated well site services, equipment and supplies	APPEA MOU in place prior to the start of the drilling program.	Records show that BP is a signatory of APPEA MOU. Notification to rig operators of the start of the drilling program has been completed.	Wells Manager
		The relief well plan is prepared as part of the Well Operation Management Plan and include identifying suitable relief well rig, feasibility and any specific considerations for relief well kill, specifying the location, well path design and dynamic kill modelling.	Prior to start of drilling in compliance with the Well Operations Management Plan: • rig suitable to drill the relief well has been identified • potential relief well surface locations identified • documented relief well path design in the WOMP • dynamic kill modelling verified	Wells Manager
	Safety case revision	Relief well rig in Australian waters with an Australian Safety Case identified prior to spud.	Verification records show relief well rig selected in WOMP is still available prior to spud.	Wells Manager
		Relief well rig safety case revision initiated as soon as practicable after LOWC event.	Relief well rig safety case documentation submission to NOPSEMA confirms timely initiation.	Wells Manager
	Testing and Drills	Pre-spud tabletop exercise to validate relief well drilling logistical readiness, including availability and mobilisation of long lead drilling items.	Testing records show logistical readiness for relief well drilling has been confirmed prior to the drilling program commencing.	Wells Manager

6.5.5 Spill Response – Monitoring Evaluation and Surveillance

For details on Monitoring, Evaluation and Surveillance (MES), refer to Section 5.3.1 of the OPEP. Table 6-23 details the risk evaluation for MES.

Table 6-23: Risk Evaluation for Spill Response – Monitoring Evaluation and Surveillance

<table>
<tr><th colspan="3">Activity</th></tr>
<tr><td colspan="3">The following activity associated with operational monitoring have the potential to interfere with marine fauna:
• Aircraft operations for aerial surveillance (fixed wing or helicopter).</td></tr>
<tr><th colspan="3">Consequence associated with Spill Response – Monitoring Evaluation and Surveillance</th></tr>
<tr><th colspan="3">Water Column / Surface</th></tr>
<tr><td colspan="3">Helicopters and aircraft generate airborne noise, which may penetrate into the marine environment. The intensity of the received sound depends upon the source level, altitude, and depth of the receiver. Richardson et al. (1995) reports figures for a Bell 214 helicopter (stated to be one of the noisiest) being audible in air for four minutes before it passed over underwater hydrophones, but detectable underwater for only 38 seconds at 3 m depth and 11 seconds at 18 m depth. Thus, impacts to fauna from aircraft or helicopters are unlikely as the latter will not be close to the sea surface and will not be approaching fauna.
Thus, potential impact severity level was assessed as Level 1 - Negligible.</td></tr>
<tr><th colspan="3">Inherent / Design Control Measures (validated control measures) and Good Practice Control Measures</th></tr>
<tr><th>Control Measure</th><th colspan="2">Context of Control Measures</th></tr>
<tr><td>EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans</td><td colspan="2">EPBC Regulations 2000 – Part 8 Division 8.1 interacting with cetaceans – The Australian Guidelines for Whale and Dolphin Watching, describes strategies to ensure whales and dolphins are not harmed during offshore interactions with people.
These guidelines were developed jointly by all state and territory governments and provide a list of good requirements that are generally adopted by the oil and gas industry to minimise the risk of fauna strike occurring; this also has the effect of ensuring a separation distance from vessels restricting the potential for noise impacts. Distances for helicopters are also provided.
AMSA Marine Notice 15/2016 Minimizing the risk of collisions with cetaceans; also identifies control measures for vessel operators to minimise the impact of underwater sound on marine fauna. These control measures are the same as those identified within EPBC Regulations 2000 and thus have not been discussed further.</td></tr>
<tr><th colspan="3">Risk Evaluation</th></tr>
<tr><th>Impact Severity Level (Table 4-2)</th><th>Likelihood</th><th>Risk Level</th></tr>
<tr><td>1 Negligible</td><td>Helicopter-based MES support will require additional helicopter movements and consequently additional underwater sound emissions. Additional helicopter movements will increase slightly the previously assessed impact of underwater sound emissions in comparison to routine operations (Section 5.5.4). However, based on the controls described, the likelihood of response activities resulting in the consequences described is considered to be Level B - Unlikely.</td><td>Low</td></tr>
<tr><th colspan="2">ALARP Decision Context (Table 4-5)</th><th>Type</th></tr>
<tr><td colspan="2">ALARP Decision Context Type A apply for MES. Inherent controls are good practice.
The risk matrix presented within the conservation Management Plan for the Blue Whale (DoE 2015) (LF cetacean) provides a risk rating of low to moderate associated with aircraft noise. Given inherent controls and relevant industry standards are applied, controls align with the priority for action recommended in this management plan.
However, the OPEP lists MES as a response strategy/control for Loss of Well Control. The risk assessment associated with Loss of Well Control was assessed as ALARP Decision Context C. Further evaluation of ALARP has been undertaken for MES in mind of LOWC ALARP decision context C.</td><td>A</td></tr>
<tr><th colspan="3">ALARP Decision Context C – Further Evaluation</th></tr>
</table>

Additional control measures	Benefit	Cost	Outcome
Utilise additional vessels and aircraft for spill observations during initial response stages	Although additional surveillance activities will provide additional information, continuous monitoring of the spill has limited benefit given significant changes in trajectory are influenced by oceanic currents and wind direction that is being continuously monitored via both tracking buoys and Meteye services. Consequently, aerial and satellite MES Team is expected to be sufficient for the initial stages of the response planning and using additional platforms is not considered to provide a considerable environmental benefit.	BP has arrangements in place to enable additional platforms to be deployed for MES activities if required and thus the cost of deploying additional platforms is not expected to be significant. However, during the initial stages of the response, deploying additional platforms increases simultaneous operations (SIMOPS) risk whilst the emergency management structure and communication protocols are being initiated. Consequently, as there is no considerable benefit of scaling up MES during the initial stages of the response implementation of this control measure has not been considered further. As the response progresses, scaling up or down of the response effort will be considered in accordance with the OPEP which reviews the effectiveness of each strategy. BP has demonstrated in the OPEP that existing arrangements are in place (such as access to helicopters and support vessels) and access to additional resources (not just those required for the initial stages of the response) if required by this process.	Not selected.
Use unmanned aerial vehicles (UAV) to provide a more rapid monitoring response with reduced safety risks	This equipment is relatively affodarble and easily accessible.	This control measure is not expected to provide significant environmental benefit as the Ironbark well is located offshore and as drone range is expected to be minimal, it is not expected to be practicable. In addition to this there is immediate in-field monitoring, and aerial surveillance will be implemented rapidly given access to helicopters via existing contracts.	Not selected
Night-time monitoring - infrared	The cost associated with utilising infra-red monitoring is not considered to be significant. As infra-red monitoring needs to be deployed from an aerial platform at night, this activity creates significant health and safety risks.	Infrared may be used to provide aerial monitoring at night time, however the benefit is minimal given trajectory monitoring (and infield monitoring during daylight hours) will give good operational awareness. In addition to this, satellite imagery may be used at night to provide additional operational awareness.	Not selected

Acceptability Assessment

Unplanned event associated with Spill Response – Monitoring Evaluation and Surveillance is ranked as Decision Context A, therefore the existing controls are considered inherently acceptable and no further evaluation is required.

Performance Management

Environmental Performance Outcomes	Performance Standards	Measurement Criteria	Responsibility

BP maintains capability to implement its OPEP.	**Well Response Resources** BP maintains the following agreements (or contractor pre-qualifications) to maintain MES capabilities: • Aerial and satellite surveillance contractors. • Satellite tracking buoys staged on the MODU and support vessels	Contracts/ agreements demonstrate preparedness.	Wells Manager
	BP will conduct an Ironbark specific source control desktop exercise.	Desktop exercise report issued within 30 days.	Wells Manager

6.5.6 Spill Response – Oiled Wildlife Response

For details on oiled wildlife response (OWR) refer to Section 5.3.2 of the OPEP. Table 6-24 details the risk evaluation for oiled wildlife response.

Table 6-24: Risk Evaluation for Spill Response – Oiled Wildlife Response

Activity		
The following activities were identified as having the potential to result in interactions with fauna: • Hazing of target species • Handling and treatment. The activities associated with OWR have the potential to result in an impact to fauna through: • Deterring non-target species from their normal activities (resting, feeding, breeding, etc.); • Distress, injury or death of target fauna from inappropriate handling and treatment.		
Consequence associated with Spill Response – Oiled Wildlife Response		
Water Column / Surface		
Untrained resources capturing and handling native fauna may cause distress, injury and death of the fauna. To prevent these impacts, only appropriately trained oiled wildlife responders will approach and handle fauna. This will eliminate any handling impacts to fauna from untrained personnel and reduce the potential for distress, injury or death of a species. Hazing and exclusion of wildlife from known congregation areas may have a short- or long-term impact on the survival of that group if they cannot access preferred resources. These effects may be experienced by target and non-target species. Due to the potential for localised short-term impacts to species/habitats of recognised conservation value but not affecting local ecosystem functioning, the impact severity level for this activity have been identified as Level 2 - Minor.		
Inherent / Design Control Measures (validated control measures) and Good Practice Control Measures		
Control Measure	**Context of Control Measures**	
OPEP	Maintaining the capability for oiled wildlife response is key for ensuring that the any response is implemented effectively and quickly.	
Consultation	Consultation In the event of a spill will ensure that relevant government agencies support the OWR strategy thus minimising potential impacts and risks to sensitivities.	
Risk Evaluation		
Impact Severity Level (Table 4-2)	**Likelihood**	**Risk Level**

2 Minor	Use of untrained oiled wildlife response resources may consequently cause distress, injury or death to marine fauna. However, given only trained oiled wildlife response resources will be used the likelihood of response activities resulting in the consequences described is considered to be Level B - Unlikely.		Low
ALARP Decision Context (Table 4-5)			**Type**
ALARP Decision Context Type A should apply for oiled wildlife response given inherent controls are good practiceHowever, the OPEP lists oiled wildlife response as a response strategy/control for Loss of Well Control. The risk assessment associated with Loss of Well Control was assessed as ALARP Decision Context C. Further evaluation of ALARP has therefore been undertaken for oiled wildlife response.			A
ALARP Decision Context C – Further Evaluation			
Additional control measures	**Benefit**	**Cost**	**Outcome**
Training and competencies	Personnel handling oiled wildlife are trained as fauna handlers or are guided by OWR-trained personnel. During an oil spill there is the potential for fauna to come into contact with floating or stranded oil. If this occurs, BP is able to draw upon the OWR arrangements and expertise developed and implemented by industry, and can also provide support to these OWR agencies	There are no significant costs associated with this control measure, however given the level of OWR expected, and the demonstrated capability to access OWR personnel, training additional personnel is expected to provide any benefit, thus has not been implemented.	Selected

Acceptability Assessment	
Unplanned event associated with Spill Response – Oiled Wildlife Response is ranked as Decision Context Type A, therefore the existing controls are considered inherently acceptable and no further evaluation is required.	

Performance Management			
Environmental Performance Outcomes	**Performance Standards**	**Measurement Criteria**	**Responsibility**
BP maintains capability to support oiled wildlife management in a Level 2 or 3 spill event.	BP maintains the following agreements to maintain OWR response capabilities: • AMOSC membership (equipment, personnel). • SeaAlarm contract (personnel). • OSRL membership. • Waste management contract. • Vessel of Opportunity listing	Contracts/memberships verify currency of membership.	Wells Manager
BP provides resources to support oiled wildlife response strategies as directed by Department of Transport or other state agency.	Relevant state agency is notified as soon as possible after the sighting of oiled wildlife has occurred.	Incident management records verify that verbal and/or written notification was provided to relevant State agency as soon as possible after the sighting was noted.	Incident Controller

	AMOSC OWR kits are deployed to site within timeframes as directed by Department of Transport.	Incident records verify oiled wildlife response kits are deployed to site as directed by Department of Transport.	Incident Controller
	BP meets Department of Transport resourcing needs throughout the response, meeting incident action plan (IAP) performance outcomes.	Incident log verifies requested BP resources met required IAP outcomes for oiled wildlife response.	Incident Controller
Wildlife is only approached or handled by Department of Transport (or other state agency) trained oiled wildlife responders.	BP personnel are inducted into wildlife interaction restrictions.	Incident records verify no interaction by BP personnel and wildlife.	Incident Controller

6.5.7 Spill Response – Waste Management

For details on waste management refer to Section 5.3.3 of the OPEP. Table 6-25 details the risk evaluation for waste management.

Table 6-25: Risk Evaluation for Spill Response – Waste Management

Activity		
The following activities associated with waste management have the potential to interfere with marine fauna through: • MODU / vessel operations (inappropriate waste storage of PPE and equipment soiled with hydrocarbons). • MODU/ vessel operations (loss of containment of oily water from containment and recovery response)		
Consequence associated with Spill Response – Waste Management		
Water Column / Surface		
The potential risks associated with inappropriate waste storage and loss of containment of small hydrocarbon spills have been evaluated in Section 6.4.1 (accidental release of waste discharged overboard) and Section 6.4.2 (accidental release of loss of containment (small hydrocarbon or chemical spill)) of this EP. Based on the nature and scale of waste management activities for spill response, the evaluation is considered appropriate and thus has not been considered further. The potential impact severity level was assessed as Level 2 – Minor.		
Inherent / Design Control Measures (validated control measures) and Good Practice Control Measures		
Control Measure	**Context of Control Measures**	
Spill response waste management support services.	Waste management contract between BP and waste management support services are in place prior to activity commencement.	
Risk Evaluation		
Impact Severity Level (Table 4-2)	**Likelihood**	**Risk Level**
2 Minor	Waste management during spill response introduces additional waste handling measures and may increase slightly the previously assessed impact of loss of containment of small hydrocarbon spills have been evaluated in Section 6.2.3 (accidental release of waste discharged overboard) and Section 6.4.2 (accidental release of loss of containment (small hydrocarbon or chemical spill)). However, based on the controls described, the likelihood of waste management activities	Low

	during spill response resulting in the consequences described is considered to be Level B – Unlikely.	
ALARP Decision Context (Table 4-5)		**Type**
ALARP Decision Context Type A applies. Inherent controls are good practice and no control measures beyond good practice are required.		A

Acceptability Assessment
Unplanned event associated with Spill Response – Waste Management is ranked as Decision Context Type A, therefore the existing controls are considered inherently acceptable and no further evaluation is required.

Performance Management			
Environmental Performance Outcomes	**Performance Standards**	**Measurement Criteria**	**Responsibility**
BP maintains capability to manage waste generated from spill response activities.	BP maintains the waste management contract to maintain the waste management response capability	Contracts/memberships verify currency of membership.	Wells Manager

6.5.8 Spill Response – Containment and Recovery

For details on containment and recovery refer to Appendix A of the OPEP. Table 6-26 details the risk evaluation for containment and recovery.

Table 6-26: Risk Evaluation for Spill Response – Containment and Recovery

Activity	
The following activities associated with containment and recovery have the potential to interfere with marine fauna and the general public: • Physical presence - vessels to deploy equipment. • Physical presence - Equipment used to contain and recover surface hydrocarbons.	
Consequence associated with Spill Response – Containment and Recovery	
Water Column / Surface	
If consideration is given to the secondary option of containment and recovery following a spill event, in such a case, the physical presence of vessels and equipment from containment and recovery activities could displace other marine users (Section 5.2) and interact with marine fauna (Section 6.2.3). Areas may also be temporarily restricted to the public while containment and recovery activities occur. An incident-specific SIMA will be undertaken to ensure there is a net environmental benefit considering the exposure of hydrocarbons and potential impacts from implementing containment and recovery. The impact severity level is assessed as Level 1 – Negligible.	
Inherent / Design Control Measures (validated control measures) and Good Practice Control Measures	
Control Measure	**Context of Control Measures**
Maintain capability as described in the OPEP.	Maintaining the capability described in OPEP is key for ensuring that any response is implemented effectively and quickly.
Consultation	Consultation in the event of a spill will enable relevant government agencies to support the tactical response arrangements thus minimising potential impacts and risks to sensitivities.
Risk Evaluation	

Impact Severity Level (Table 4-2)	Likelihood	Risk Level
1 Negligible	Containment and recovery typically involve the deployment of booms and oil skimmers from suitable vessels, as well as the collection, transfer and disposal of oil and oily water recovered during the response. Due to their slow speeds, the vessels used to store and transport the oily waste have a very low probability of displacing other marine users (Section 5.2) or interact with marine fauna (Section 6.2.3). Therefore based on the controls described, the likelihood of containment and recovery resulting in the consequences described is considered to be Level B - Unlikely.	Low
ALARP Decision Context (Table 4-5)		**Type**
ALARP Decision Context Type A should apply for containment and recovery given inherent controls are good practice However, the OPEP lists containment and recovery as a response strategy/control for Loss of Well Control. The risk assessment associated with Loss of Well Control was assessed as ALARP Decision Context C. Further evaluation of ALARP has therefore been undertaken for containment and recovery.		A

ALARP Decision Context C – Further Evaluation			
Additional control measures	**Benefit**	**Cost**	**Outcome**
Pre-planning containment and recovery based upon protection priorities (if this secondary option selected for implementation)	The benefit in pre-planning specific protection measures at priority protection sites relates to a potential reduction in overall habitat oiling, or even complete prevention of oiling to a sensitive habitat.	This control is not applicable given modelling predicted no shoreline contact.	Not selected

Acceptability Assessment
Unplanned event associated with Spill Response – Containment and Recovery is ranked as Decision Context A, therefore the existing controls are considered inherently acceptable and no further evaluation is required.

Performance Management			
Environmental Performance Outcomes	**Performance Standards**	**Measurement Criteria**	**Responsibility**
BP maintains capability to implement contain and recover in a Level 2 or 3 spill event. Level 2 and Level 3 spill event is defined in Section 1.3.1 the OPEP.	**Agreements** BP maintains the following agreements to maintain containment and recovery capabilities: • AMOSC membership (equipment, personnel, CORE Group. Mutual aid). • AMSA MoU (equipment, personnel). • OSRL membership (equipment).	Agreements/memberships are current. MoU in place.	Wells Manager

	• Scientific resource support agreement. • Waste management contract.		

6.5.9 Spill Response – Surface Dispersant Application

For details on surface dispersant application refer to Section 5 and Appendix A of the OPEP. Table 6-27details the risk evaluation for surface dispersant application.

Table 6-27: Risk Evaluation for Spill Response – Surface Dispersant Application

<table>
<tr><th colspan="3">Activity</th></tr>
<tr><td colspan="3">The activities associated with the application of surface dispersants are:
• Vessel operations – application of dispersants
• Aircraft operations – application of dispersants
Application of surface dispersants has the potential to result in an impact to values and sensitivities in the water column through:
• Chemical toxicity.</td></tr>
<tr><th colspan="3">Consequence associated with Spill Response – Surface Dispersant Application</th></tr>
<tr><th colspan="3">Water Column / Surface</th></tr>
<tr><td colspan="3">The potential risks of surface dispersant application include a temporary increase in entrained hydrocarbons (for the duration of the response) and introduction of chemical dispersants into the marine environment. Both dispersants and the resultant increase of entrained hydrocarbons will be toxic to some marine organisms (NOAA 2019).
If the secondary response option of surface dispersant application is considered, use would be limited to patches of surface hydrocarbons that may form that threaten to impact sensitive receptors, and outside of state waters and state or national marine parks. Given dispersant application would be used on patches of surface hydrocarbons, impacts associated with the use of dispersant application is considered negligible as it would be considered only if an incident-specific SIMA indicated there would be a net environmental benefit to do so.
The impact severity level is assessed as Level 1 – Negligible.</td></tr>
<tr><th colspan="3">Inherent / Design Control Measures (validated control measures) and Good Practice Control Measures</th></tr>
<tr><th>Control Measure</th><th colspan="2">Context of Control Measures</th></tr>
<tr><td>Maintain capability as described in the OPEP.</td><td colspan="2">Maintaining the capability described in OPEP is key for ensuring that the any response is implemented effectively and quickly.</td></tr>
<tr><td>AMSA Register of oil spill control agents</td><td colspan="2">BP will use dispersants products listed on the AMSA Register of oil spill control agents</td></tr>
<tr><td>Consultation</td><td colspan="2">Consultation In the event of a spill will ensure that relevant government agencies support the surface dispersant application strategy thus minimising potential impacts and risks to sensitivities.</td></tr>
<tr><th colspan="3">Risk Evaluation</th></tr>
<tr><th>Impact Severity Level (Table 4-2)</th><th>Likelihood</th><th>Risk Level</th></tr>
<tr><td>1 Negligible</td><td>The use of surface dispersants will increase in-water concentrations of hydrocarbons. The temporary increase of in-water hydrocarbons will slightly increase the concentration of in-water hydrocarbon impacts to marine fauna (Section 6.4.5.4). The slight increase in in-water hydrocarbons in unlikely to greatly contribute to impacting marine fauna in the event of a spill. Additionally, use of dispersants would not be implemented without first conducting an incident-</td><td>Low</td></tr>
</table>

	specifc Spill Impact Mitigation Assessment (SIMA) to consider specifically any potential impacts to marine fauna at the time. Therefore the likelihood of surface dispersant application resulting in the consequences described is considered to be Level B - Unlikely.	

