Scarborough 4D B1 Marine Seismic Survey Environment Plan

Exploration

October 2021

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

1.1 Overview

Woodside Energy Scarborough Pty Ltd. (Woodside), as Titleholder (together with BHP Petroleum (Australia) Pty Ltd) under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Commonwealth) (referred to as the Environment Regulations), proposes to undertake a three-dimensional (3D) marine seismic survey (MSS) within the Northern Carnarvon Basin on the Exmouth Plateau in Petroleum titles WA-61-L, WA-62-L and WA-61-R. These activities will hereafter be referred to as the Petroleum Activities Program.

This EP has been prepared to meet the [Offshore Petroleum and Greenhouse Gas Storage Act 2006 (Commonwealth) (OPGGS Act)] Environment Regulations as administered by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).

1.2 Purpose of the Environment Plan

In accordance with the objectives of the Environment Regulations, the purpose of this EP is to demonstrate that:

- The potential environmental impacts and risks (planned (routine and non-routine) and unplanned) that may result from the Petroleum Activities Program are identified.
- Appropriate management controls are implemented to reduce impacts and risks to a level that is ‘as low as reasonably practicable’ (ALARP) and acceptable.
- The Petroleum Activities Program is carried out in a manner consistent with the principles of ecologically sustainable development (ESD) (as defined in Section 3A of the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)).

This EP describes the process and resulting outputs of the risk assessment, whereby impacts and risks are managed accordingly.

The EP defines activity-specific environmental performance outcomes (EPOs), environmental performance standards (EPSs) and measurement criteria (MC). These form the basis for monitoring, auditing and managing the Petroleum Activities Program to be performed by Woodside and its contractors. The implementation strategy (derived from the decision support framework tools) specified within this EP provides Woodside and NOPSEMA with the required level of assurance that impacts and risks associated with the activity are reduced to ALARP and are acceptable.

1.3 Scope of the Environment Plan

The scope of this EP covers the activities that define the Petroleum Activities Program, as described in **Section 3**. The spatial boundary of the Petroleum Activities Program has been described and assessed using the Operational Area. The Operational Area defines the spatial boundary of the Petroleum Activities Program, and is further described in **Section 3.4**.

This EP addresses potential environmental impacts from planned activities and any potential unplanned risks that originate from within the Operational Area. Transit to and from the Operational Area by vessels associated with the Petroleum Activities Program and support vessels, as well as port activities associated with these vessels, are not within the scope of this EP. Vessels supporting the Petroleum Activities Program operating outside the Operational Area (e.g. transiting to and from port) are subject to applicable maritime regulations and other requirements and are not managed by this EP.

1.4 Environment Plan Summary

An EP summary is provided in **Table 1-1** as required by Regulation 11(4).

Table 1-1: EP summary

EP summary material requirement	Section of EP
The location of the activity	**Section 3.4**
A description of the receiving environment	**Section 4**
A description of the activity	**Section 3**
Details of the environmental impacts and risks	**Section 6**
The control measures for the activity	**Section 6**
The arrangements for ongoing monitoring of the titleholder's environmental performance	**Section 7.5**
Response arrangements in the oil pollution emergency plan	**Section 7.10**
Consultation already undertaken and plans for ongoing consultation	**Section 5**
Details of the titleholder's nominated liaison person for the activity	**Section 1.71.7.2**

1.5 Structure of the Environment Plan

The EP has been structured to reflect the process and requirements of the Environment Regulations, as outlined in **Table 1-2**.

Table 1-2: EP process phases, applicable Environment Regulations and relevant section of EP

Criteria for acceptance	Content requirements/relevant regulations	Elements	Section of EP
Regulation 10A(a): *is appropriate for the nature and scale of the activity*	Regulation 13: *Environmental Assessment* Regulation 14: *Implementation strategy for the environment plan* Regulation 16: *Other information in the environment plan*	The principle of 'nature and scale' applies throughout the EP	**Section 2** **Section 3** **Section 4** **Section 5** **Section 6** **Section 7**
Regulation 10A(b): *demonstrates that the environmental impacts and risks of the activity will be reduced to as low as reasonably practicable* Regulation 10A(c): *demonstrates that the environmental impacts and risks of the activity will be of an acceptable level*	Regulation 13(1)–13(7): *13(1) Description of the activity* *13(2)(3) Description of the environment* *13(4) Requirements* *13(5)(6) Evaluation of environmental impacts and risks* *13(7) Environmental performance outcomes and standards* Regulation 16(a)–16(c): *A statement of the titleholder's corporate environmental policy* *A report on all consultations between the titleholder and any relevant person*	Set the context (activity and existing environment) Define 'acceptable' (the requirements, the corporate policy, relevant persons) Detail the impacts and risks Evaluate the nature and scale Detail the control measures – ALARP and acceptable	**Section 1** **Section 2** **Section 3** **Section 4** **Section 5** **Section 6** **Section 7**
Regulation 10A(d): *provides for appropriate environmental performance outcomes, environmental*	Regulation 13(7): *Environmental performance outcomes and standards*	Environmental Performance Outcomes (EPOs) Environmental Performance Standards (EPSs) Measurement Criteria (MC)	**Section 6**

Criteria for acceptance	Content requirements/relevant regulations	Elements	Section of EP
performance standards and measurement criteria			
Regulation 10A(e): *includes an appropriate implementation strategy and monitoring, recording and reporting arrangements*	Regulation 14: *Implementation strategy for the environment plan*	Implementation strategy, including: systems, practices and procedures performance monitoring Oil Pollution Emergency Plan (OPEP) and scientific monitoring ongoing consultation.	**Section 7** **Appendix D**
Regulation 10A(f): *does not involve the activity or part of the activity, other than arrangements for environmental monitoring or for responding to an emergency, being undertaken in any part of a declared World Heritage property within the meaning of the EPBC Act*	Regulation 13 (1)–13(3): *13(1) Description of the activity* *13(2) Description of the environment* *13(3) Without limiting [Regulation 13(2)(b)], particular relevant values and sensitivities may include any of the following:* *(a) the world heritage values of a declared World Heritage property within the meaning of the EPBC Act;* *(b) the national heritage values of a National Heritage place within the meaning of that Act;* *(c) the ecological character of a declared Ramsar wetland within the meaning of that Act;