ALARP Decision Context (Table 4-5)	**Type**
ALARP Decision Context Type A should apply for surface dispersant application given inherent controls are good practiceHowever, the OPEP lists surface dispersant application as a secondary response strategy/control for Loss of Well Control. The risk assessment associated with Loss of Well Control was assessed as ALARP Decision Context C. Further evaluation of ALARP has been undertaken for surface dispersant application in mind of LOWC ALARP decision context C.	A

ALARP Decision Context C – Further Evaluation

Additional control measures	**Benefit**	**Cost**	**Outcome**
Pre-planning surface dispersant application based upon protection priorities (if the secondary option selected for implementation)	The benefit in pre-planning specific protection measures at priority protection sites relates to a potential reduction in overall habitat oiling, or even complete prevention of oiling to a sensitive habitat.	The financial cost associated with the development of tactical response plans is negligible compared with the potential benefit of preventing or reducing oil exposure to priority sites, therefore it is deemed reasonable to develop tactical response plans for all identified priority sites.	Selected

Acceptability Assessment

Unplanned event associated with Spill Response – Surface Dispersant Application is ranked as Decision Context A, therefore the existing controls are considered inherently acceptable and no further evaluation is required.

Performance Management

Environmental Performance Outcomes	**Performance Standards**	**Measurement Criteria**	**Responsibility**
BP maintains access to dispersant and equipment resources	**Well Response Resources** BP maintains the following agreements (or contractor pre-qualifications) to maintain dispersant application capabilities: • AMOSC membership (equipment, personnel, CORE Group. Mutual aid). • AMSA MoU (equipment, personnel). • OSRL membership (Global Dispersant Stockpile). • BP-owned dispersant stocks.	Contracts/ agreements demonstrate preparedness.	Wells Manager
No unacceptable risk chemicals used for activities described	**OSCA Register** All dispersants planned for use shall be selected from those available on the AMSA OSCA Register	Records show that dispersants employed are listed on the OSCA register.	Incident Controller Commander
Dispersant use is targeted	Dispersant use would be targeted on isolated patches of surface	Daily field report shows areas where dispersant was actually	Incident Commander

	hydrocarbons that may threaten sensitive receptors	applied relative to modelling results.	
Dispersant effectiveness is monitored	During the response the following parameters will be monitored and compared at least daily: • Dispersant product used. • Dispersant volumes applied. • Dispersant dilutions applied. • Locations of dispersant application • Results of efficacy monitoring	Daily field reports provide dispersant application and monitoring results for the day.	Incident Commander
Dispersant is only used when and where needed as per incident-specific SIMA	Dispersant use is terminated if any of the following criteria are met: • SIMA indicates no additional benefit of applicationMonitoring shows no efficacy of dispersant application.	Incident log verifies where criteria met for termination.	Incident Commander

7 Implementation Strategy

The Implementation Strategy described in this section, as required by Regulation 14 of the OPGGS(E)R, is a summary of the arrangements in place to:

- Confirm that control measures detailed in the EP are effective in reducing the environmental impacts and risks of the activity to ALARP and acceptable levels, and that EPOs and EPSs are continually met as required by regulations 14(1)-14(6) – Section 7.1.1 and Section 7.1.6

- Monitor and record planned and unplanned emissions and discharges as required by regulation 14(7) – Section 5 and Section 7.8.

- Respond to and monitor impacts of, oil pollution emergencies as required by regulations 14(8), 14(8AA), 14(8D) and 14(8E) – refer to Section 7.5, Appendix D - OPEP and Appendix E - OSMP.

- Test the response arrangements in the OPEP as appropriate to the nature and scale of the impacts and risks of the activity as required by regulations 14(8A), 14(8B) and 14(8D) – Section 7.5.2.

- Provide for effective ongoing stakeholder consultation throughout the implementation of the activity as required by regulation 14(9) – Section 7.10.

BP systems, practices and procedures in place to manage the environmental impacts and risks associated with the drilling program to ALARP. This section describes how each of the environmental aspects described in Section 5 and Section 6 will be managed in order to meet the respective objectives. The implementation strategy identifies:

- Systems, practices and procedures (Regulation 4),
- Specific roles and responsibilities (Regulation 4),
- Employee training,
- Monitoring, auditing and recording requirements,
- Emergency response planning.

7.1 BP Operating Management System

As one of the world's leading integrated oil and gas companies, BP aims to create long-term value for shareholders by helping to meet growing demand for energy in a safe and responsible way. The BP Operating Management System (OMS) defines a systematic and consistent approach to managing BP operating activities, helping to continuously improve performance while meeting a commitment to operate safe, reliable and compliant operations. BP is committed to responsible environmental management using the BP OMS and this course of action is highlighted in BP's commitment to HSSE performance. A copy of the BP's commitment to HSSE performance is included as Appendix G to this EP.

BP's OMS provides a single framework for BP operations, covering people, plant, process, and performance; which is illustrated in Figure 7-1 and summarised in Table 7-1. The OMS applies whenever

BP carries out or uses a contractor to carry out operating activities. It brings together BP requirements on health, safety, security, environment, social responsibility and operational reliability, as well as related issues such as maintenance, working with contractors and organizational learning, into a common management system.

The BP OMS has two purposes:

1. Managing health, safety, security and environmental (HSSE) and operational risks in its operating activities by setting out what it needs to do.
2. Improving the quality of its operating activities through an annual Performance Improvement Cycle.

All BP businesses covered by the OMS are required to progressively align with the OMS Framework through an annual Performance Improvement Cycle. The OMS defines a set of operating requirements and outlines a systematic way for businesses to deliver them. The requirements address eight focus areas - “the Elements of Operating” - under people, plant, process and performance (Figure 7-1). Each element contains a series of statements on what each operation needs to do, ranging from leaders providing clear direction through to collecting and learning from performance data. Where necessary, the statements are supported by practices and procedures that set out how to meet the requirements.

The BP ‘Group Essentials’ define what’s required and are categorised against the sub elements. The Group Essentials are the Group operating requirements with which each entity shall comply. There is a set of practices that detail business processes that must be implemented as part of the local OMS to deliver one or more of the Group Essentials.

Element 3 (Risk) and Element 4 (Procedures) and Element 7 (Privilege to Operate) of the OMS provides a framework for managing HSSE risks as described in this EP. Additional risk assessments must be undertaken if the Management of Change Sub-Element is triggered. Element 3 (Risk) and Element 4 (Procedures) of the OMS are the management system Elements used to demonstrate the requirements of Regulation 14(3)(a) that impacts and risks of the petroleum activity continue to be identified and reduced to ALARP.

Figure 7-1: The BP Operating Management System Framework

Table 7-1: Summary of BP OMS Elements

Category	Element	Principle
People	1. Leadership	Our operating leaders are competent, exhibit visible, purposeful and systematic leadership and are respected by the organisations they lead.
	2. Organisation	We have fit for purpose and agile organisations staffed with competent people and teams.
Process	3. Risk	The workforce at all levels of our organisation understands and manages operating risk to prevent accidents and harm to people, to reduce damage to the environment and to achieve competitive performance.
	4. Procedures	We document and rigorously follow procedures for safe, compliant and reliable operations.
Plant	5. Assets	Our plants, facilities, assets and floating systems are fit for purposes throughout the lifecycle of the operation.
	6. Optimisation	Our operations area continuously optimised to improve performance and delivery from our assets.

Performance	7. Privilege to Operate	We deliver what is promised and address issues raised by our key stakeholders, including regulators.
	8. Results	Measurement is used to understand and sustain performance.

7.1.1 Element 3 – Risk: Risk Assessment and Management

BP's Risk Assessment and Management process is detailed under Sub-Element 3.1 and BP's Impact Management process is detailed under Sub-Element 3.6 of the BP OMS. These processes supports the management of HSSE risks and aligns with the methodology described in Section 4 of this EP. Additional risk assessments must be undertaken if the Management of Change Process (Section 7.1.2) is triggered. Risk assessments are undertaken in accordance with this process.

This Risk Assessment and Management process and the Management of Change Process (Section 7.1.2) are the management system measures used to demonstrate the requirements of Regulation 14(3)(a) that impacts and risks of this activity continue to be identified and reduced to ALARP.

7.1.2 Element 4 – Procedures: Management of Change

The BP Management of Change (MoC) process is detailed under Sub-Element 4.2 of the BP OMS. This process aims to identify potential hazards and impacts when a permanent, temporary, or emergency change in 'people', 'plant', or 'process' is undertaken or a 'deviation' occurs.

1. People changes shall include changes to personnel, organisation structure, or roles and responsibilities that could lead to a loss of knowledge, experience, or continuity.
2. Process changes shall include changes to approved, controlled documents.
3. Plant changes shall include changes to existing equipment, or deviation from either the documented design or operating limits.
4. Deviation changes are a specific type of change, where change is needed to a BP Practice or Specification.

Potential impacts arising from the change or deviation shall be risk assessed and reviewed prior to the change or deviation being 'approved' in the final step of the MoC process. The process also requires BP to implement a method to monitor compliance with legal and regulatory requirements.

The process outlines requirements and guidance around who should be involved in verifying, reviewing, approving and authorising an MoC, and how any changes should be communicated to the affected workforce. The process includes the following tasks:

- Reviewer – verify the risk level after assessment using risk management tools; evaluate adherence to HSSE policies, practices, processes and procedures; assist in the identification of proposed changes that could conflict with any legal requirements and notify the appropriate parties to act accordingly.
- Approver – verify whether a comprehensive risk assessment has been conducted and that mitigating actions have been identified and documented.
- Authoriser – Assure the appropriate level of management has participated in the Verification Risk Assessment and Review stages, and that this is documented within the MoC system.

Following this MoC process, BP will ensure that any relevant changes are communicated to key stakeholders, which can include the Regulatory Compliance & Environment Lead, who will assess the proposed change against regulatory requirements, regulatory documents, internal policies and procedures and the project risk assessment register. Specifically, the assessment will focus on whether the proposed change:

- Is considered to represent a new activity (from that described in Section 2.3)
- Is considered to represent a significant modification to, or a new stage of, an existing activity (from that described in Section 2.3)
- Will create a significant new environmental impact or risk that is not provided for in the current EP
- Will result in a series of new (or increased) environmental impacts or risks that, together, will result in a significant new environmental impact or risk, or a significant increase in an existing environmental impact or risk.

Based on the outcome of the assessment, should the proposed change trigger a requirement to revise the EP and/or OPEP under Regulation 17 of the OPGGS(E)R, the updated EP and/or OPEP will be submitted to NOPSEMA for acceptance.

Third party service providers are expected to have internal MoC procedures to address changes to equipment, procedures, and material owned by the third-party service provider and changes to their personnel. In the event of changes to third party-owned equipment installed on a drilling rig, it is the third-party contractors' MoC that is used to address these changes. For instances in which installed equipment is to be removed from the rig or changed out, the drilling contractor's MoC procedure is normally used to manage the change.

Changes proposed through third party MoC would require BP sign-off if there is a possibility that performance outcomes and standards listed in the EP are not met.

In extenuating circumstances (i.e. COVID-19 Pandemic), further engagement with NOPSEMA may be required to evaluate the scale of changes to an activity or proposed management measures/performance standards listed in this EP triggered from COVID-19 related measures and restrictions. In accordance with NOPSEMA Compliance Strategy COVID-19 Pandemic Policy (N-00000-PL1907), BP will follow the process identified in Table 7-2 to determine whether engagement with NOPSEMA following completion of the management of change process is required. .

Table 7-2: Triggers for NOPSEMA Engagement in the Management of Change Process in Extenuating Circumstances

Assessed Change	MoC process criteria for	Relevant activity	MoC Mechanism	NOPSEMA Engagement	Timeframes
Minor	Change does not result in a material change to intent of measures described in approval document	All petroleum facilities and activities	BP MoC process	No	N/A
Moderate	Change does not result in the occurrence of any significant new impact or risk, or significant	All petroleum	BP MoC process	Yes, seek guidance on nature of the	N/A

	increase in any existing impact or risk described in approval document	facilities and activities		change and proposed control measures	
	Change does not result in the occurrence of any significant new impact or risk, or significant increase in any existing impact or risk described in approval document	Facilities or activities providing essential services*	Regulatory exemption to act in a different manner to that described in ana approval document	Yes, seek approval of relevant ENVID assessment and MoC documentation	ASAP (<7 days)
Significant	Change results in significant new impact or risk, or significant increase in an existing impact or risk described in approval document	All facilities and activities	Revisions and resubmissions of relevant approval document	Yes, seek acceptance of revised approval document	ASAP (<30 days) for essential services* Within statutory timeframes for all other facilities or activities

*What constitutes "essential service" in contributing to, or maintaining energy needs in the short and medium term will be informed by advice from relevant Government agencies

7.1.3 Element 4 – Procedures: Incident Notification, Investigation and Reporting

BP's incident notification process is detailed under Sub-Element 4.4 of the BP OMS. This process, as applied to this activity, describes how BP reports and investigates incidents.

The process includes:

- The contractor will verbally notify BP personnel of any work incident as soon as practicable. The contractor will report and investigate all incidents related to work, including near misses.
    - In the event work is stopped due to occurrence of a high potential Near Miss or Major incident, work will not resume without BP's approval.
- BP will determine if BP personnel or the contractor personnel will lead the incident investigation.
- If the contractor leads the incident investigation, the contractor will:
    - Document the scope, limitations, plan and team members and submit to BP Personnel for endorsement prior to commencement of the investigation
    - Track progress of the investigation to ensure completion of the investigation and resulting actions
    - Ensure HSSE learnings from investigations are appropriately captured
    - Communicate the status of investigations, findings, conclusions, root causes and recommendations to BP through the course of the investigation.

The contractor will analyse results of incident investigations at determined intervals, if necessary, to identify trends in immediate and system causes. BP will ensure that the contractor will have a contact distribution list, timing and method for reporting incidents to BP.

BP's database for incident action tracking (IRIS) will be used to progress reporting and escalation during the Ironbark-1 exploration drilling program.

7.1.4 Element 7 – Privilege to Operate: Regulatory Compliance

BP's Sub-Element 7.1 Regulatory Compliance establishes and implements operational controls needed to accomplish the identified compliance tasks.

Continual monitoring of Health, Safety and Environment (HSE) legislation is conducted, including new or updated legislation, which can include plans of management (or similar) under the EPBC Act. Legislative changes are proactively assessed based on their nature and scale to ensure that potential business impacts are understood and effectively managed, and that HSE permits and controls remain fit-for-purpose.

7.1.5 Element 7 – Privilege to Operate: Community and Stakeholder Relationships

BP's Communities and Stakeholder Relationships process is detailed under Sub-Element 7.2 of the BP OMS. This process systematically identifies stakeholders and plans and executes engagement to foster mutual understanding, dialogue, and trust.

In accordance with Regulation 14(9) of the OPGGS(E)R, Section 7.11 describes the process undertaken for appropriate consultation with relevant authorities and relevant interested persons or organisations. BP will continue to engage with relevant stakeholders as described in Section 7.11.

7.1.6 Element 8 – Results: Assessment and Audit

BP's Assessment and Audit process is detailed under Sub-Element 8.2 of the BP OMS. This process is used if audit findings identify that activities in the scope of this EP are not being implemented in accordance with the control measures stated in Sections 5 and 6. Sub-Element 8.2 also addresses the establishment of audit programs to verify the effectiveness of controls and the extent to which requirements are met. Routine audits and inspections of activities in the scope of this EP will be undertaken in accordance with the audit program/schedule, which will be regularly reviewed and updated to ensure effective verification of environmental compliance requirements. The audit program/schedule will include the time frames, location, and scope of the audits.

Typically, routine inspections will be worksite-based (such as HSE inspections) and conducted regularly, with the frequency and scope determined by the risk profile of individual sites and activities. Audits will focus on in-field activities (such as site audits) and/or administrative processes (such as desktop audits of relevant information).

The following is a summary of various planned audits:

- Pre-Start Up Reviews – e.g., including drilling, marine, and aviation. An example would include the Rig Verification that considers the design and operating effectiveness of preventative and mitigative barriers to prevent major accident risk events.
- Internal assessments – e.g., Audits, Assurance, Self-verification/Oversights.

  - Self-verification/Oversight – established and led within the project. Includes system and task level and can include all or part of the OMS within the project. Frequency and need is established by upcoming work scope to assess the barrier strengths.
  - Assurance – established and conducted by independent entity (i.e. Safety & Operational Risk) above the project/region.
  - Audits – established and conducted by independent entity (i.e. BP Group Audit) above the project/region.
- Management reviews.
  - Annual performance reviews
  - Monthly Safety and Operational Risk Committee (SORC) reviews
- Independent and external audits (e.g., NOPSEMA, and third-party verifications (e.g. DNV))
- Contractor HSSE self-verification

All findings arising from the Audit, Assurance, and Self-verification process (local, internal, and external) will be used to facilitate continuous improvement of HSE based on the lessons learned and experiences gained from the findings. These findings will allow specific HSE issues to be identified early and corrective actions to be taken, as well as providing an assurance that the BP and its contractors' HSE management systems remain fit for purpose.

Audit protocols and inspection checklists will be followed for all audits and inspections, and actions will be tracked until closure. Audit findings and corrective actions are recorded and tracked in an audit findings tracker or a Joint Action Tracker for timely closure of actions.

Audit findings that identify a breach of an environmental performance outcome or environmental performance standard will be reported in accordance with Section 7.9.

Any suggested changes to activities or control measures arising from audit findings or instances of potential non-compliance will be subject to a management of change in accordance with Section 7.1.2.

7.2 Contractor Management System

BP's OMS defines requirements and practices for working with contractors (Sub-Element 2.5), in particular the requirement for contracts to include clear and consistent information, and specific details of BP's expectations. Contracts are awarded taking into account factors such as safety, technical quality and cost. Contractors and subcontractors shall be required to demonstrate conformance with the requirements that have been established, including HSSE standards and performance requirements. In particular, BP requires that contracted companies have in place a HSE management system that provides a systematic approach for controlling risk, complying with regulatory requirements and continually improving HSE performance.

Contractors are responsible for providing fully certified equipment to the MODU and all vessels that meets their respective class designation including equipment, crews, and HSE management systems and competent personnel to ensure compliance with BP's practices, local regulation, and industry standards.

In addition to BP's OMS, project-specific guidance documents and procedures designed to ensure that full integration and harmonization of HSSE standards, policies, and procedures covering the full scope of the authorized work activity are in place.

Contractors who are defined as responsible for the performance management outcomes and performance standards/controls as listed in this Environment Plan, are obligated to to provide evidence or report incidents and non-compliances to BP on a weekly basis to inform the monthly incident reporting requirements to NOPSEMA (Section 7.9).

Bridging documents are necessary in some cases to define how BP's safety management systems and those of BP's contractors will co-exist to manage impacts and risks of a project. These key interface documents are designed to formally address and manage any gaps or differences between the HSE management systems of the drilling, vessels, or helicopter contractors and the BP policies and procedures. Each bridging document describes in specific detail how contractor's and BP's HSE policies are mapped to act as an interface tool for the control of work and management of applicable hazards and risks to ALARP.

7.3 Chemical Selection Process

The Ironbark-1 chemical selection and usage process is applied to fluids used in drilling operations that are planned or likely to be discharged to the environment, to ensure that the impact of any release is considered acceptable. Any request for the use of new chemical formulations during the drilling activities, or modification or substitution of an existing agreed formulation, is subject to this process.

BP's chemical suppliers will be responsible for ensuring that all substances are registered on the Australian Inventory of Chemical Substances (AICS) before import or use in Australia. Before the import or use of any new substances which are not AICS listed the supplier, who is importing and/or formulating chemical products in Australia, must have notified Australia's National Industrial Chemicals Notification and Assessment Scheme (NICNAS). BP's chemical supplier must also ensure that all substances are registered with NICNAS in their appropriate use categories.

The Ironbark-1 chemical selection and usage process references the CEFAS Offshore Chemical Notification Scheme (OCNS) which evaluates and registers chemical products used offshore by the oil and gas industry in UK and Netherlands waters. Hazard assessment of offshore chemicals is performed on the basis of the OSPAR Harmonised Mandatory Control Scheme. Chemicals are ranked according to their calculated Hazard Quotients by the CHARM (Chemical Hazard Assessment and Risk Management) mathematical model, which uses toxicity, biodegradation and bioaccumulation data provided by suppliers on the HOCNF form. The Hazard Quotient is converted to a colour banding and assessed products are published on Definitive Ranked Lists of Registered Products.

Products not amenable to the CHARM model (i.e. inorganic substances, hydraulic fluids, pipe dopes or chemicals used only in export pipelines with no other applications elsewhere in the hydrocarbon extraction process) are not assigned a colour banding, but assigned a OCNS grouping, A – E based on the Persistence, Bioconcentration and Toxicity data. Group A products are considered to have the greatest hazard potential and Group E the least.

Formulations that have been registered and tested under the UK OCNS are approved for use, providing a 'GOLD' or 'SILVER' [CHARM] and 'E' OR 'D' [non-CHARM] ranking, as they do not represent a significant risk to the environment. Chemicals and formulation constituents on the following lists are also considered approved for use:

i. PLONOR (pose little or no risk to the environment when discharge to sea)

ii. REACH (EC 1907/2006) Annex IV
iii. REACH (EC 1907/2006) Annex V

Chemicals unable to meet the criteria above will be replaced with a suitable alternative where possible. Where well integrity deems it necessary, certain critical chemicals with no viable substitution options may be used if deemed acceptable following an ALARP assessment.

7.4 Incident Management

BP manages incidents resulting from its offshore petroleum activities in accordance with a project specific Incident Management Plan (IMP). The purpose of the IMP is to provide the Incident Management Team (IMT) with the necessary information to respond to any emergency, including hydrocarbon spills. The IMP:

- Describes the emergency notification and management process.
- Details the response process.
- Lists the roles and responsibilities for the IMT members.
- Provides useful resources (e.g. forms, templates) that can be used to store and organise information during an emergency situation.

An Ironbark Exploration Drilling Program specific IMP will be prepared prior to the commencement of the drilling activities. Incidents relevant to this EP are spill events that may result from the Ironbark Exploration Drilling Program. In order to manage these potential spill events, BP has prepared an Oil Pollution Emergency Plan (OPEP) which will be implemented in accordance with BP's Operating Management System (OMS). The OPEP is provided in Appendix D and summarised in Section 7.5 below.

7.5 Oil Pollution Emergency Plan

Regulation 14(8) of the OPGGS (E) Regulations 2009 requires the implementation strategy to contain an OPEP and the provision for the OPEP to be updated. A summary of the regulatory requirements and a reference to where the obligations are met is provided below. The OPEP is presented in Appendix D.

In accordance with Regulation 14 (8AA) of the OPGGS (E) Regulations 2009, the OPEP must include arrangements to respond to and monitor oil pollution, including:

- The control measures necessary for a timely response to an oil pollution emergency (Table 2-1 and Table 2-2 of the OPEP, and the controls provided in Section 6.5 of this EP).
- The arrangements and response capability to implement a timely implementation of those controls, including ongoing maintenance of that capability (Section 7.5.3 of this EP and Section 8 of the OPEP).
- The arrangements and capability for monitoring the effectiveness of the controls and ensuring that performance standards for those controls are met (Sections 3.2 and 3.3 of the OSMP).
- The arrangements and capability for monitoring oil pollution to inform response activities (refer to OPEP (Appendix D) and Operational and Scientific Monitoring Program (Appendix E).
- The provision for the OPEP to be updated (Section 7.5.1).

7.5.1 Review of OPEP

The OPEP should be reviewed internally at least annually, in addition, the OPEP will be reviewed under the following circumstances:

- Prior to undertaking a new activity not currently provided for, and prior to the submission or re-submission of a new Environment Plan for activities, in accordance with the MoC process.
- Following any exercises or other means of testing of the arrangements, as required, to capture learnings.
- Following activation, to capture lessons learned.

Changes to the OPEP or the OSMP resulting from exercise outcomes, altered contractual arrangements, corrective actions, routine information updates (i.e. contact details change), or other items will be managed as per the MoC process.

7.5.2 Testing Arrangements

In accordance with Regulation 14 (8A) & (8C) of the OPGGS(E)R, the response arrangements will be tested:

- When they are introduced;
- When they are significantly amended;
- Not later than 12 months after the most recent test;
- If a new location for the activity is added to the EP after the response arrangements have been tested, and before the next test is conducted – testing the response arrangement in relation to the new location as soon as practicable after it is added to the plan; and
- If a facility becomes operational after the response arrangements have been tested and before the next test is conducted – testing the response arrangements in relation to the facility when it becomes operational.

As required by the Environment Regulation 14(8A), the testing must relate to the nature and scale of the risk of oil pollution relevant to this exploration drilling activity.

BP will conduct a series of tabletop and functional training and exercises to test/validate the OPEP and contractor ERPs and SOPEPs for emergency response scenarios detailed in Section 6.5 (refer to Table 8-2 of OPEP). The Training and Exercise Program is anticipated to begin in Q1 2020 and will continue throughout the duration of the program. The Loss of Well Control Exercise is expected to occur in Q3 2020 (approx. 2 months prior to earliest spud date).

A summary of testing arrangements appropriate to the nature and scale of BP's activities are included in Table 7-3. For further details on the outline of the oil spill response–related training and exercise elements planned for the Ironbark-1 Exploration Drilling Program, refer to Section 8.3.2 of the OPEP.

Table 7-3: OPEP Testing Schedule Summary

Test/Exercise	Timeframe/Activity Phase
Tabletop Exercise – Activation of IMT **Activation of IMT, ICP setup, scenarios may include notifications, security, medivac, de-manning**	Q2 2020 / Prior to activity and ongoing until activity completion (MODU sail-away).
Tabletop Exercise – Source Control	Q3 2020 / Prior to activity and ongoing until activity completion (MODU sail-away).

Source control branch (Sunbury-based with/Perth support) each focused on aspect of source control – ROV intervention, capping stack, relief well support mechanisms including Source Control	
Tabletop Exercise – Loss of Well Control **Multi-faceted command- post exercise, with participation of Perth IMT, MRT & Source Control Teams, and relevant external support (AMOSC/OSRL etc.) and Agencies based on WCD scenario.** **Includes life/safety and source control/spill response aspects with intervening tabletops and training**	Q3 2020 / Ongoing if changes to the OPEP have been made.

7.5.3 Equipment Maintenance and Inspection

Up-to-date information about the location, quantity, and specifications of all response equipment is maintained by the equipment owners and monitored by BP. Oil spill response equipment is stored and maintained in accordance with manufacturers' specifications, and regular inspections are undertaken by the equipment owner and verified by BP in accordance with BP's OMS.

7.6 Operational Scientific Monitoring Program

The OSMP (Appendix E; Document Reference AU001-HS-PLN-600-00003) provides a flexible framework for defining environmental monitoring requirements and implementation. The OSMP allows monitoring to be adapted to the nature and scale of the emergency spill event.

The OSMP provides clear initiation triggers for the individual components for the operational or scientific monitoring scopes based upon activation of the Emergency Response Organisation and/or results from monitoring and surveillance techniques.

The framework for the OSMP is based on a series of oil spill sensitivity maps that identify ecological receptors and socioeconomic and heritage features along the Western Australian coastline compiled by the Department of Transport (2017).

The OSMP components include a range of different studies that directly and indirectly reflect the particular values and sensitivities associated with this EP. Table 2-2 in the OSMP identifies the particular values and sensitivities identified within this EP with the impacts and risks associated with the emergency events, and how these relate to the specific components of the OSMP.

The components of the OSMP cater to all particular values and sensitivities with the potential to be affected by an emergency event, and the initiation triggers are clearly integrated and linked with the OPEP; therefore, the OSMP is considered appropriate for the emergency events described in this EP.

7.7 Roles and Responsibilities

7.7.1 Chain of Command

In accordance with Regulation 14(4) of the OPGGS(E)R, a clear chain of command for the implementation of the drilling program is outlined in Figure 7-2.

BP has overall accountability for compliance with all commitments made under the regulatory authorization process. As contractors perform the majority of the “hands on work”, contractor oversight and management is paramount. Through contracting, BP will assess that adequate HSE oversight is in place at all project work sites (including the MODU) to ensure that contractors are able to comply with applicable legal and regulatory obligations. During the execution of operations, should any gaps in HSE oversight or competency be identified, BP will ensure that gaps are addressed.

The provision of operational HSE oversight, relating to the drilling operation and MODU, is shared between the BP Wells Superintendent (based in Perth) and the offshore BP Well Site Leader. Specific roles and responsibilities are described in the applicable job descriptions. The BP Well Site Leader has the primary responsibility of performing and verifying that the day-to-day operational integrity and HSE oversight activity is conducted on-board, in accordance with the MODUs International Association of Drilling Contractors (IADC) HSE Plan and this implementation strategy.

The provision of environmental aspects of HSE oversight by BP on the stand-by and supply vessels is the responsibility of the BP Global Operations Organisation Marine Team Lead with specific roles and responsibilities described in the applicable logistics bridging document and the BP-contractor bridging documents and the applicable operator HSE cases.

The provision of environmental aspects of HSE oversight for offshore aviation activity will be performed by the project BP Aviation Team Lead, who is responsible for HSE and compliance. This role includes internal inspection and assurance activity.

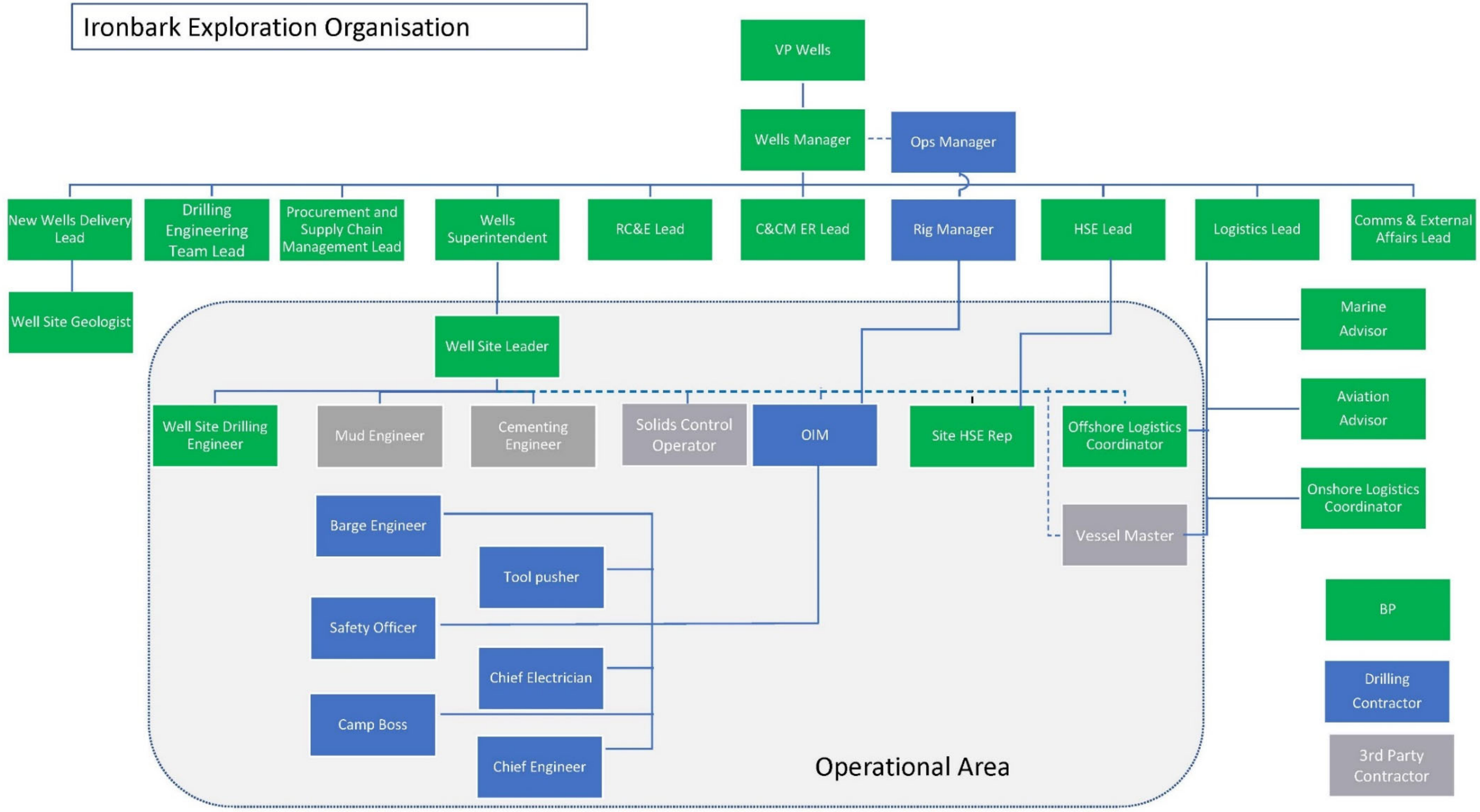


Figure 7-2: Chain of Command

7.7.2 Roles and Responsibilities

Detailed key roles and responsibilities are listed and described in Table 7-4.

Table 7-4: Key Roles and Responsibilities

Role	Responsibilities
BP Wells Manager	Senior person responsible for the operational execution of the project and the adherence to EP control measures. Accountable for ensuring Health, Safety, Security, & Environmental Management Systems are fully implemented and effective, providing input on strategy development for each project deliverable, sanctioning the manpower, and resources necessary for implementation of the EP control measures and holding personnel accountable for its implementation and continued maintenance.
BP Wells Superintendent	Responsible for the day-to-day execution of drilling operations and offshore activity and compliance with the EP.
BP Well Site Leader	Offshore BP single point of contact who provides assurance that contractors are working to stated environmental policies and objectives. Responsible for ensuring environmental corrective and preventative actions are applicable and followed up in a timely manner.
BP Functional Team Leaders	The "Leaders/Leads" of teams responsible for familiarizing themselves with the EP and applicable bridging documents and communicating the specific requirements applicable to their subordinate team members and contractors, while ensuring that all HSE performance objectives and deliverables are achieved. Responsible for ensuring compliance with the requirements of the EP and operating authorization conditions to the extent applicable within their respective functional teams.
BP Regulatory Compliance & Environment Lead	Responsible for developing, maintaining, and amending the EP as needed and directly corresponding plans associated with the EP.
BP Crisis and Continuity Management/Emergency Response Lead	Responsible for developing, maintaining, and amending the IMP, OPEP and OSMP as needed and directly corresponding plans associated with the IMP.
BP Communication and External Affairs Lead	Responsible for developing and maintaining stakeholder engagement in preparation for and throughout the drilling campaign.
Site HSE Representation	HSE resources will be deployed as needed to support the safe execution of the project work activity. These resources will focus specifically on the implementation and integration of contractor and site HSE management systems and tools and conformity to project bridging arrangements designed to meet the requirements and intent of the EP.
Contractors	All Contractors are responsible for familiarizing themselves with the relevant BP EP control measures and emergency procedures and any other applicable HSE reference or guidance documents for their specific site and operations. Workers will be orientated by front-line HSE leads and supervisors during project kick-off, orientation, and induction activities to ensure that BP's HSE objectives are fully understood and maintained at all times. All BP contractors, service companies, and third parties are required to conduct work activity in accordance with the requirements of this plan and the specific documents referenced herein.

7.7.3 Environmental Awareness

In accordance with Regulation 14 (5) of the OPGGS(E)R, each employee responsible for the implementation of task-specific control measures during operational activities shall be aware of their specific responsibilities detailed in this EP. People who hold responsibilities relating to the implementation of this EP are hired by BP on the basis of their particular qualifications, experience, and competency.

The responsibilities identified in this EP are summarised in Table 7-4. Personnel with specific responsibilities under this EP were included during the internal review of this EP and are made aware of their role-specific responsibilities under this EP. Table 7-5 details the inductions required to be undertaken by responsible personnel.

Table 7-5: Inductions

Induction	Required Personnel	Induction Scope
Environment Plan Roll-out	Personnel with specific responsibilities under this EP (Table 7-4)	Plan-specific environmental roll-out covering requirements in this EP, including roles and responsibilities outlined in Table 7-4.
OPEP/OSMP Roll-out	Personnel with specific responsibilities under the OPEP/OSMP (OPEP Table 8-2; OSMP Table 2-6)	Plan-specific roll-out covering requirements in the OPEP and OSMP, including roles and responsibilities outlined in OPEP Table 8-2; OSMP Table 2-6.
Program Induction	Ironbark-1 exploration crew	All MODU and support vessel crews, including subcontractors, will attend an induction that includes an overview of this EP. This induction fosters environmental stewardship amongst all personnel and ensures that they are aware of the control measures implemented to minimise the potential impact on the environment, before commencing operations. The induction will include: • Awareness of BP’s Health, Safety, Security and Environment (HSSE) Policy, • An overview of environmental sensitivities, and key risks from the activity, • An outline of the control measures in this EP to achieve the environmental performance outcomes, • Incident reporting requirements, • Incident response arrangements.

7.8 Monitoring

Regulation 14(7) of the OPGGS(E)R requires that the implementation strategy provides for sufficient monitoring of, and maintaining a quantitative record of, emissions and discharges such that a record can be used to assess whether the environmental performance outcomes and standards in the EP are being met.

Planned emissions and discharges associated with this petroleum activity are assessed in Section 5 and includes requirements regarding environmental monitoring. Discharges and emissions are quantified wherever practicable and the relevant environmental performance outcomes and standards ensures continuous improvement is achieved. The impacts associated with discharges and emissions have been assessed in Section 5 as lower level impacts where impact severity levels have been ranked "Negligible" or "Minor".

In the event of an emergency event resulting in an unplanned release to the environment, BP will implement the OSMP (Section 7.6). This OSMP is identified as a control measure in Section 6.4.4and 6.4.5. The OSMP describes a program of monitoring, and is the principal tool for determining the extent, severity, and persistence of environmental impacts from an emergency condition and the emergency response activities to be undertaken by BP.

In addition to the results of environmental monitoring, all documents and records relating to the petroleum activity will be retained by BP for a minimum of five years in accordance with the BP document retention policy.

7.9 Recording and Reporting

Element 4 (Procedures) of the OMS requires that BP records and reports environmental incidents. There are also obligations under Part 3 of the OPGGS(E) to report incidents and non-compliances to NOPSEMA within a specified time period.

7.9.1 Incident Reporting

Environmental incidents will be reported by BP in accordance with Table 7-6.

Table 7-6: Incident Reporting

Recordable Incident Reporting – Regulation 26B	
Legislative definition of 'recordable incident': *'Recordable incident, for an activity, means a breach of an environmental performance outcome or environmental performance standard, in the environment plan that applies to the activity, that is not a reportable incident'* **Recordable incidents are breaches of environmental performance outcomes and standards.**	
Reporting Requirements	**Report to / Timing**
Written notification to NOPSEMA by the 15th of each month **As a minimum, the written incident report must describe:** • **The incidents and all material facts and circumstances concerning the incidents.** • **Any actions taken to avoid or mitigate any adverse environmental impacts.** • **Any corrective actions already taken, or that may be taken, to prevent a repeat of similar incidents.** • **If no recordable incidents occur during the reporting month, a 'nil report' will be submitted.**	Submit written report to NOPSEMA by the 15th of each month.
Reportable Incident Reporting – Regulation 26, 26A and 26AA	
Legislative definition of 'reportable incident': ***'Reportable incident, for an activity means an incident relating to an activity that has caused, or has the potential to cause an adverse environmental impact; and under the environmental risk assessment process the environmental impact is categorised as moderate to significant environmental damage.'***	

Therefore, reportable incidents under this EP are those unplanned events that have a moderate or greater impact severity (or risk) level. In accordance with this definition, the reportable incidents identified under this EP are: • **Introduction of Invasive Marine Species (Section 6.3),** • **Failure of Slip Joint Packer / Unplanned Riser Disconnect (Section 6.4.3),** • **Vessel Collision (Section 6.4.4), and** • **Total Loss of Well Control Event (Section 6.4.5).**	
Reporting Requirements	**Report to / Timing**
Verbal or written notification must be undertaken within two hours of the incident or as soon as practicable. **This information is required:** • **The incident and all material facts and circumstances known at the time,** • **Any actions taken to avoid or mitigate any adverse environmental impacts.**	Report verbally to NOPSEMA within two hours or as soon as practicable and provide written record of notification by email. Phone: (08) 6461 7090 Email: submissions@nopsema.gov.au
Verbal notifications must be followed by a written report as soon as practicable, and not later than 3 days following the incident. **At a minimum, the written incident report will include:** • **The incident and all material facts and circumstances,** • **Actions taken to avoid or mitigate any adverse environmental impacts,** • **Any corrective actions already taken, or that may be taken, to prevent a recurrence.** **If the initial notification of the reportable incident was verbal, this information must be included in the written report.**	Written report to be provided to NOPSEMA, the National Offshore Petroleum Titles Authority, and the WA Department of Mines, Industry Regulation and Safety. Email: submissions@nopsema.gov.au Email: info@nopta.gov.au Email: petroleum.environment@dmp.wa.gov.au
Additional Reporting Requirements	
Reporting Requirements	**Report to**
Death or injury to individual(s) from an EPBC Act Listed Species as a result of the petroleum activities	Report injury to or mortality of EPBC Act Listed Threatened or Migratory species within seven business days of observation to DAWE or equivalent: Phone: +61 2 6274 1111 Email: EPBC.Permits@environment.gov.au
Vessel collision with marine mammals (whales)	Reported as soon as practicable. https://data.marinemammals.gov.au/report/shipstrike
Presence of any suspected marine pest or disease within 24 hours	DPIRD by email (mailto:biosecurity@fish.wa.gov.au) or phone via the FishWatch 24 hour hotline on 1800 815 507.
Identification of any historic shipwrecks or relics	Written notification provided to the Western Australian Museum – Maritime Archaeology Department, within one week.

	Email: reception@museum.wa.gov.au
Oil exposure to AMPs as a result of an oil spill	The Director of National Parks is to be aware of the oil spill likely to impact an AMP as soon as possible. Report to Director of National Parks through notification to the Marine Park Compliance Duty Officer 0419 293 465.
Oil exposure to the Ningaloo Coast World Heritage Property as a result of an oil spill	Ningaloo Coast WHA Executive Officer is to be aware of the oil spill likely to impact the Ningaloo Coast World Heritage Property as soon as possible. Ningaloo Coast WHA Executive Officer C/- Department of Biodiversity, Conservation and Attractions – Parks and Wildlife Service PO Box 201 Exmouth WA 6707 Tel: 08 9947 8000 Email: exmouth@dpaw.wa.gov.au

7.9.2 Routine Reporting

Regulation 26C of the OPGGS(E)R requires the reporting of environmental performance of this EP. This is described in Table 7-7.

Table 7-7: Routine External Reporting Requirements

Reporting Requirement	Description	Reporting to	Timing
Environmental performance reporting (annual)	A report detailing environmental performance of the activity detailed in this EP	NOPSEMA submissions@nopsema.gov.au Phone: +61 8 6461 7090	Annually from commencement of activities.
Notification of start and end of activity	BP shall complete Form (FM1405) and submit to NOPSEMA 10 days before activity commencement	NOPSEMA Submissions NOPSEMA GPO Box 2568 PERTH 6001 Western Australia https://securefile@nopsema.gov.au/ filedrop/submissions	One-off (10 days before activity commencement)
End of EP Notification	BP shall complete Form (FM1405) and submit to NOPSEMA within 10 days of activity completion		One-off (10 days after activity completion)

7.10 Environment Plan Review

Revisions and/or resubmission of this EP to NOPSEMA will be undertaken in accordance with Regulation 17 of the OPGGS(E)R. If revisions and/or resubmittal of the EP is necessary, BP's OMS Sub-Element 4.2 Management of Change (Section 7.1.2) will be utilised.

In addition to this, the oil spill response arrangements (Section 7.4) will be subject to review where learnings arise from the exercise completed under this plan, or any other exercise conducted by BP over the course of this activity where learnings are deemed relevant.

The Description of Environment (Section 3) will be reviewed annually to include any relevant changes to source documents, which may include State/Federal Management Plans, Recovery Plans, EPBC status or new published research, in case of a delayed start of the drilling program. Any suggested changes to the description of environment or risk assessment arising from this review will be subject to a management of change in accordance with Section 7.1.2.

Prior to commencement of the activity, BP will complete a gap assessment of commitments made in the EP, OPEP and OSMP against current applicable COVID-19 Industry protocols, documenting required contingencies, where required, to ensure that the environmental performance outcomes, environmental performance standards and other relevant commitments in these documents can be maintained. This will as a minimum include a review of the following:

- Offshore Petroleum Industry- COVID-19 Oil Spill Response and Source Control Service Provider Capability Validation Report
- Disease Management Guideline for Oil Spill Response Personnel
- Australian Upstream Oil & Gas Industry Offshore Protocol

7.11 Stakeholder Engagement

In accordance with BP's OMS Sub-Element 7.2 Community and Stakeholder Relationships process and the requirements of OPGGS(E)R, BP has undertaken stakeholder consultation for this activity as follows:

- Identify relevant stakeholders,
- Provide sufficient information to enable stakeholders to understand how this activity may affect their functions, interests, or activities,
- Assess the merit of any objections or claims raised by stakeholders,
- Provide a response to the objection or claim, and ensure this is provided in this EP**.**

7.11.1 Identify Relevant Stakeholders

In accordance with Regulation 11A(e), BP considers relevant authorities, persons and organisations, etc. are those whose functions, interests or activities may be affected by the activity. Such that any person or organisation with functions, interests or activities within the Operational Area, Hydrocarbon Exposure Area or EMBA are considered relevant for consultation, in addition to those defined in Regulation 11A(a), (b), (c) and (d) (relevant stakeholders).

In the course of preparing the BP Ironbark Exploration Drilling Environment Plan, BP held a workshop to develop BP's 5-Category Stakeholder Consultation Approach.

Category 1 – A person or organisation whose functions, interests or activities may be affected by the activity in the Operational Area.

- Category 1 definition is derived from Regulation 11A(d) and NOPSEMA's Environment plan content requirements (GN1344).
- Operational Area is defined as the environment that may be affected by planned components of the activities and extends for 10.5 km around the indicative well location.

Category 2 – A person or organisation whose functions, interests or activities may be affected by the activity in the Hydrocarbon Exposure Area.

- Category 2 definition is derived from Regulation 11A(d) and GN1344. Such that the Hydrocarbon Exposure Area is defined as the environment that may be affected by the activity used to inform the evaluation of environmental impacts and risks.
- The Hydrocarbon Exposure Area is based on the outcomes of stochastic modelling using moderate/high exposure values for each of the modelled oil components and includes all probabilities of exposure.

Category 3 – A person or organisation whose functions, interests or activities may be affected by the activity in the EMBA.

- Category 3 definition is derived from Regulation 11A(d) and NOPSEMA Bulletin #1. Such that the EMBA is defined as an area where a change to ambient environmental conditions may potentially occur as a result of planned activites or unplanned events.
- The EMBA is based on the cumulative extent of 300 seasonal model simulations using 'low' exposure values for each of the modelled oil components and includes all probabilities of exposure.

Category 4 – Each Department or agency of the Commonwealth or of a State or the Northern Territory to which the activities to be carried out under the EP, or the revision of the environment plan, may be relevant (derived from Regulation 11A(a) and (b)).

Category 5 – The Department of the responsible State Minister, or the responsible Northern Territory Minister (derived from Regulation 11A(c)).

Table 7-8 lists and categorises the relevant stakeholders identified for the BP Ironbark Exploration Drilling activities to be carried out within WA-359-P, and describes the information provided to those stakeholder categories.

Table 7-8: Stakeholders for the BP Ironbark Exploration Drilling Activities

Stakeholder Group	Category	Stakeholder
Government	4	Parks Australia (a division of the DAWE)
	4	DFAT WA
	4	Australian Maritime Safety Authority (AMSA)
	4	Department of Transport – Marine Safety
	4	Department of Biodiversity, Conservation and Attractions (DBCA)
Fishery Associations	4	Australian Fisheries Management Authority (AFMA)
	4	WA Department of Primary Industries and Regional Development (DPIRD)
	4	Commonwealth Fisheries Association (CFA)
	4	Western Australian Fishing Industry Council (WAFIC)
	4	Pearl Producers Association
	4	Professional Specimen Shell Fishermen's Association
	4	Australian Southern Bluefin Tuna Association (ASBTIA)
	2	North-west Slope Trawl Fishery

Stakeholder Group	Category	Stakeholder
Commonwealth Fisheries (only active licence holders in WA)	1	Southern Bluefin Tuna Fishery
	2	Western Deepwater Trawl Fishery
	1	Western Skipjack Fishery
	1	Western Tuna and Billfish Fishery
State Fisheries	3	Shark Bay Blue Swimmer Crab Fishery
	2	Gascoyne Demersal Scalefish Fishery
	2	West Coast Deep Sea Crustacean Fishery
	3	Exmouth Gulf Prawn Fishery
	3	Shark Bay Prawn and Scallop Managed Fisheries
	2	Kimberley Crab and Pilbara Crab (North Coast Crab Fisheries)
	2	Beche-De-Mer (Sea Cucumber) Fishery
	2	Pearl Oyster Fishery
	1	Mackerel Managed Fishery
	1	Pilbara Fish Trawl (Interim) Managed Fishery
	1	Pilbara Trap Managed Fishery
	1	Pilbara Line Fishery
	2	Onslow Prawn Managed Fishery (OPMF)
	2	Nickol Bay Prawn Managed Fishery (NBPMF)
	2	Broome Prawn Managed Fishery (BPMF)
	2	Specimen Shell Managed Fishery (SSMF)
	2	Marine Aquarium Fish Managed Fishery (MAFMF)
	2	Pearl Hatcheries
Shipping	1	Australian Hydrographic Office (AHO) / Commonwealth Department of Defence (DoD)
Industry	2	Oil and Gas Operators
Tourism and Recreation	2	Boating Industry Association WA (BIAWA)
	2	RecFishWest
Other	5	Department of Mines, Industry Regulation and Safety (DMIRS)
	4	Australian Petroleum Production and Exploration Association (APPEA)
	4	National Offshore Petroleum Titles Administrator (NOPTA)
Oil spill response organisations	4	Australian Marine Oil Spill Centre (AMOSC)
	4	OSRL
Conservation Groups	4	International Fund for Animal Welfare

Stakeholder Group	Category	Stakeholder
	4	The Wilderness Society

7.11.2 Provision of Sufficient Information to Stakeholders

Under the NOPSEMA Decision-Making Guideline – Criterion-10A(g) Consultation Requirements (NOPSEMA 2016), sufficient information must be provided to enable stakeholders to understand how this activity may affect their functions, interests, or activities.

Based on the BP 5-Category Stakeholder Consultation Approach, stakeholders are provided with information applicable to their functions, interests or activities which ensures the context provided is meaningful and relevant. BP's stakeholder approach workshop identified the most effective and efficient manner to consult with the identified relevant stakeholders for each category. To ensure that sufficient information was provided to relevant stakeholders, factsheets detailing specific information regarding the activities covered under this EP were sent out at the earliest in August 2019.

Category 1 – Email or letter containing the following relevant information as an attached pamphlet:

- Description of the activity including timeframe and implemented safety zones.
- Summary of potential planned impacts associated with the Operational Area and relevant to the stakeholders.
- Proposed control measures.
- Contact details.

Category 2 – Email or letter containing the following relevant information as an attached detailed factsheet:

- Description of the activity including timeframe and implemented safety zones.
- Summary of potential impacts associated with the Hydrocarbon Exposure Area and relevant to the stakeholders.
- Proposed control measures.
- Contact details.

Category 3 – Email or letter containing the following relevant information as an attached high-level factsheet:

- Description of the activity including timeframe and implemented safety zones.
- Summary of potential impacts associated with the EMBA and relevant to the stakeholders.
- Proposed control measures.
- Contact details.

Category 4 and 5 – Email or letter containing the following relevant information:

- Description of the activity including timeframe and implemented safety zones.
- Proposed control measures.
- Contact details.

Following these fact sheets, additional information has been provided based upon comments, objections and claims from relevant stakeholders.

Copies of the consultation materials are included in Appendix F. Supporting evidence of consultation, including contact details and correspondence have been submitted to NOPSEMA separately as sensitive information.

7.11.3 Sufficient Time Given for Consultation

As part of its consultation process, BP endeavours to allow a reasonable period of time for the stakeholder to review and respond to any information provided, typically two to four weeks. For the Ironbark-1 drilling program, BP commenced consultation early in the EP scoping process, starting in August 2019, which resulted in a period of four months of engagement between BP and identified stakeholders. The EP was subsequently submitted to NOPSEMA for assessment on 19 December 2019, with an additional four weeks where the EP was available for public comment. Since the end of the EP Public Comment period, BP has continued to engage with relevant stakeholders. Timing of stakeholder engagement activities is summarised in Table 7-9.

Table 7-9: Timing of Stakeholder Engagement Activities

Stakeholders	Timing	Information Provided
• **Parks Australia (a division of DoEE)** • **Australian Maritime Safety Authority (AMSA)** • **Department of Transport – Marine Safety** • **Department of Biodiversity, Conservation and Attractions (DBCA)** • **Australian Fisheries Management Authority (AFMA)** • **WA Department of Primary Industries and Regional Development (DPIRD)** • **Commonwealth Fisheries Association (CFA)** • **Australian Hydrographic Office (AHO)** • **RecFish West** • **Department of Mines, Industry, Regulations and Safety (DMIRS)** • **Western Australian Fishing Industry Council (WAFIC)**	13th August 2019	• Email advising of proposed exploration drilling activity and consultation Information Sheet
Pearl Producers Association (PPA)	3rd October 2019	• Follow-up email sent to confirm receipt of information
	13th August 2019	• Email sent advising of proposed exploration drilling activity and consultation Information Sheet
	3rd October 2019	• Follow-up email sent to confirm receipt of information

Stakeholders	Timing	Information Provided
	24th March 2020	• Follow-up email sent with additional information regarding the project.
Boating Industry Association WA (BIAWA)	11th September 2019	• Email sent advising of proposed exploration drilling activity and consultation Information Sheet
	3rd October 2019	• Follow-up email sent to confirm receipt of information
• **International Fund for Animal Welfare** • **Australian Petroleum Production and Exploration Association (APPEA)** • **The Wilderness Society**	16th September	• Email sent advising of proposed exploration drilling activity and consultation Information Sheet
	3rd October 2019	• Follow-up email sent to confirm receipt of information
National Offshore Petroleum Titles Administrator (NOPTA)	31st October 2019	• Email sent advising of proposed exploration drilling activity and consultation Information Sheet
Chevron	16th September 2019	• Email sent advising of proposed exploration drilling activity and consultation Information Sheet.
Woodside	16th September 2019	• Email sent advising of proposed exploration drilling activity and consultation Information Sheet
	3rd October 2019	• Follow-up email sent to confirm receipt of information
DFAT WA	18th November 2019	• Form submitted through DFAT WA website advising of proposed exploration drilling activity and consultation Information Sheet
Australian Southern Bluefin Tuna Association (ASBTIA)	31st October 2019	• Email sent advising of proposed exploration drilling activity and consultation Information Sheet

Stakeholders	Timing	Information Provided
	6th November 2019	• Email sent providing additional information and associated scientific references related to underwater noise.
	18th November 2019	• Follow-up email sent to confirm receipt of information
North-west Slope Trawl Fishery (Austfish Pty Ltd)	19th November 2019	• Category 1 & 2 Information Sheet and pamphlet sent that includes the description of the activity, planned impacts associated with the Operational Area and/or Hydrocarbon Exposure Area, control measures and contact details.
	10th March 2020	• Follow-up correspondence sent to confirm receipt of information
• **North-west Slope Trawl Fishery** • **Southern Bluefin Tuna Fishery Western Deepwater Trawl Fishery** • **Western Tuna and Billfish Fishery**	4th November 2019	• Category 1 & 2 Information Sheet and pamphlet sent that includes the description of the activity, planned impacts associated with the Operational Area and/or Hydrocarbon Exposure Area, control measures and contact details.
	10th March 2020	• Follow-up correspondence sent to confirm receipt of information
• **Pilbara Fish Trawl (Interim Managed Fishery)** • **Pilbara Trap Managed Fishery** • **Pilbara Line Fishery**	29th September 2019	• Category 1 & 2 Information Sheet and pamphlet sent that includes the description of the activity, planned impacts associated with the Operational Area and/or Hydrocarbon Exposure Area, control measures and contact details.
	10th March 2020	• Follow-up correspondence sent to confirm receipt of information

Stakeholders	Timing	Information Provided
• **Shark Bay Blue Swimmer Crab Fishery** • **Gascoyne Demersal Scalefish Fishery Kimberley Crab and Pilbara Crab (North Coast Crab Fisheries)**	6th November 2019	• Category 3 & 4 Information Sheet that includes the description of the activity, planned impacts associated with the EMBA, control measures and contact details
	10th March 2020	• Follow-up correspondence sent to confirm receipt of information
• **Exmouth Gulf Prawn Fishery** • **Shark Bay Prawn and Scallop Managed Fisheries**	8th November	• Category 3 & 4 Information Sheet that includes the description of the activity, planned impacts associated with the EMBA, control measures and contact details
	10th March 2020	• Follow-up correspondence sent to confirm receipt of information
• **Bech-De-Mer- (Sea Cucumber) Fishery**	19th November 2019	• Category 3 & 4 Information Sheet that includes the description of the activity, planned impacts associated with the EMBA, control measures and contact details
	10th March 2020	• Follow-up correspondence sent to confirm receipt of information
• **Nickol Bay Prawn Managed Fishery (NBPMF)** • **Broome Prawn Managed Fishery (BPMF)**	19th November 2019	• Category 1 & 2 Information Sheet and pamphlet sent that includes the description of the activity, planned impacts associated with the Operational Area and/or Hydrocarbon Exposure Area, control measures and contact details.
	10th March 2020	• Follow-up correspondence sent to confirm receipt of information
• **Mackerel Managed Fishery** • **West Coast Deep Sea Crustacean Fishery**	1st March 2020	• Category 3 & 4 Information Sheet that includes the description of the activity, planned impacts

Stakeholders	Timing	Information Provided
• **Onslow Prawn Marine Aquarium Fish Managed Fishery (MAFMF)** • **Specimen Shell Fishery**		associated with the EMBA, control measures and contact details
	25th March 2020	• Follow-up correspondence sent to confirm receipt of information
Australian Marine Oil Spill Centre (AMOSC)	16th September 2019	• Email advising of proposed exploration drilling activity and consultation Information Sheet
Oil Spill Response Limited (OSRL)	31st October 2019	• Email advising of proposed exploration drilling activity and consultation Information Sheet

7.11.4 Assessment of Merit of any Objections or Claims

Table 7-9summarises the objections and claims made by relevant stakeholders, assesses their merits, and describes how each objection or claim is managed in this EP.

7.11.5 Provision of Response to Objections or Claims

Based on the outcomes of the merit assessments, responses to objections and claims (where relevant) were provided to stakeholders.

7.11.6 Ongoing Consultation

From the stakeholder consultation undertaken, the notifications and ongoing consultation required for this activity is captured in Table 7-. If any additional information is identified that results in a significant change to environmental impacts or risks (in accordance with Section 7.1.2) or is considered a material change to information previously provided to stakeholders identified as relevant to this activity, additional consultation will be sought.

Table 7-9: Consultation Summary – Objections or Claims and Assessment of Merits

Stakeholder	Initial contact from BP (Date, Record Number and Information provided)	Objection or Claim	Assessment of Merit	Follow up (Date, Record Number and Information provided)	Further Action Required
Parks Australia (a division of DAWE)	Date: 13/08/2019 Record: PA_01 Information provided: Ironbark Initial General fact sheet	Date: 15/08/2019 Record: PA_02 Request for further information regarding distance to closest marine parks	Approval from the Director of National Parks is required if Petroleum Activity occurs within an Australian Marine Park.	Date: 16/09/2019 Record: PA_03 Information provided: Distance to closest marine parks provided. Date: 03/10/2019 Record: PA_04 Email follow up sent to confirm receipt of information Date: 16/10/2019 Record: PA_05 Stakeholder confirms that no further approval from Director of National Parks is required.	No
DFAT WA	Date: 18/11/2019 Information provided: Ironbark Initial General fact sheet Submitted through DFAT WA website.	No objection or claim raised	N/A	None	No
Australian Maritime Safety Authority (AMSA)	Date: 13/08/2019 Record: AMSA_01 Information provided: Ironbark Initial General fact sheet	Date: 13/08/2019 Record: AMSA_02 AMSA provided communication channels for ongoing consultation with AMSA's Joint Rescue Coordination Centre (JRCC) and the Australian Hydrographic Office (AHO) (Refer to Table 7-9)	BP acknowledge ongoing consultation requirement.	Date: 03/10/2019 Record: AMSA_03 Email follow up sent to confirm receipt of information Date: 04/10/2019 Record: AMSA_04 Acknowledgement of email receipt and informed to communicate through AMSA Connect email address	No further information required to close out EP engagement phase. BP acknowledge ongoing consultation requirement – refer to Table 7- 10
Department of Transport – Marine Safety	Date:13/08/2019 Record: DoT_MS_01 Information provided: Ironbark Initial General fact sheet	Date: 19/02/2020 Record: DoT_MS_05 Requires clarification on the level of consultation undertaken with DOT Date: 10/03/2020 Record: DoT_MS_07 Requests copy of OPEP to be submitted for review. Date: 05/05/2020 Record: DoT_MS_11 DOT confirms requirement to submit OPEP. Date: 04/06/20 Record: DoT_MS_13 DOT issues OPEP review comments and queries.	DOT is a relevant stakeholder for spill response planning purposes	Date: 03/10/2019 Record: DoT_MS_02 Email follow up sent to confirm receipt of information Date: 07/01/2020 Record: DoT_MS_03 Meeting request to discuss response planning Date: 07/01/2020 Record: DoT_MS_04 Confirming availability for meeting to discuss response planning Date: 19/02/2020 Record: DoT_MS_06 BP confirms that DOT has been consulted and participated in a spill response planning exercise meeting. Date: 10/03/2020 Record: DoT_MS_08 BP requests clarification re OPEP submission process. Date: 10/03/2020 Record: DoT_MS_09 DOT confirms consultation process and information requirements. Date: 28/04/2020 Record: DoT_MS_10 BP issues requested information. Date: 14/05/2020 Record: DoT_MS_12 BP issues draft OPEP Date: 07/07/2020 Record: DoT_MS_14 BP issues response to DOT and proposed edits to OPEP	BP acknowledge ongoing consultation requirement – refer to Table 7-10
Department of Biodiversity, Conservation and Attractions (DBCA)	Date: 13/08/2019 Record: DBCA_01 Information provided: Ironbark Initial General fact sheet	No objection or claim raised	N/A	Date: 03/10/2019 Record: DBCA_02 Email follow up sent for confirmation of receipt of information Date: 07/10/2019 Record: DBCA_03	No

Table 7-9: Consultation Summary – Objections or Claims and Assessment of Merits

				No further information required.	
Australian Fisheries Management Authority (AFMA)	Date:13/08/2019 Record: AFMA_01 Information provided: Ironbark Initial General fact sheet	No objection or claim raised	Fisheries licence holder's data reviewed and included in consultation plan.	Date: 03/10/2019: Record: AFMA_02 Email follow up for confirmed receipt of information Date: 31/10/2019: Record: AFMA_03 BP requested contact details of active licence holders for Commonwealth Fisheries operating in WA Date: 31/10/2019 Record: AFMA_04 AFMA supplied link to petroleum industry consultation with the commercial fishing industry information. Date: 31/10/2019 Record: AFMA_05 BP email following up phone call to AFMA, requesting contact information of specific fisheries licence holders. Date: 4/11/2019 Record: AFMA_06 AFMA confirmed there are 40 active fisher licences within fisheries requested. Date: 4/11/2019 Record: AFMA_07 BP confirmed request for contact details of 40 active fisher licences identified by AFMA. Date: 4/11/2019 Record: AFMA_08 AFMA revised advise on number of active fishers in western waters to 24. Date: 4/11/2019 Record: AFMA_09 BP confirmed only requires contact details for active fishers in Western waters of Australia. Date: 04/11/2019 Record: AFMA_10 AFMA supplied the contact information for active fishers in Western water in an attached file: Attachments: AFMA_03_Contact List - BP Australia - Tzila Katzel; and AFMA_03_INVOICE BP Australia - L00271 – Paid	No
WA Department of Primary Industries and Regional Development (DPIRD)	Date: 15/05/2019 Record: DPIRD_00a BP submitted request for entry in, or extract from the register for 9 fisheries. Date: 13/08/2019 Record: DPIRD_01 Information provided: Ironbark Initial General fact sheet	No objection or claim raised	Fisheries licence holder's data reviewed and included in consultation plan.	Date: 20/05/2019 Record DPIRD_00b DPIRD provided details for list of 9 fisheries requested. Attachments: 2019(05)May20 Abalone; 2019(05)May20 Mackerel; 2019(05)May20 Marine Aquarium; 2019(05)May20 Onslow Prawn; 2019(05)May20 Pilbara Fish Trawl; 2019(05)May20 Pilbara Trap; 2019(05)May20 South West Coast Salmon; 2019(05)May20 Specimen Shell; 2019(05)May20 West Coast Deep Sea Crustacean; Receipt. Date: 26/09/2019 Record: DPIRD_02 BP requested contact details of active licence holders for the Pilbara Line Fishery Date: 26/09/2019 Record: DPIRD_03 DPIRD sent a receipt and contacts details requested. Attachments: FBL- Condition Pilbara Line. Date: 03/10/2019 Record: DPIRD_04 BP sent email follow up for confirmed receipt of information Date: 31/10/2019 Record: DPIRD_05 [No Evidence supplied by BP] BP requested contact details of additional active licence holders for WA fisheries. Date: 31/10/2019 Record: DPIRD_06 DPIRD responding to BP request for active fishers contact details to confirm request.	No

Table 7-9: Consultation Summary – Objections or Claims and Assessment of Merits

				Date: 31/10/2019 Record: DPIRD_07 BP provide clarification around contact detail request. Date: 31/10/2019 Record: DPIRD_08 DPIRD confirming there are 9 active fisheries relevant to BP request. Date: 31/10/2019 Record: DPIRD_09 BP confirming 9 active fisheries identified by DPIRD is correct. Date: 01/11/2019 Record: DPIRD_10 DPIRD provided 9 lists of fisheries contract details requests and confirmed that Shark Bay Prawns and Shark Bay scallop fisheries are independent. DPIRD confirming is BP would like Shark Bay Scallop contact details also. DPIRD provides advice for alternative points of contact for Pearl Producers Association consultation. Attachments: Pilbara Crab; Beche De Mer; Broome Prawn; Exmouth Gulf Prawn; Gascoyne Demersal Scalefish; Kimberley Crab; Nichol Bay Prawn; Shark Bay Crab; and Shark Bay Prawn. Date: 04/11/2019 Record: DPIRD_11 BP requests Shark Bay Scallop contact list. Date: 05/11/2019 Record: DPIRD_12 DPIRD IT delay in providing Shark Bay Scallop contact list. Date: 05/11/2019 Record: DPIRD_13 DPIRD provides Shark Bay Scallop contact list. Attachments: Shark Bay Scallop.	
Commonwealth Fisheries Association (CFA)	Date: 13/08/2019 Record: CFA_01 Information provided: Ironbark Initial General fact sheet	No objection or claim raised	N/A	N/A	No
Western Australian Fishing Industry Council (WAFIC)	Date: 13/08/2019 Record: WAFIC_01 Information provided: Ironbark Initial General fact sheet	Date: 13/08/2019 Record: WAFIC_02 WAFIC concern raised over generic approach to engagement with commercial fishers. WAFIC attached their Fee-for-Service Schedule. Date:15/08/2019 Record: WAFIC_4 WAFIC reiterated need for efficient, bespoke consultation and concern with consultation process. Date: 29/01/20 Record: WAFIC_07 WAFIC follow up seeking project updates. Date: 05/02/20 Record: WAFIC_08 WAFIC raised EP consultation process concerns with NOPSEMA. Date: 10/03/20 Record: WAFIC_10 Further concern raised over the form of engagement and process to determine relevance of stakeholders. Date: 17/03/20 Record: WAFIC_12	BP considered the concern raised regarding the process of engagement. Internal BP workshop was held to determine more effective and relevant stakeholder engagement process. Further information regarding the activity and consultation activities undertaken with relevant fisheries was provided. Further concerns raised by WAFIC assessed to diverging view on effectiveness of consultation process, rather than impacts and risks of the activity.	Date: 15/08/2019 Record: WAFIC_03 Acknowledgement of receipt of correspondence. BP confirmed would engage directly with relevant fishers identified through Fishcube data and identified additional opportunities to engage directly through face to face meeting. Date: 15/08/2020 Record: WAFIC_05 BP acknowledged receipt of previous email and stated would consider further points raised by WAFIC. Declined offer for fee-paying consultation service, as against BP's policy. Date: 31/10/2020 Record: WAFIC_06 BP provided additional information about "relevant stakeholder" selection process based on internal BP workshop held to determine more effective and relevant stakeholder engagement process based on WAFIC concerns. Date: 03/03/2020 Record: WAFIC_9 BP offered face to face meeting with WAFIC to resolve concerns. Date: 17/03/20 Record: WAFIC_11 Additional information provided regarding the consultation process and justification for determining relevance of stakeholders. Date: 16/04/20 Record: WAFIC_13 Provided further information in response to list of information request provided by WAFIC. Date: 12/05/2020	Date: 12/05/2020 Record: WAFIC_15 WAFIC acknowledge receipt of email. No further concerns raised. Provided advice on start/finish of activity notification to commercial fishermen.

Table 7-9: Consultation Summary – Objections or Claims and Assessment of Merits

		Further concern raised over the form of engagement and process to determine relevance of stakeholders.		Record: WAFIC_14 Email sent to follow up confirmation of receipt of information	
Pearl Producers Association	Date:13/08/2019 Record: PPA_01 Information provided: Ironbark Initial General fact sheet Date:13/08/2019 Record: PPA_02 Information provided: Ironbark Initial General fact sheet	No objection or claim raised	N/A	Date: 03/10/2019 Record: PPA_03 Email sent to follow up confirmation of receipt of information Date: 24/03/2020 Record: PPA_04 Email sent to follow up confirmation of receipt of information	No
Australian Southern Bluefin Tuna Association (ASBTIA)	Date: 31/10/2019 Record: ASBTIA_01 Following phone call to ASBTIA, BP information provided: Ironbark Initial General fact sheet.	Date: 05/11/2019 Record: ASBTIA_02 Concern raised regarding impact of underwater sound	BP considered the request for further information on impacts from u/w sound emissions.	Date: 06/11/2019 Record: ASBTIA_03 BP provided excerpt from the EP underwater sound emissions section via email. Date: 18/11/2019 Record: ASBTIA_04 Email sent to follow up confirmation of receipt of information	Date: 19/11/2019 Record: ASBTIA_05 Concluding email from ASBTIA received. No further action required
North-west Slope Trawl Fishery (active licence holders)	Fishery: Austfish Pty Ltd. Date: 19/11/2019 Record: AUSTFISH_01 Refer to Commonwealth individual fishers contact details Information provided: Ironbark Commercial Fisheries Categ 1 & 2 fact sheet Sent via Australia Post express mail	No objection or claim raised	N/A	Date: 10/03/2020 Record: AUSTFISH_02 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Fishery: Seafresh Holdings Pty Ltd. Date: 04/11/2019 Record: SEAFRESH_FABRON_01 Refer to Commonwealth individual fishers contact details. Information provided: Ironbark Commercial Fisheries Categ 1 & 2 fact sheet	No objection or claim raised	N/A	Date: 19/11/2019 Record: SEAFRESH_FABRON_02 Sent via Australia Post express mail a follow up for confirmed receipt of information Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Fishery: Seafresh Holdings Pty Ltd. & Fabron Holdings Pty Ltd Date: 04/11/2019 Record: SEAFRESH_FABRON_01 Refer to Commonwealth individual fishers contact details Information provided: Ironbark Commercial Fisheries Categ 1 & 2 fact sheet	No objection or claim raised	N/A	Date: 19/11/2019 Record: SEAFRESH_FABRON_02 Sent via Australia Post express mail a follow up for confirmed receipt of information Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Fishery: WA Seafood Exporters Pty Ltd. Date:04/11/2019 Record: WA_SEAFOOD_EXPORTERS_01 Refer to Commonwealth individual fishers contact details Information provided: Ironbark Commercial Fisheries Categ 1 & 2 fact sheet	No objection or claim raised	N/A	Date: 10/03/2020 Record: WA_SEAFOOD_EXPORTERS_02 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
Southern Bluefin Tuna Fishery (active licence holders)	Fishery: Australian Fishing Enterprises Pty Ltd. Date: 04/11/2019 Record: AUS_FISHING_ENTERPRISES_01 Refer to Commonwealth individual fishers contact details Information provided: Ironbark Commercial Fisheries Categ 1 & 2 fact sheet	No objection or claim raised	N/A	Date: 19/11/2019 Record: AUS_FISHING_ENTERPRISES_02 Email sent to follow up confirmation of receipt of information Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Fishery: Australian Tuna Fisheries Pty Ltd Date: 04/11/2019 Record: AUS_TUNA_01 Refer to Commonwealth individual fishers contact details Information provided: Ironbark Commercial Fisheries Categ 1 & 2 fact sheet	No objection or claim raised	N/A	Date: 19/11/2019 Record: AUS_TUNA_02 Email sent to follow up confirmation of receipt of information Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Fishery: Blaslov Fishing Pty Ltd. Date: 04/11/2019 Record: BLASLOV_01 Refer to Commonwealth individual fishers contact details	No objection or claim raised	N/A	Date: 28/02/2020 Record: BLASLOV_02 Email sent to follow up confirmation of receipt of information Date: 10/03/2020	No

Table 7-9: Consultation Summary – Objections or Claims and Assessment of Merits

	Information provided: Ironbark Commercial Fisheries Categ 1 & 2 fact sheet			Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	
	Fishery: Christopher G. Hansen Date: 04/11/2019 Record: CHRISTOPHER_G_HANSEN_01 Refer to Commonwealth individual fishers contact details Information provided: Ironbark Commercial Fisheries Categ 1 & 2 fact sheet	No objection or claim raised	N/A	Date: 28/02/2020 Record: CHRISTOPHER_G_HANSEN_02 Email sent to follow up confirmation of receipt of information Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Fishery: Fina K Pty Ltd. Date: 04/11/2019 Record: FINA_K_01 Refer to Commonwealth individual fishers contact details Information provided: Ironbark Commercial Fisheries Categ 1 & 2 fact sheet	No objection or claim raised	N/A	Date: 19/11/2019 Record: FINA_K_02 Email sent to follow up confirmation of receipt of information Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Fishery: Lukin Fisheries Pty Ltd. Date: 04/11/2019 Record: LUKIN_01 Refer to Commonwealth individual fishers contact details Information provided: Ironbark Commercial Fisheries Categ 1 & 2 fact sheet	No objection or claim raised	N/A	Date: 19/11/2019 Record: LUKIN_02 Email sent to follow up confirmation of receipt of information Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Fishery: Markane Seafoods Pty Ltd. Date: 04/11/2019 Record: MARKANE_01 Refer to Commonwealth individual fishers contact details Information provided: Ironbark Commercial Fisheries Categ 1 & 2 fact sheet	No objection or claim raised	N/A	Date: 19/11/2019 Record: MARKANE_02 Email sent to follow up confirmation of receipt of information Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Fishery: Marnikol Fisheries Pty Ltd. Date: 04/11/2019 Record: MARNIKOL_01 Refer to Commonwealth individual fishers contact details Information provided: Ironbark Commercial Fisheries Categ 1 & 2 fact sheet	No objection or claim raised	N/A	Date: 19/11/2019 Record: MARNIKOL_02 Email sent to follow up confirmation of receipt of information Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Fishery: Morris L & Christine M Wolf Date: 04/11/2019 Record: MORRIS_CHRISTINE_WOLF_01 Refer to Commonwealth individual fishers contact details Information provided: Ironbark Commercial Fisheries Categ 1 & 2 fact sheet	No objection or claim raised	N/A	Date: 19/11/2019 Record: MORRIS_CHRISTINE_WOLF_02 Email sent to follow up confirmation of receipt of information Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Fishery: Nils J Bush Date: 04/11/2019 Record: NILS_BUSH_01 Refer to Commonwealth individual fishers contact details Information provided: Ironbark Commercial Fisheries Categ 1 & 2 fact sheet	No objection or claim raised	N/A	Date: 19/11/2019 Record: NILS_BUSH_02 Email sent to follow up confirmation of receipt of information Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Fishery: R & R Hobart Investments Pty Ltd. Date: 04/11/2019 Record: R&R_INVESTMENTS_01 Refer to Commonwealth individual fishers contact details Information provided: Ironbark Commercial Fisheries Categ 1 & 2 fact sheet	No objection or claim raised	N/A	Date: 19/11/2019 Record: R&R_INVESTMENTS_02 Email sent to follow up confirmation of receipt of information Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Fishery: Ross H Haldane Date: 04/11/2019 Record: ROSS_H_HALDANE_01 Refer to Commonwealth individual fishers contact details Information provided: Ironbark Commercial Fisheries Categ 1 & 2 fact sheet	No objection or claim raised	N/A	Date: 19/11/2019 Record: ROSS_H_HALDANE_02 Email sent to follow up confirmation of receipt of information Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Fishery: Sarine Marine Date: 04/11/2019 Record: SARINE_MARINE_FARM_01	No objection or claim raised	N/A	Date: 19/11/2019 Record: SARINE_MARINE_FARM_02 Email sent to follow up confirmation of receipt of information	No

Table 7-9: Consultation Summary – Objections or Claims and Assessment of Merits

	Refer to Commonwealth individual fishers contact details Information provided: Ironbark Commercial Fisheries Categ 1 & 2 fact sheet			Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	
	Fishery: Stehr Group Pty Ltd. Date: 04/11/2019 Record: STEHR_01 Refer to Commonwealth individual fishers contact details Information provided: Ironbark Commercial Fisheries Categ 1 & 2 fact sheet	No objection or claim raised	N/A	Date: 19/11/2019 Record: STEHR_02 Email sent to follow up confirmation of receipt of information Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Fishery: Tony's Tuna International Pty Ltd. Date: 04/11/2019 Record: TONY_TUNA_01 Refer to Commonwealth individual fishers contact details Information provided: Ironbark Commercial Fisheries Categ 1 & 2 fact sheet	No objection or claim raised	N/A	Date: 19/11/2019 Record: TONY_TUNA_02 Email sent to follow up confirmation of receipt of information Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Fishery: Tuna Farmers Pty Ltd. Date: 04/11/2019 Record: TUNA_FARMERS_01 Refer to Commonwealth individual fishers contact details Information provided: Ironbark Commer Commercial Fisheries Categ 1 & 2 fact sheet	No objection or claim raised	N/A	Date: 19/11/2019 Record: TUNA_FARMERS_02 Email sent to follow up confirmation of receipt of information Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
Western Deepwater Trawl Fishery (active licence holders)	Fishery: Seafresh Holdings Pty Ltd. Date: 04/11/2019 Record: SEAFRESH_FABRON_01 Refer to Commonwealth individual fishers contact details Information provided: Ironbark Commercial Fisheries Categ 1 & 2 fact sheet	No objection or claim raised	N/A	Date: 19/11/2019 Record: SEAFRESH_FABRON_02 Sent via Australia Post express mail a follow up for confirmed receipt of information Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Fishery: Seafresh Holdings Pty Ltd. & Fabron Holdings Pty Ltd Date: 04/11/2019 Record: SEAFRESH_FABRON_01 Refer to Commonwealth individual fishers contact details Information provided: Ironbark Commercial Fisheries Categ 1 & 2 fact sheet	No objection or claim raised	N/A	Date: 19/11/2019 Record: SEAFRESH_FABRON_02 Sent via Australia Post express mail a follow up for confirmed receipt of information Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
Western Tuna and Billfish Fishery (active licence holders)	Fishery: Best of Boat Worlds Pty Ltd. Date: 04/11/2019 Record: BEST_BOAT_WORLDS_01 Refer to Commonwealth individual fishers contact details Information provided: Ironbark Commercial Fisheries Categ 1 & 2 fact sheet	No objection or claim raised	N/A	Date: 19/11/2019 Record: BEST_BOAT_WORLDS_02 Email sent to follow up confirmation of receipt of information Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Fishery: Marellen Pty Ltd. Date: 04/11/2019 Record: MARELLEN_01 Refer to Commonwealth individual fishers contact details Information provided: Ironbark Commercial Fisheries Categ 1 & 2 fact sheet	No objection or claim raised	N/A	Date: 19/11/2019 Record: MARELLEN_02 Email sent to follow up confirmation of receipt of information Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Fishery: Raymond W. Davies Date: 04/11/2019 Record: RAYMOND_W_DAVIES_01 Refer to Commonwealth individual fishers contact details Information provided: Ironbark Commercial Fisheries Category 1 & 2 fact sheet	No objection or claim raised	N/A	Date: 19/11/2019 Record: RAYMOND_W_DAVIES_02 Email sent to follow up confirmation of receipt of information Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Fishery: Uptop Fisheries Pty Ltd. Date: 04/11/2019 Record: UPTOP_FISHERIES_01 Refer to Commonwealth individual fishers contact details Information provided: Ironbark Commercial Fisheries Category 1 & 2 fact sheet.	No objection or claim raised	N/A	Date: 19/11/2019 Record: UPTOP_FISHERIES_02 Email sent to follow up confirmation of receipt of information Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No

Table 7-9: Consultation Summary – Objections or Claims and Assessment of Merits

Shark Bay Blue Swimmer Crab Fishery	Licence holders: Bayana Pty Ltd Date: 06/11/2019 Record: BAYANA_01 Information Provided: Ironbark fact sheet Category 3 & 4 Refer to record reference DPIRD_10_Extract Enquiry for fishery contact. Sent via Australia Post express mail	No objection or claim raised	N/A	Date: 10/03/2020 Information Provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Licence holders: Sea Harvest Fishing Company Pty Ltd. Date: 06/11/2019 Record: SEA_HARVEST_ FISHING_01 Information provided: Ironbark fact sheet Category 3 & 4 Refer to record reference DPIRD_10_Extract Enquiry for fishery contact. Sent via Australia Post express mail	No objection or claim raised	N/A	Date: 10/03/2020 Information Provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Licence holders: Correia Fishing CO (WA) Pty Ltd. Date: 06/11/2019 Record: CORREIA_FISHING_01 Information Provided: Ironbark fact sheet Category 3 & 4 Refer to record reference DPIRD_10_Extract Enquiry for fishery contact. Sent via Australia Post express mail	No objection or claim raised	N/A	Date: 10/03/2020 Information Provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Licence holders: Far West Scallops Industries P/L. Date: 06/11/2019 Record: FAR_WEST_SCALLOPS_01 Information provided: Ironbark fact sheet Category 3 & 4 Refer to record reference DPIRD_10_Extract Enquiry for fishery contact. Sent via Australia Post express mail	No objection or claim raised	N/A	Date: 10/03/2020 Information Provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Licence holders: CSBS Fishing Pty Ltd. Date: 06/11/2019 Record: CSBS_FISHING_01 Information provided: Ironbark fact sheet Category 3 & 4 Refer to record reference DPIRD_10_Extract Enquiry for fishery contact. Sent via Australia Post express mail	No objection or claim raised	N/A	Date: 10/03/2020 Information Provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Licence holders: Puresea Investments Pty Ltd. Date: 06/11/2019 Record: PURESEA_INVESTMENTS_01 Information provided: Ironbark fact sheet Category 3 & 4 Refer to record reference DPIRD_10_Extract Enquiry for fishery contact. Sent via Australia Post express mail	No objection or claim raised	N/A	Date: 10/03/2020 Information Provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Licence holders: Laburnum Pty Ltd. Date: 06/11/2019 Record: LABURNUM_01 Information provided: Ironbark fact sheet Category 3 & 4 Refer to record reference DPIRD_10_Extract Enquiry for fishery contact. Sent via Australia Post express mail	No objection or claim raised	N/A	Date: 10/03/2020 Information Provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	Licence holders: Seafresh Holdings Pty Ltd. & Fabron Holdings Pty Ltd. Date: 06/11/2019 Information provided: Ironbark Commercial Fisheries Category 1 & 2 fact sheet. Refer to record reference DPIRD_10 & SEAFRESH_FABRON_01 Sent via Australia Post express mail	No objection or claim raised	N/A	Date: 19/11/2019 Record: SEAFRESH_FABRON_02 Sent via Australia Post express mail a follow up for confirmed receipt of information Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
Gascoyne Demersal Scalefish Fishery	Date: 06/11/2019	No objection or claim raised	N/A	Date: 10/03/2020 Information Provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No

Table 7-9: Consultation Summary – Objections or Claims and Assessment of Merits

	Information provided: Ironbark Category 1&2 letter template& Ironbark Commercial Fisheries Category 1 & 2 fact sheet. Refer to record reference DPIRD_10 Sent via Australia Post express mail				
Exmouth Gulf Prawn Fishery	Date: 04/11/2019 Record: MARELLEN_01 Information Provided: Ironbark Category 1&2 letter template& Ironbark Commercial Fisheries Category 1 & 2 fact sheet. Refer to record reference DPIRD_04.	No objection or claim raised	N/A	Date: 19/11/2019 Record: MARELLEN_02 Email sent to follow up confirmation of receipt of information Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
Shark Bay Prawn and Scallop Managed Fisheries	Date: 08/11/2019 Information provided: Ironbark Exploration Drilling letter Category 3 and Ironbark fact sheet Category 3 & 4. Refer to record reference DPIRD_10 & DPIRD_13 for fishery contact. Sent via Australia Post express mail	No objection or claim raised	N/A	Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
Kimberley Crab and Pilbara Crab (North Coast Crab Fisheries)	License holder: Cervan Marine Pty Ltd. Date: 06/11/2019 Record: CERVAN_MARINE_01 Information provided: Ironbark fact sheet Category 3 & 4 Refer to record reference DPIRD_10_Extract Enquiry for fishery contact. Sent via Australia Post express mail	No objection or claim raised	N/A	Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	License holder: Alan John Fraser. Date: 06/11/2019 Record: Mr_Alan_Fraser_01 Information provided: Ironbark fact sheet Category 3 & 4 Refer to record reference DPIRD_10. Sent via Australia Post express mail	No objection or claim raised	N/A	Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	License holder: Robert George Mcintosh Date: 06/11/2019 Record: Mr_ Robert_Mcintosh_01 Information provided: Ironbark fact sheet Category 3 & 4 Refer to record reference DPIRD_10. Sent via Australia Post express mail	No objection or claim raised	N/A	Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
	License holder: Paul Merendino Date: 28/02/2020 Record: Mr_ Paul_Merendino_01 Information provided: Ironbark Category 1&2 letter template& Ironbark Commercial Fisheries Category 1 & 2 fact sheet. Refer to record reference DPIRD_10. Sent via Australia Post express mail	No objection or claim raised	N/A	Date: 01/04/2020 Telephone call to confirm receipt of information. BP received confirmation that information was received and no further follow up required.	No
Beche-De-Mer (Sea Cucumber) Fishery	Date: 19/11/2019 Information provided: Ironbark Category 1&2 letter template& Ironbark Commercial Fisheries Category 1 & 2 fact sheet. Refer to record reference DPIRD_10. Sent via Australia Post express mail.	No objection or claim raised	N/A	Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
Pearl Oyster Fishery ***Secretariat by PPA/WAFIC***	Refer to PPA and WAFIC consultation				
Pilbara Fish Trawl (Interim) Managed Fishery	Date: 29/09/2019 Information provided: Ironbark Category 1&2 letter template & Ironbark Commercial Fisheries Category 1 & 2 fact sheet. Refer to record reference DPIRD_00b Sent via Australia Post express mail	No objection or claim raised	N/A	Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
Pilbara Trap Managed Fishery	Date: 10/12/2019 DPIRD supply public register for licence holders (eight companies). Refer to record reference DPIRD_00b	No objection or claim raised	N/A	Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No

Table 7-9: Consultation Summary – Objections or Claims and Assessment of Merits

	Date: 29/09/2019 Information provided: Ironbark Category 1&2 letter template & Ironbark Commercial Fisheries Category 1 & 2 fact sheet. Sent via Australia Post express mail				
Pilbara Line Fishery	Date: 29/09/2019 Information provided: Ironbark Category 1&2 letter template& Ironbark Commercial Fisheries Category 1 & 2 fact sheet. Refer to record reference DPIRD_10 Sent via Australia Post express mail	No objection or claim raised	N/A	Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
Nickol Bay Prawn Managed Fishery (NBPMF)	Date: 19/11/2019 Information provided: Ironbark Category 1&2 letter template & Ironbark Commercial Fisheries Category 1 & 2 fact sheet. Refer to record reference DPIRD_10 Sent via Australia Post express mail	No objection or claim raised	N/A	Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
Broome Prawn Managed Fishery (BPMF)	Date: 19/11/2019 Information provided: Ironbark Category 1&2 letter template & Ironbark Commercial Fisheries Category 1 & 2 fact sheet. Refer to record reference DPIRD_10 Sent via Australia Post express mail	No objection or claim raised	N/A	Date: 10/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
West Coast Deep Sea Crustacean Fishery	Date: 01/03/2020 Information provided: Ironbark information sheet 5 Refer to record references DPIRD_00b Sent via Australia Post express mail	No objection or claim raised	N/A	Date: 25/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
Mackerel Managed Fishery	Date: 01/03/2020 Information provided: Ironbark information sheet Category 5 Refer to record references DPIRD_00b	No objection or claim raised	N/A	Date: 25/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
Onslow Prawn	Date: 01/03/2020 Information provided: Ironbark information sheet 5 Refer to record references DPIRD_00b Sent via Australia Post express mail	No objection or claim raised	N/A	Date: 25/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
Marine Aquarium Fish Managed Fishery (MAFMF)	Date: 01/03/2020 Information provided: Ironbark information sheet 5 Refer to record references DPIRD_00b Sent via Australia Post express mail	No objection or claim raised	N/A	Date: 25/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
Specimen Shell Fishery	Date: 01/03/2020 Information provided: Ironbark information sheet 5 Refer to record references DPIRD_00b Sent via Australia Post express mail	No objection or claim raised	N/A	Date: 25/03/2020 Information provided: Ironbark follow up letter & Ironbark Information sheet 5 Sent via Australia Post express mail a follow up for confirmed receipt of information	No
Pearl Hatcheries (Secretariated by WAFIC and PPA)	Refer to PPA and WAFIC consultation				
Australian Hydrographic Office (AHO) / Commonwealth Department of Defence (DoD)	Date: 13/08/2019: Record: AHO_DoD_01 Information provided: Ironbark Initial General fact sheet	No objection or claim raised. Confirmation received of receipt of factsheet, direction to use AMSA Connect for notifications	N/A	Date: 13/08/2019 Record: AHO_DoD_02 Acknowledgement that email was received Date: 03/10/2019 Record: AHO_DoD_03 Email sent to follow up confirmation of receipt of information	No
Chevron	Date: 16/09/2019 Record: CHEVRON_01 Information provided: Ironbark Initial General fact sheet	No objection or claim raised	N/A	N/A	No
Woodside	Date: 16/09/2019 Record: WOODSIDE_01 Information provided: Ironbark Initial General fact sheet	No objection or claim raised	N/A	Date: 03/10/2019 Record: WOODSIDE_02 Email sent to follow up confirmation of receipt of information Date: 04/10/2019 Record: WOODSIDE_03	No

Table 7-9: Consultation Summary – Objections or Claims and Assessment of Merits

				Confirmed no comments	
Boating Industry Association WA (BIAWA)	Date: 11/09/2019 Record: BIAWA_01 Information provided: Ironbark Initial General fact sheet	No objection or claim raised	N/A	Date: 03/10/2019 Record: BIAWA_02 Email sent to follow up confirmation of receipt of information	No
RecFishWest	Date: 13/08/2019 Record: RECFW_01 Information provided: Ironbark Initial General fact sheet	No objection or claim raised	N/A	Date: 03/10/2019 Record: RECFW_02 Email sent to follow up confirmation of receipt of information	No
Department of Mines, Industry Regulation and Safety (DMIRS)	Date: 13/08/2019 Record: DMIRS_01 Information provided: Ironbark Initial General fact sheet	No objection or claim raised	N/A	Date: 03/10/2019: Record: DMIRS_02 Email sent to follow up confirmation of receipt of information	No
Australian Petroleum Production and Exploration Association (APPEA)	Date: 16/09/2019 Record: APPEA_01 Information provided: Ironbark Initial General fact sheet	No objection or claim raised	N/A	Date: 16/09/2019 Record: APPEA_02 APPEA agreed to share the email with the right contacts within their organisation. Date: 16/09/2019 Record: APPEA_03 Acknowledgement sent	No
National Offshore Petroleum Titles Administrator (NOPTA)	Date: 31/10/2019 Record: NOPTA_01 Information provided: Ironbark Initial General fact sheet	No objection or claim raised	N/A	N/A	No
Australian Marine Oil Spill Centre (AMOSC)	Date: 16/09/2019 Record: AMOSC_01 Information provided: Ironbark Initial General fact sheet	Date: 25/09/2019 Record: AMOSC_02 Request for meeting face to face to discuss project	AMOSC is a relevant stakeholder for spill response planning purposes	Date: 25/09/2019 Record: AMOSC_03 Response to meeting request Meeting held with WA Manager	No
Oil Spill Response Limited (OSRL)	Date: 31/10/2019 Record: OSRL_01 Information provided: Ironbark Initial General fact sheet	No objection or claim raised	N/A	N/A	No
International Fund for Animal Welfare	Date: 16/09/2019 Record: IFAW_01 Information provided: Ironbark Initial General fact sheet	No objection or claim raised	N/A	Date: 03/10/2019 Record: IFAW_02 Email sent to follow up confirmation of receipt of information	No
The Wilderness Society	Date: 16/09/2019: Record: WS_01 Information provided: Ironbark Initial General fact sheet Date: 17/09/2019: Record: WS_02 Information provided: Ironbark Initial General fact sheet	No objection or claim raised	N/A	Date: 03/10/2019 Record: WS_03 Email sent to follow up confirmation of receipt of information	No

Table 7-10: Ongoing Consultation Requirements

Stakeholder	Additional Requirements	Timing
AMSA	Notify AMSA's Joint Rescue Coordination Centre (JRCC) through rccaus@amsa.gov.au<mailto:rccaus@amsa.gov.au> (Phone: 1800 641 792 or +61 2 6230 6811) for promulgation of radio-navigation warnings	24-48 hours before operations commence
	Contact the Australian Hydrographic Office at datacentre@hydro.gov.au<mailto:datacentre@hydro.gov.au> with the details related to the operations. The AHO will promulgate the appropriate Notice to Mariners (NTM), to ensure other vessels are informed of BP drilling activities.	No less than four working weeks before operations
Department of Transport	Follow up with Emergency Response Branch to ensure transboundary arrangements described within OPEP have been successfully tested.	As per OPEP testing schedule
Commercial fishermen notifications	Issue activity start and end notifications to fishermen as requested by WAFIC	Start and end of Activity

8 References

Adam P. 1990. Saltmarsh Ecology. Cambridge University Press, Cambridge

Adam P, 2002. Rarity, rare plant species and the New South Wales Threatened Species Conservation Act - conservation opportunities and challenges., *Cunninghamia*, vol. 7, pp. 651 - 669

Alldredge, A., Elias, M. & Gotschalkt, C. 1986. Effects of drilling muds and mud additives on the primary production of natural assemblages of marine phytoplankton. Published by the Marine Environmental Research, 19(2), 157-176.

Almeda, R., Baca, S., Hyatt, C., Buskey E.J. 2014. Ingestion and sublethal effects of physically and chemically dispersed crude oil on marine planktonic copepods. Ecotoxicology, 23 (2014), pp. 988-1003

American Chemistry Council. 2006. A Comparison of the Environmental Performance of Olefin and Paraffin Synthetic Base Fluids (SBF).

AMSA. 2019. Map showing the Ironbark-A well and Survey Area Offshore Dampier WA, with AIS Data (November 2018 to January 2019).

Andriguetto-Filho JM, Ostrensky A, Pie MR, Silva UA and Boeger, WA. 2005. Evaluating the impact of seismic prospecting on artisanal shrimp fisheries. Continental Shelf Research 25(14): 1720-1727.

Austin, M., Hannay, D. & Broker, K. 2018. Acoustic characterization of exploration drilling in the Chuckchi and Beaufort seas. Published by the Journal of the Acoustical Society of America. 144(1): 115-123. DOI: 10.1121/1.5044417

Austin, M., Hannay, D. & Quijano, J. 2018. Composite underwater noise footprint of a shallow artic exploration drilling project. Published by IEE Journal of Oceanic Engineering. PP(99): 1-12. DOI: 10.1109/JOE.2018.2858606

Austin, M., Hannay, D. & Quijano, J. 2018. Spatio- temporal modelling of underwater noise related to an artic exploration drilling program. Published by the Journal of the Acoustical Society of America, 144(3): 1733-1733. DOI: 10.1121/1.5067686

Australian Maritime Safety Authority (AMSA). 2011. Biofouling and in-water cleaning- marine notice 9/17. Published by the Australian Government, AMSA.

Australian Maritime Safety Authority (AMSA). 2013. Australian Supplement to Guidelines for Offshore Marine Operations. Published by the Australian Government.

Australian Maritime Safety Authority (AMSA). 2013b. The Effects of Maritime Oil Spills on Wildlife Including Non-avian Marine Life, Vol. 2013. Canberra: Australian Maritime Safety Authority

Baker, C., Potter, A., Tran, M. and Heap, A.D., 2008. Geomorphology and Sedimentology of the Northwest Marine Region of Australia. Geoscience Australia, Record 2008/07. Geoscience Australia, Canberra. 220pp.

Beckley L. E., Muhling B.A., and Gaughan, D.J. 2009. Larval fishes off Western Australia: influence of the Leeuwin Current. Journal of the Royal Society of Western Australia 92, 101–109

Bennelongia (2009). Ecological Character Description for Roebuck Bay. Report to the Department of Environment and Conservation. Bennelongia Pty Ltd, Jolimont.

Black, K.P., Brand, G.W., Grynberg, H., Gwyther, D., Hammond, L.S., Mourtikas, S., Richardson, B.J. and Wardrop, J.A. 1994. Production facilities. In: Environmental implications of offshore oil and gas

Black, S., Willing, T & Dureau, D. 2010. A comprehensive survey of the flora, extent and condition of Vine Thickets on coastal sand dunes of Dampier Peninsula, West Kimberley 2000-2002. Prepared for the Broome Botanical Society, Broome

BP. 2010. BP releases report on causes of Gulf of Mexico tragedy. Published by BP.

BP. 2013. Shah Deniz 2 Project. Environmental & Socio-Economic Impact Assessment. BP Development Pty Ltd. https://www.bp.com/en_az/caspian/sustainability/environment/ESIA.html

Branch, T. A., Matsuoka, K. and Miyashita, T. 2004. Evidence for increases in Antarctic blue whales based on Bayesian modelling. Marine Mammal Science 20(4): 726-754.

Brewer, D.T., Lyne, V., Skewes, T.D., and Rothlisberg, P. 2007. Trophic Systems of the North West Marine Region. Report to The Department of the Environment and Water Resources. CSIRO Cleveland. 156 pp

Butcher, R., and Hale, J., 2010, Ecological Character Description for The Dales Ramsar Site. Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Burke, C. & Veil, J. 1995. Potential environmental benefits from regulatory consideration of synthetic drilling muds. Published by the environmental assessment division, argonne national laboratory.

Carroll AG, Przeslawski R, Duncan A, Gunning M and Bruce B, 2017. A critical review of the potential impacts of marine seismic surveys on fish and invertebrates. Marine Pollution Bulletin 114: 9-24.

Carruthers, TJB, Dennison, WC, Kendrick, G, Waycott, M, Walker, DI & Cambridge, M, 2007. Seagrasses of south west Australia: a conceptual synthesis of the world's most diverse and extensive seagrass meadows. Journal of Experimental Marine Biology & Ecology, 350: 21-45.

Cecere J.G., Calabrese L., Rocamora G., Catoni C., 2013. Movement Patterns and Habitat Selection of Wedge-tailed Shearwaters (Puffinus pacificus) Breeding at Aride Island, Seychelles. Available online at: https://bioone.org/journals/waterbirds/volume-36/issue-4/063.036.0414/Movement-Patterns-and-Habitat-Selection-of-Wedge-tailed-Shearwaters-Puffinus/10.1675/063.036.0414.full

Centre for Environment, Fisheries and Aquaculture Science (CEFAS). 2019. OSPAR list of substances used and discharged offshore which are considered to pose little or no risk to the environment (PLONOR). Published by the OSPAR Commission.

Commander DP. 1988. Geology and hydrogeology of the superficial formations and coastal lakes between Harvey and Leschenault inlets (Lake Clifton Project). Western Australian Geological Survey Professional Papers. Report No. 23, 37-50.

Commonwealth of Australia. 2015. Conservation Management Plan for the Blue Whale. Available from: https://www.environment.gov.au/system/files/resources/9c058c02-afd1 -4e5d-abff-11cac2ebc486/files/blue-whale-conservation-management-plan.pdf.

Commonwealth of Australia. 2017. Recovery for Marine Turtles in Australia. Available at http://www.environment.gov.au/system/files/resources/46eedcfc-204b-43de-99c5-4d6f6e72704f/files/recovery-plan-marine-turtles-2017.pdf

Cowles, Timothy & F. Remillard, J. 1983. Effects of exposure to sublethal concentrations of crude oil on the copepod Centropages hamatus - I. Feeding and egg production. Marine Biology. 78. 45-51. 10.1007/BF00392970.

Crawford, R., Davis, S., Harding, R., Jackson, L., Leshoro, T., Meyer, M., Randall. R., Underhill, L., Upfold, L., Van Dalsen, A., Van der Merwe, E., Whittington, P., Williams, A. & Wolfaardt, A. 2000. Initial impact of the treasure oil spill on seabirds off Western South Africa. Volume 22, Published by African Journal of Marine Science.

Commonwealth of Australia (CoA). 2017. Recovery Plan for Marine Turtles in Australia. Department of the Environemnt and Energy https://www.environment.gov.au/marine/publications/recovery-plan-marine-turtles-australia-2017

CSIRO. 2017. Cape Grim Greenhouse Gas Data. Available from: http://www.csiro.au/greenhousegases.

Dalen, J, Ona, E, Soldal, AV & Saetre, R. 1996. Seismic investigations at sea: an evaluation of consequences for fish and fisheries. Institute of Marine Research, Fisken og Havet, 9: 26 pp.

Day RD, McCauley RM, Fitzgibbon QP, Hartmann K, Semmens JM. 2016. Assessing the impact of marine seismic surveys on southeast Australian scallop and lobster fisheries. Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania

DBCA. 2017. Pilbara Inshore Islands Nature Reserves. Parks and Wildlife Services, Department of Biodiversity, Conservation and Attractions. Government of Western Australia. https://parks.dpaw.wa.gov.au/park/pilbara-inshore-islands

Department of Agriculture and Water Resources (DAWE). 2017. Australian Ballast Water Management Requirements. Available online at: http://www.agriculture.gov.au/biosecurity/avm/vessels/ballast/australian-ballast-water-management-requirements

Department of Conservation and Land Management (CALM). 2005. Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area 2005 – 2015. Department of Conservation and Land Management.

Department of Environment and Conservation (DEC). 2011. Sedgelands in Holocene dune swales: Interim recovery plan 2011-2016. Published by Department of Environment and Conservation Species and Communities Branch.

Department of the Environment and Energy (DotEE). 2017. Species Profile and Threats Database: Rhincodon typus — Whale Shark. http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=66680

Department of Primary Industries and Regional Development (DPIRD). 2018. Marine aquarium fish resource of Western Australia, Harvest Strategy 2018-2022, version 1.0. Published by DPIRD. Available from: http://www.fish.wa.gov.au/Documents/management_papers/fmp292.pdf

Department of Sustainability, Environment, Water Population and Communities (DSEWPAC). 2013. Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies – Significant impact guidelines 1.2: Environment Protection and Biodiversity Conservation Act 1999. Department of Sustainability, Environment, Water Population and Communities, Canberra, Australian Capital Territory. Available from: http://www.environment.gov.au/system/files/resources/a0af2153-29dc-453c-8f04-3de35bca5264/files/commonwealth-guidelines_1.pdf

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). 2012. Species group report card—dugongs: supporting the marine bioregional plan for the North Marine Region. Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT.

Department of the Environment, Water, Heritage and the Arts (DEWHA). 2008a. The north-west marine bioregional plan: bioregional profile. Department of the Environment, Water, Heritage and the Arts, Canberra.

Department of the environment, water, heritage and the arts (DEWHA). 2008b. EPBC Act Policy Statement 2.1- Interaction between offshore seismic exploration and whales. Published by DEWHA.

Department of Transport (DoT). 2017. DOT307215 Provision of Western Australian Marine Oil Pollution Risk Assessment- Protection Priorities: Protection Priority Assessment for Zone 3: Midwest. Published by the Department of Transport. https://www.transport.wa.gov.au/mediaFiles/marine/MAC_P_DOT307215_MidwestProtectionPriorities.pdf

Dernie, K. M., Kaiser, M. J., & Warwick, R. M. 2003. Recovery rates of benthic communities following physical disturbance. *Journal of Animal Ecology*, *72*(6), 1043-1056.

Dernie, K. M., Kaiser, M. J., Richardson, E. A., & Warwick, R. M. 2003. Recovery of soft sediment communities and habitats following physical disturbance. *Journal of Experimental Marine Biology and Ecology*, *285*, 415-434.

DFO. 2004. Review of Scientific Information on Impacts of Seismic Sound on Fish, Invertebrates, Marine Turtles and Marine Mammals. Canadian Science Advisory Secretariat (CSAS), Habitat Status Report 2004/002, Department of Fisheries and Oceans (DFO), Canada. 15 pp.http://www.dfo-mpo.gc.ca/csas/Csas/status/2004/HSR2004_002_e.pdf

Donovan, A, Brewer, D, van der Velde, T & Skewes, T. 2008. Scientific descriptions of four selected key ecological features (key ecological features) in the North-west Bioregion: final report, report to the Australian Government Department of Environment, Water Heritage and the Arts, CSIRO Marine and Atmospheric Research, Cleveland.

Double, M.C., V. Andrews-Goff, K.C.S. Jenner, M.-N. Jenner, S.M. Laverick, T.A. Branch & N.J. Gales. 2014. Migratory movements of pygmy blue whales (Balaenoptera musculus brevicauda) between Australia and Indonesia as revealed by satellite telemetry. *PloS one*. 9:e93578

DSEWPC. 2011b. Background Paper. Population Status and Threats to Albatrosses and Giant Petrels Listed as Threatened under the Environment Protection and Biodiversity Conservation Act 1999. Department of Sustainability, Environment, Water, Population and Communities. Australian Antarctic Division. Hobart.

Duncan, A. J. and Parsons, M. J.G. 2011. How wrong can you be? Can a simple spreading formula be used to predict worst-case underwater sound levels?, in D.J. Mee and I.D.M. Hillock (ed), Proceedings of Acoustics 2011: Breaking New Ground, Nov 2-4 2011, pp. 1-8. Gold Coast, Qld.: Australian Acoustical Society.

Dunlop, R., Noad, M., McCauley, R., Kniest, E, Slade, R., Paton, D. & Cato, D. 2017. The behavioural response of migrating humpback whales to a full seismic airgun array. Published by the Royal Society. https://doi.org/10.1098/rspb.2017.1901

EA. 2002. Blue whale migration and recognised aggregation areas mapping. Environment Australia. Canberra.

Fairweather P. 2011. Saltmarshes. In: Scientific Working Group (2011). The vulnerability of coastal and marine habitats in South Australia. Marine Parks, Department of Environment, Water and Natural Resources South Australia.

Faulkner, R., Farcas, A. and Merchant, N. 2018. Guiding principles for assessing the impact of underwater noise. Journal of Applied Ecology. Available online at: https://doi.org/10.1111/1365-2664.13161

Fewtrell, J. L. and McCauley, R. D. 2012. Impact of air gun noise on the behaviour of marine fish and squid. Marine Pollution Bulletin 64 (2012) 984–993.

Fields, DM, Handegard, NO, Dalen, J , Eichner, C , Malde, K, Karlsen, Ø, Skiftsvik, A Durif, C. & Browman, H. 2019. Airgun blast used in marine seismic surveys have limited effects on mortality, and no sublethal effects on behaviour or gene expression, in the copepod *Calanus finmarchicus.* Published y ICES Journal of Marine Science. https://doi.org/10.1093/icesjms/fsz126

Fodrie, F. J., Able, K. W., Galvez, F., Heck Jr, K. L., Jensen, O. P., López-Duarte, P. C., & Whitehead, A. 2014. Integrating organismal and population responses of estuarine fishes in Macondo spill research. *BioScience*, *64*(9), 778-788.

Forrest, B. M., Gardner, J. P., & Taylor, M. D. 2009. Internal borders for managing invasive marine species. *Journal of Applied Ecology*, *46*(1), 46-54.

Fotheringham, D. O. U. G., & Coleman, P. E. R. I. 2008. Salt marshes. *Natural History of Gulf St Vincent. Royal Society of South Australia Inc., Adelaide*, 81-94.

Fraker, M. 2013. Killer whale (*Orcinus orca)* Deaths in Prince William Sound, Alaska, 1985-1990. Published by Human and ecological risk assessment: an international journal, 19(1): 28-52.

French McCay, D.P. 2004. Oil spill impact modeling: Development and validation. Environmental Toxicology and Chemistry 23(10):2441–2456.

Froend, R., Loomes, R. Horwitz, P., Bertuch, M., Storey, A. and Bamford, M. 2004. Study of Ecological Water Requirements on the Gnangara and Jandakot Mounds under Section 46 of the Environmental Protection Act. Task 2: Determination of Ecological Water Requirements. Report prepared for the Water and Rivers Commission by Centre for Ecosystem Management, ECU, Joondalup.

Gage, J.D. 1996. Why are there so many species in deep-sea sediments? J Exp Mar Biol Ecol200:257-286

Gales, N. I. C. K., Double, M. C., Robinson, S. A. R. A. H., Jenner, C. U. R. T., Jenner, M. I. C. H. E. L. I. N. E., King, E. R. I. C., ... & Paton, D. A. V. E. 2010. Satellite tracking of Australian humpback (Megaptera novaeangliae) and pygmy blue whales (Balaenoptera musculus brevicauda). *White paper presented to the Scientific Committee of the International Whaling Commission*. http://www.marinemammals.gov.au/__data/assets/pdf_file/0017/137312/sc-62-sh21.pdf

García-Párraga D, Crespo-Picazo JL, Bernaldo de Quirós Y, Cervera V and others, 2014. *Decompression sickness ('the bends') in sea turtles*. Dis Aquat Org 111:191-205. Accessed 1 April 2019 https://doi.org/10.3354/dao02790

Gavrilov A. N., McCauley R. D., Paskos G., and Alexey G. 2018. Southbound migration corridor of pygmy blue whales off the northwest coast of Australia based on data from ocean bottom seismographs. The Journal of the Acoustical Society of America. https://doi.org/10.1121/1.5063452

Geraci JR, St. Aubin OJ .1982. Study of the effects of oil on cetaceans. Final Report. U.S. Dept. of the Interior, Bureau of Land Management, Contract No. AA 551- CT-29 Un of Guelph, Guelph, Ontario, Canada.

Geraci, J.R. and St. Aubin, D.J. 1988. Synthesis of Effects of Oil on Marine Mammals. Report to US Department of the Interior, Minerals Management Service, Atlantic OCS Region, OCS Study. Ventura, California.

Green, R.H. 1969. The birds of Flinders Island. Records of the Queen Victoria Museum, 34:1 -32

Hale, J. and Butcher, R., 2007, Ecological Character Description of the Peel-Yalgorup Ramsar Site, Report to the Department of Environment and Conservation and the Peel-Harvey Catchment Council, Perth, Western Australia.

Hale, J. and Butcher, R., 2009, Ecological Character Description of the Eighty-mile Beach Ramsar Site, Report to the Department of Environment and Conservation, Perth, Western Australia.

Hale, J. and Butcher, R., 2010, Ecological Character Description for Hosnies Spring Ramsar Site. Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Hale, J. and Butcher, R. 2013. Ashmore Reef Commonwealth Marine Reserve Ramsar Site Ecological Character Description. A report to the Department of the Environment, Canberra.

Hannay, D., MacGillivray, A., Laurinolli, M. and Racca, R. 2004. Source Level Measurements from 2004 Acoustics Programme, Sakhalin Energy, pp. 66.

Hanson C., Waite A., Thompson P. A., & Pattiaratchi C. 2007. Phytoplankton community structure and nitrogen nutrition in Leeuwin Current and coastal waters off the Gascoyne region of Western Australia. Deep Sea Research Part II: Topical Studies in Oceanography, 54(8-10), 902-924. https://doi.org/10.1016/j.dsr2.2006.10.002

Hayes, K., C. Sliwa, S. Mugus, F. McEnnulty, and P. Dunstan. 2005. National priority pests: Pt 2 Ranking of Australian marine pests, CSIRO marine Research. Available from: www.marine.csiro.au/crimp/Reports/publications.html

Heap, A. D., Przeslawski, R., Radke, L., Trafford, J., Battershill, C., & Party, S. 2010. Seabed environments of the eastern Joseph Bonaparte Gulf, northern Australia: SOL4934, post-survey report. *Geoscience Australia, Canberra, ACT, Australia*.

Heap, A.D. and Harris, P.T. 2008. Geomorphology of the Australian margin and adjacent seafloor, Australian Journal of Earth Sciences 55(4): 555-585.

Hegmann, G., C. Cocklin, R. Creasey, S. Dupuis, A. Kennedy, L. Kingsley, W. Ross, H. Spaling and D. Stalker. 1999. Cumulative Effects Assessment Practitioners Guide. Prepared by AXYS Environmental Consulting Ltd. and the CEA Working Group for the Canadian Environmental Assessment Agency, Hull, Quebec.

Helm, R. C., Costa, D. P., DeBruyn, T. D., O'Shea, T. J., Wells, R. S., & Williams, T. M. 2015. Overview of effects of oil spills on marine mammals. In *Handbook of Oil Spill Science and Technology* (pp. 455-475). Wiley-Blackwell.

Heyward, A., Jones, R., Meeuwig, J., Burns, K., Radford, B., Colquhoun, J., Cappo, M., Case, M. O'Leary, R., Fisher, R., Meekan, M. and Stowar, M. 2012. Monitoring Study S5 banks and Sholas, Montara 2011 Offshore banks Assessment Survey. Report for PTTEP Australasia (Ashmore Cartier) Pty. Ltd. Australian Institute of Marine Science. Townsville.

Heyward, A., Moore, C., Radford, B. and J. Colquhoun. 2010. Monitoring Program for the Montara Well Release Timor Sea: Final Report on the Nature of Barracouta and Vulcan Shoals. Report for PTTEP AA Australasia (Ashmore Cartier) Pty. Ltd. Australian Institute of Marine Science, Townsville, Queensland.

Hinwood JB, Poots AE, Dennis LR, Carey JM, Houridis H, Bell RJ, Thomson JR, Boudreau P, Ayling AM. 1994. Drilling activities. In: Swan JM, Neff JM, Young PC (eds) Environmental Implications of offshore oil and gas development in australia: findings of an independent scientific review. Australian Petroleum Production and Exploration Association, Canberra, pp 123–207.

Hjermann, D. Ø., Melsom, A., Dingsør, G. E., Durant, J. M., Eikeset, A. M., Røed, L. P., ... & Stenseth, N. C. 2007. Fish and oil in the Lofoten–Barents Sea system: synoptic review of the effect of oil spills on fish populations. *Marine Ecology Progress Series*, *339*, 283-299.

Hook, S., Batley, G., Holoway, M., Irving P., Ross, A. 2016. Oil Spill Monitoring Handbook. CSIRO Publishing

Hoshke, A. & Whisson, G. 2016. First aggregation of grey nurse sharks (*Carcharias Taurus)* confirmed in Western Australia. Published by Marine Biodiversity Records 9(17).

Houde, E.D. and Zastrow, C.E. 1993. Ecosystem- and taxon-specific dynamic and energetics properties of larval fish assemblages. Bulletin of Marine Science 53 (2): 290-335.

Huertas, C., Fessi, H. & Elaissari, A. 2011. Influences of process and formation parameters on the formation of submicron particles by solvent displacement and emulsification- diffusion methods: critical comparison. Published by Advances in Colloid and Interference Science, 63(2): 90-122. https://doi.org/10.1016/j.cis.2011.02.005

Huisman, J.M. 2000. Marine Plants of Australia. University of Western Australia Press.

Illingworth and Rodkin. 2014. Cook Inlet Exploratory Drilling Program – underwater sound source verification assessment, Cook Inlet, Alaska. Prepared for BlueCrest Energy, Inc. by Illingworth & Rodkin, Inc., Petaluma, California.

International Association of Oil & Gas Producers (IOGP) 2016. Environmental fates and effects of ocean discharge of drill cuttings and associated drilling fluids from offshore oil and gas operations. Report No. 543. IOGP, 2016. 144 p.

IOGP, 2019. Risk assessment data directory – Blowout frequencies. Available online at: https://www.iogp.org/bookstore/product/risk-assessment-data-directory-blowout-frequencies/

Irvine, L. G., Thums, M., Hanson, C. E., McMahon, C. R., & Hindell, M. A. (2018). Evidence for a widely expanded humpback whale calving range along the Western Australian coast. *Marine Mammal Science*, *34*(2), 294-310.

ITOPF. 2011a. Effects of Oil Pollution on the Marine Environment. Technical Information Paper 13. The International Tanker Owners Pollution Federation Ltd. London. Available online at: https://www.itopf.org Accessed 29 March 2019.

ITOPF. 2011b. The Use of Chemical Dispersants to Treat Oil Spills. Technical Information Paper 4. The International Tanker Owners Pollution Federation Ltd. London.

Jenner, K.C.S., Jenner, M-N.M, and McCabe, K.A. 2001. Geographical and Temporal Movements of Humpback Whales in Western Australian Waters. In APPEA Journal 2001 (41): 749–765.

Jimenez-Arranz G., Hedgeland D., Cook S., Banda N., Johnston P., and Oliver E. Acoustic characterisation of a mobile offshore drilling unit, Proceedings of Meetings on Acoustics. 37, 070005 (2019); https://doi.org/10.1121/2.0001193

Johnstone, R. & Burbidge, A. 1991. The avifauna of Kimberley rainforests. (pp 364–391). In: McKenzie, N.L., Johnston, R.B. and Kendrick, P.G (eds), Kimberley rainforests of Australia. Surrey Beatty: Sydney.

Kendrick, P.G. and Rolfe, J.K. 1991. The reptiles and amphibians of Kimberley rainforests (pp 347–359). In: McKenzie, N.L., Johnston, R.B. and Kendrick, P.G (eds), Kimberley rainforests of Australia. Surrey Beatty: Sydney.

Kenneally, K., Edinger, D. & Willing, T. 1996. Broome and Beyond. Published by the Department of Conservation and Land Management.

Kinhill Pty Ltd. 1998. East Spar Benthic Survey. Biological Monitoring Program. A report to Apache Energy. October 1998. Report EA-66-RI-006/B.

Kirkman, H. 1997. Seagrasses of Australia, Australia: State of the Environment, Technical Paper Series (Estuaries and the Sea). Environment Australia, Commonwealth of Australia.

Kjeilen-Eilertsen G., H. Trannum, R.G. Jak, M.G.D. Smit, J. Neff & G. Durell. 2004. Literature report on burial: derivation of PNEC as component in the MEMW model tool. Report AM 2004/024. ERMS report 9B.

Knap A.H, Wyers S.C, Dodge R.E, Sleeter T.D, Frith H.R, Smith S.R, Cook C.B. 1985. The effects of chemically and physically dispersed oil on the brain coral Diploria strigosa. 1985 Oil Spill Conf, Publ 4385. Am Petroleum Inst, Washington, DC: 547-551.

Laist, D.W., Knowlton, A.R., Mead, J.G., Collet, A.S., & Podesta, M. 2001. Collisions between Ships and Whales. Marine Mammal Science, Vol. 17, Issue 1, pp 35-75.

Langford, T.E.L. 1990. Ecological effects of thermal discharges, xi, 468p. Elsevier.

Lewis, J.A. 1990. Effects of Underwater Sound on Marine Fish and Mammals. Aeronautical and Maritime Research Laboratory Defence Science and Technology Organisation G.P.O. Box 4331 Melbourne, Vic. 3001 Australia DSTO Unpublished Report 1990. https://pdfs.semanticscholar.org/c5db/815afa20640815d5dad94635a1b36ec39fe5.pdf

Limpus, C.J. 2008. A biological review of Australian Marine Turtles. 1. Loggerhead Turtle *Caretta caretta* (Linneaus). Queensland Environment Protection Agency. Available from: http://www.epa.qld.gov.au/publications/p02785aa.pdf/A_Biological_Review_Of_Australian_Marine_Turtles_1_Loggerhead_Turtle_emCaretta_Caretta/em_Linnaeus.pdf.

Lindquist, D.C., Shaw, R.F. and Hernandez Jr, F.J. 2005. Distribution patterns of larval and juvenile fishes at off shore petroleum platforms in the north central Gulf of Mexico. Estuarine, Coastal and Shelf Science 62: 655-665.

Mackay, A.I., Bailluel, F., Childerhouse, S., Donnelly, D., Harcourt, R., Parra, G.J. and Goldsworthy, S.D. 2015. Offshore migratory movement of southern right whales: addressing critical conservation and management needs. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication No. F2015/000526-1. SARDI Research Report Series No. 859. 40pp. https://www.researchgate.net/publication/282747679_Offshore_migratory_movement_of_southern_right_whales_informing_critical_conservation_and_management_needs

Marchesan, M, Spotto, M, Verginella, L & Ferrero, EA. 2005. Behavioural Effects of Artificial Light on Fish Species of Commercial Interest, Fisheries Research, vol. 73, pp. 171-185.

Marquenie, J., Donners, M., Poot, H., Steckel, W. and de Wit, B. 2008. Adapting the spectral composition of artificial lighting to safeguard the environment. Petroleum and Chemical Industry Conference Europe - Electrical and Instrumentation Applications, pp 1–6.

McCauley RD, Day RD, Swadling KM, Fitzgibbon QP, Watson RA. 2017. Widely used marine seismic survey air gun operations, negatively impact zooplankton.

McCauley RD. 1994. The environmental implications of offshore oil and gas development in Australia – seismic surveys. In: Swan, J.M., Neff, J.M. and Young, P.C. (eds.), Environmental Implications of Offshore Oil and Gas Development in Australia - The Findings of an Independent Scientific Review. 123-207 pp. Australian Petroleum Exploration Association, Sydney. 19-21 pp.

McCauley, R. D., Fewtrell, J., Duncan, A. J., Jenner, C., Jenner, M.-N., Penrose, J. D., Prince, R. I., Adhitya, A., Murdock, J. and McCabe, K. 2000. Marine seismic surveys - a study of environmental implications. Aust. Pet. Prod. Explor. Assoc. J. 40, 692-708. doi:10.1071/AJ99048

McCauley, R., Jenner, C., 2010. Migratory patterns and estimated population size of pygmy blue whales (Balaenoptera musculus brevicauda) traversing the Western Australian coast based on passive acoustics (International Whaling Commission Report No. SC/62/SH26). International Whaling Commission.

McCauley, R.D. 1998. Radiated underwater noise measured from the drilling rig ocean general, rig tenders Pacific Ariki and Pacific Frontier, fishing vessel Reef Venture and natural sources in the Timor Sea, Northern Australia. Prepared by Rob McCauley for Shell Australia.

McClatchie, S., Middleton, J., Pattiaratchi, C., Currie, D., and Kendrick, G. 2006. The South-west Marine Region: Ecosystems and Key Species Groups. Department of the Environment and Water Resources. Australian Government.

McDonald MA, Hildebrand JA & Webb SC .1995. Blue and fin whales observed on a seafloor array in the northeast Pacific. Journal of the Acoustical Society of America 98(2): 712-21.

McIntyre, A.D. and Johnson, R. 1975. Effects of nutrient enrichment from sewage in the sea. In: ALH Gameson, ed. Discharge of sewage from sea outfalls. New York: Pergamon Press. Pp. 131–141

McLeay, L.J., Sorokin, S.J., Rogers, P.J. and Ward, T.M. 2003. *Benthic Protection Zone of the Great Australian Bight Marine Park: Literature Review*. South Australia Marine Research and Development Institute (Aquatic Sciences), Commonwealth Department of Environment and Heritage.

Mclntyre, A. 1982. Oil pollution and fisheries. Published by the Royal Society, 297(1087). https://doi.org/10.1098/rstb.1982.0050

McMahon K, Statton J and Lavery P. 2017. Seagrasses of the northwest of Western Australia: biogeography and considerations for dredging-related research. Report of Theme 5 - Project 5.1.2 prepared for the Dredging Science Node, Western Australian Marine Science Institution, Perth, Western Australia. 39 pp.

McMahon, K., Young, E., Montgomery, S., Cosgrove, J., Wilshaw, J., & Walker, D. I. 1997. Status of a shallow seagrass system, Geographe Bay, south-western Australia. *Journal of the Royal Society of Western Australia*, *80*, 255.

McPherson, C.R, M. Wood and R. Racca. 2016. Potential Impacts of Underwater Noise from Operation of the Barossa FPSO Facility on Marine Fauna, ConocoPhillips Barossa Project. Document 01117, Version 1.0. Technical report by JASCO Applied Sciences for Jacobs.

McPherson, C.R, J.E. Quijano, M.J. Weirathmueller, K.R. Hiltz, and K. Lucke. 2019. Browse to North West Shelf Project Noise Modelling Study: Assessing Marine Fauna Sound Exposures. Document 01824, Version 2.2. Technical report by JASCO Applied Sciences for Jacobs. https://www.epa.wa.gov.au/sites/default/files/PER_documentation2/Appendix%20D%203.pdf

Meekan, M. G., Wilson, S. G., Halford , A. and Retzel, A. 2001. A comparison of catches of fishes and invertebrates by two light trap designs, in tropical NW Australia. Marine Biology 139: 373–381.

Mi SWACO. 2011. Offshore TCC Hammermill System. Published by Mi SWACO.

Miller, B.S., N. Kelly, M.C. Double, S.J. Childerhouse, S. Laverick & N. Gales. 2012. Cruise report on SORP 2012 blue whale voyages: development of acoustic methods. Paper SC/64/SH1 1 presented to the IWC Scientific Committee.

Milton S.L. & Lutz P. 2003. *Physiological and Genetic response to Environmental Stress*. The Biology of Sea Turtles 2. CRC Press, Boca Raton. pp163.

Milton, D. A. V. I. D. 2005. Birds of Ashmore Reef National Nature Reserve: an assessment of its importance for seabirds and waders. *The Beagle, Records of the Museums of Art Galleries of the Northern Territory 2005, Supplement*, *1*, 133-141.

Moody, C. & Field, J. 2000. Perfluorinated Surfactants and the Environmental Implications of their use in Fire-Fighting Foams. Published by the American Chemical Society, 34(18): 3864-3870.

Moore L, Knot, B and Stanley N. 1983. The Stromatolites of Lake Clifton, Western Australia – Living Structures Representing the Origins of Life. Search14:11-12 309-314.

Moore LS. 1990. Lake Clifton – An Interationally Significant Wetland in need of Management. Land and Water Research News,8:37-41, Water Authority of Western Australia, Leederville.

Morandi, A., S. Berkman, J. Rowe, R. Balouskus, D.S. Etkin, C. Moelter, and D. Reich. 2018. Environmental Sensitivity and Associated Risk to Habitats and Species on the Pacific West Coast and Hawaii with Offshore Floating Wind Technologies; Volume 1: Final Report. US Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region, Camarillo, CA. OCS Study BOEM 2018-031. 100 p. Accessed on 1 April 2019 at < https://www.boem.gov/BOEM-2018-031-Vol1/>

Moriyasu M, Allain R, Benhalima K and Clayton R. 2004. Effects of seismic and marine noise on invertebrates: A literature review. Canadian Science Advisory Secretariat research document; 2004/126. Fisheries and Oceans Canada. 50 pp. http://www.dfo-mpo.gc.ca/Library/317113.pdf.

National Energy Resources Australia (NERA). 2018. Environmental Plan Reference Case: Anchoring of Vessels and Floating Facilitates. Published by NERA. Available from: https://referencecases.nera.org.au/Attachment?Action=Download&Attachment_id=223

National Marine Fisheries Service. 2018a. 2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59. 167 pp. https://www.fisheries.noaa.gov/webdam/download/75962998.

National Marine Fisheries Service. 2018b. Manual for Optional User Spreadsheet Tool (Version 2.0) for: 2018 Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. Silver Spring, Maryland: Office of Protected Resources, National Marine Fisheries Service.

National Oceanic and Atmospheric Administration. 2013. Draft guidance for assessing the effects of anthropogenic sound on marine mammals: Acoustic threshold levels for onset of permanent and temporary threshold shifts, December 2013, 76 pp. Silver Spring, Maryland: NMFS Office of Protected Resources. http://www.nmfs.noaa.gov/pr/acoustics/draft_acoustic_guidance_2013.pdf

National Offshore Petroleum Safety and Environmental Management Authority. 2019. Bulletin 1: Oil spill modelling. Rev 0. National Offshore Petroleum Safety and Environmental Authority, Perth, Western Australia. Available from: https://www.nopsema.gov.au/assets/Bulletins/A652993.pdf

National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA). 2018. ‘At a glance: Oil spill modelling’, viewed 15 November 2018, https://www.nopsema.gov.au/assets/Publications/A626200.pdf

National Offshore Petroleum Safety and Environmental Management Authority. 2019. Guideline: Environment plan decision making GL1721. Rev 6. National Offshore Petroleum Safety and Environmental

Management Authority, Perth, Western Australia. Available from: https://www.nopsema.gov.au/assets/Guidelines/A524696.pdf

National Offshore Petroleum Safety and Environmental Management Authority. 2016. Operational and Scientific monitoring programs: information paper. National Offshore Petroleum Safety and Environmental Management Authority, Perth, Western Australia.

National Research Council (2003) Ocean Noise and Marine Mammals. Washington, DC: The National Academies Press. https://doi.org/10.17226/10564.. Available from: https://www.ncbi.nlm.nih.gov/books/NBK221255/

Neff, J.M. 2005. Composition, environmental fates, and biological effects of water based drilling muds and cuttings discharged to the marine environment: a synthesis and annotated bibliography. Report prepared for the Petroleum Environmental Research Forum (PERF). Washington DC: American Petroleum Institute.

Nehring S. 2002. Biological invasions into German waters: an evaluation of the importance of different human-mediated vectors for nonindigenous macrozoobenthic species. In: Leppäkoski E, Gollasch S, Olenin S (eds), Invasive aquatic species of Europe – distribution, impact and management. Dordrecht, Boston, London: Kluwer Academic Publishers, 374–384

NERA 2018*. Environment Plan Reference Case Consequence analysis of an accidental release of diesel.* National Energy Resources Australia. Accessed at*:* https://referencecases.nera.org.au/Article?Action=View&Article_id=130

Nichol, S.L., Howard, F.J.F., Kool, J., Stowar, M., Bouchet, P., Radke, L., Siwabessy, J., Przeslawski, R., Picard, K., Alvarez de Glasby, B., Colquhoun, J., Letessier, T. & Heyward, A. 2013. Oceanic Shoals Commonwealth Marine Reserve (Timor Sea) Biodiversity Survey: GA0339/SOL5650 – Post Survey Report. Record 2013/38. Geoscience Australia: Canberra.

NOAA 2010a. Oil Spills in Coral Reefs planning & response considerations. National Oceanic and Atmospheric Administration.

NOAA 2010b. *Oil and Sea Turtles*: Biology, Planning, and Response. National Oceanic and Atmospheric Administration. Accessed at: https://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/resources/oil-and-sea-turtles.html

NRDA. 2012. April 2012 Status Update for the Deepwater Horizon Oil Spill. A WWW publication accessed at: http://www.gulfspillrestoration.noaa.gov. Natural Resource Damage Assessment.

O'Brien, P. Y. & P. S. Dixon, 1976. The Effects of Oil and Oil Components on Algae: A review. British Phycological Journal 11:115-142.

OGUK. 2014. The UK offshore oil and gas industry guidance on risk-related decision making. Oil and Gas UK.

OSPAR. 2014. Establishment of a list of Predicted No Effect Concentrations (PNECs) for naturally occurring substances in produced water. OSPAR Commission. OSPAR Agreement: 2014–05

Owen, K., Jenner, C.S., Jenner, M.M. et al. 2016. A week in the life of a pygmy blue whale: migratory dive depth overlaps with large vessel drafts. Anim Biotelemetry 4, 17 (2016). https://doi.org/10.1186/s40317-016-0109-4

Parnell, P.E. 2003. The effects of sewage discharge on water quality and phytoplankton of Hawai'ian Coastal Waters. Marine Environmental Research, Vol. 44, pp 293-311.

Parry GD and Gason A. 2006. The effect of seismic surveys on catch rates of rock lobsters in western Victoria, Australia. Fisheries Research, 79: 272–284.

Patterson, H., Larcombe, J., Nicol, S. and Curtotti, R. 2018. Fishery status reports 2018, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra. CC BY 4.0.

Paulay, G. Kirkendale, L. Lambert, G. and Meyer, C. 2002. Anthropogenic biotic interchange in a coral reef ecosystem: A case study from Guam. Pacific Science 56(4): 403–422

Peel, D., Smith, J.N. and Childerhouse, S. 2016. Historical Data on Australian Whale Vessel Strikes. International Whaling Commission. SC/66b/HIM/05 Rev1.

Peng C, Zhao X, Liu G. 2015. Noise in the Sea and Its Impacts on Marine Organisms. Int J Environ Res Public Health. 2015 Sep 30;12(10):12304-23. https://www.ncbi.nlm.nih.gov/pubmed/26437424#:~:targetText=Studies%20showed%20that%20anthropogenic%20noise,service%20functions%20of%20marine%20ecosystems.

Peters, EC, Meyers, PA, Yevich, PP and Blake, NJ. . 1981. Bioaccumulation and histopathological effects of oil on a stony coral. Marine Pollution Bulletin 12(10):333-339

Popper, A.N., Hawkins, A.D., Fay, R.R., Mann, D.A., Bartol, S., Carlson, T.J., Coombs, S., Ellison, W.T., Gentry, R.L., Halvorsen, M.B. and Løkkeborg, S. 2014. Sound exposure guidelines for fishes and sea turtles. Springer Briefs in Oceanography. DOI, 10(1007), pp.978-3.

Przeslawski, R., Daniell, J., Nichol, S., Anderson, T. & Barrie, J.V., 2011. Seabed Habitats and Hazards of the Joseph Bonaparte Gulf and Timor Sea, Northern Australia. Record 2011/040. Geoscience Australia, Canberra.

Przeslawski, R., McArthur, M. A., & Anderson, T. J. 2013. Infaunal biodiversity patterns from Carnarvon shelf (Ningaloo reef), Western Australia. *Marine and Freshwater Research*, *64*(6), 573-583.

Purba, N., Pranowo, W., Faizal, I., Adiwira, H. 2018. Temperature-Salinity stratification in the Eastern Indian Ocean using argo float. IOP Conf. Series: Earth and Environmental Science 162 (2018) 012010

Raffensperger, C., Barrett, K. & Schettler, T. 1999. The precautionary principle: protecting public health and the environment. Published by Science and Environmental health network. http://www.sehn.org

Reeves, R.R., Jefferson, T.A., Karczmarski, L., Laidre, K., O'Corry-Crowe, G., Rojas-Bracho, L., Secchi, E.R., Slooten, E., Smith, B.D., Wang, J.Y. and Zhou, K. 2008. Orcaella brevirostris. In: IUCN 2013. IUCN Red List of Threatened Species. (Version 2013.2). Viewed online on 27 March 2014 at: <www.iucnredlist.org>.

Reilly, S.B., Bannister, J.L., Best, P.B., Brown, M., Brownell Jr., R.L., Butterworth, D.S., Clapham, P.J., Cooke, J., Donovan, G.P., Urbán, J. & Zerbini, A.N. 2008. Balaenoptera musculus. The IUCN Red List of Threatened Species 2008: e.T2477A9447146

Reise, K. 2002. Sediment mediated species interactions in coastal waters.

Reise, K., Dankers. & Essink, K. 2004. Introduced species. Published by Wadden Sea quality status report, 155-161.

Ren, L., Huang, X-D., McConkey, B.J., Dixon, D.G. and Greenberg, B.M. 1994. Photoinduced toxicity of three polycyclic aromatic hydrocarbons (Fluoranthene, Pyrene and Napthalene) to the duckweed Lemna gibba. Ecotoxicology and Environmental Safety 28:160–170.

Rennie, S., McCauley, R. & Pattiaratchi C. 2006. Thermal structure above the Perth canyon reveals Leeuwin current, undercurrent and weather influences and the potential for upwelling. Published by Marine and Freshwater Research, 57(8): 849-861. https://doi.org/10.1071/MF05247

Richardson AJ, Matear RJ and Lenton A. 2017. Potential impacts on zooplankton of seismic surveys. CSIRO, Australia. 34 pp.

Richardson W.J., Greene Jnr. C.R., Malme C.I. and Thomson D.H. 1995. Marine Mammals and Noise. Academic Press, California.

Richardson, W.J. (ed,). 1997. Northstar marine mammal monitoring program, 1996: Marine mammal and acoustical monitoring of a seismic program in the Alaskan Beaufort Sea. Rep. frOID LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for BP Explor. (Alaska) Inc., Anchorage, AK, and Nat. Mar. Fish. Serv., Anchorage, AK, and Silver Spring, MD.

Richardson, W.J., Greene, C.R., Malme, C.I and Thomson, D.H. 1995. Marine Mammals and Noise. Academic Press. San Diego. 576 p.

Ross, P., Minchinton, T. & Ponder, W. 2009. The ecology of molluscs in Australian saltmarshes. Published by CSIRO, Melbourne, Australia.

RPS. 2019. BP Developments Australia Ironbark Block WA-569-P Drill Cuttings and Muds Dispersion Modelling. RPS AUSTRALIA WEST PTY LTD, Bundle, QLD Australia.

Ruiz, G., Carlton, J., Grosholz, E. & Hines, A. 1997. Global invasions of marine and estuarine habitats by non-indigenous species: mechanisms, extent, and consequences. Published by the integrative and comparative biology, 37(6): 621-632.

Saintilan N, Rogers K and Howe A. 2009. Chapter 3: Geomorphology and habitat dynamics. In: Australian Saltmarsh Ecology. Ed. N Saintilan. CSIRO Publishing, Victoria.

Saintilan, N. & Rogers, K. 2013. The significance and vulnerability of Australian saltmarshes: implications for management in a changing climate. Published by Marine and Freshwater Research, 64(1), 66-79.

Sanderson, J. 1997. Subtidal macroalgae assemblages in temperate Australian coastal waters. Published by Environment Australia, Canberra.

Schaefer, T. 2008. Fire Fighting Foam Concentrate. Published by the US Patent Application, 11(885), 495.

Shaw, R. F., Lindquist, D. C., Benfield, M. C., Farooqi, T., Plunket, J. T. 2002. Offshore petroleum platforms: functional significance for larval fish across longitudinal and latitudinal gradients. Prepared by the Coastal

Fisheries Institute, Louisiana State University. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2002-077, p. 107.

Shell, 2009. Prelude Floating LNG Project Draft EIS. Available online at: https://www.shell.com.au/sustainability/environment.

Simmonds, M.P., Dolman, S.J. and Weilgart, L. (eds). 2004. Oceans of Noise [Online]. http://www.wdcs.org/submissions_bin/OceansofNoise.pdf. AWDCS Science Report Published by the Whale and Dolphin Conservation Society.

Terrens, G., Gwyther, D. & Keough, M. 1998. Environmental assessment of synthetic-based drilling mud discharges to bass strait, Australia. Published by the APPEA Journal, 38(1):610-625.

The International Tanker Owners Pollution Federation Limited (ITOPF). 2014. Fate of Marine Oil Spills: Technical Information Paper. Published by ITOPF.

Threatened Species Scientific Committee (TSSC). 2015. *Megaptera novaeangliae* (humpback whale) conservation advice.

TWMA. 2019. TWMA TCC RotoMill. Published by TWA.

Tzioumis, V & Keable, S (Eds). 2007. Description of key species groups in the East Marine Region, final report to the Australian Government Department of the Environment, Water, Heritage and the Arts, Australian Museum, Sydney.

UniQuest. 2010. Shoreline Ecological Assessment Aerial and Ground Surveys 7-19 November 2009. As part of the Scientific Monitoring Study of the Montara Monitoring Plan A report commissioned by PTTEP Australasia (Ashmore Cartier) PL for the Department of the Environment, Water, Heritage and the Arts (DEWHA). https://www.environment.gov.au/system/files/pages/bcefac9b-ebc5-4013-9c88-a356280c202c/files/shoreline-ecological-assessment.pdf

United Nations Educational, Scientific and Cultural organization (UNESCO). 2019. Ningaloo Coast. Published by UNESCO. https://whc.unesco.org/en/list/1369/

United Nations Environment Programme, (UNEP). 1985. GESAMP: Thermal discharges in the marine environment. UNEP Regional Seas Reports and Studies No. 45.

Veron, J. E. N. 1993. Hermatypic corals of Ashmore Reef and Cartier Island. *Marine Faunal Surveys of Ashmore Reef and Cartier Island North-Western Australia. Perth: Records of the Western Australian Museum*, 13-14.

Wahlberg, M. & Westerberg, H. 2005. Hearing in fish and their reactions to sounds from offshore wind farms. Marine Ecology Progress Series, 288, 295–309.

Ward, D., Heathershaw, D. & David A. 2001. The environmental impact of underwater sound. Published by the Proceedings Institute of Acoustics. 23(4):1-12.

Wardle CS, Carter TJ, Urquhart, GG, Johnstone, ADF, Ziolkowski, AM, Hampson, G and Mackie, D. 2001. Effects of seismic air guns on marine fish. Continental Shelf Research 21: 1005-1027.

WDCS. 2006. Vessel Collisions and Cetaceans: What happens when they don't miss the boat. Whale and Dolphin Society. United Kingdom

Whiting, S. D., & Guinea, M. L. 1999. Nocturnal foraging by the Black-necked Stork Ephippiorhynchus asiaticus on sea turtle hatchlings. *Emu-Austral Ornithology*, *99*(2), 145-147.

Whiting, S. D., Long, J. L., Hadden, K. M., Lauder, A. D., & Koch, A. U. 2007. Insights into size, seasonality and biology of a nesting population of the Olive Ridley turtle in northern Australia. *Wildlife Research*, *34*(3), 200-210.

Wiese, F., Montevecchi, W., Davoren, G., Huettmann, F., Diamond, T. & Linke, J. 2002. Seabirds at risk around offshore oil platforms in the North-west Atlantic. Published by the Marine Pollution Bulletin, 42(12): 1285-1290. DOI: 10.1016/S0025-326X(01)00096-0

Woodside Energy Ltd. 2014. Browse FLNG Development, Draft Environmental Impact Statement. EPBC 2013/7079. November 2014. Woodside Energy, Perth WA.

Woodside Energy Ltd. 2019. Scarborough Offshore Project Proposal. June 2019. Woodside Energy, Perth WA.

World Bank Group (WBG). 2015. Environmental, health, and safety guidelines for offshore oil and gas development. Published by the World Bank Group. http://documents.worldbank.org/curated/en/378221479466912449/Environmental-health-and-safety-guidelines-for-offshore-oil-and-gas-development

WRM (2007) Ecological Character Description for the Vasse-Wonnerup Wetlands Ramsar Site in South-west Western Australia. Unpublished report to the Department of Environment and Conservation and Geographe Catchment Council Inc. by Wetland Research & Management. September 2007.

Xuejun X, Yuan-lin Z, Yu Z, Hao F, Mao-cai G,Lin T and Qiang F. 2017. Study on the Application of Biocides in the Seawater Cooling System and Their Killing Effect in the Laboratory. Advances in Engineering, Volume 100. International Conference on Manufacturing Engineering and Intelligent Materials. https://download.atlantis-press.com/article/25874040.pdf

Yamaji Marlpa Aboriginal Corporation. 2015. Nyangumarta Indigenous Protected Area (IPA). Published by Yamaji Marlpa Aboriginal Corporation. http://ymac.org.au/case-studies/nyangumarta-indigenous-protected-area-ipa/

Zhu, T., & Carroll, H. B. 1994. *Status Report A Review of Slimhole Drilling* (No. NIPER/BDM-0059). BDM-Oklahoma, Inc., Bartlesville, Oklahoma.

Zieman, J., Orth, R., Phillips, R., Thorhaug, A. & Thayer, G. 1984. The effects of oil spills on seagrass ecosystems. Published by Butterworth Publishers.

Appendix A

Matters of National Environmental Significance Report

Appendix B

Cuttings and Mud Dispersion Modelling

Appendix C

Oil Spill Modelling

Appendix D

Oil Pollution Emergency Plan

Appendix E

Operational and Scientific Monitoring Plan

Appendix F

Stakeholder Engagement Materials

Appendix G

BP Commitment to HSSE Performance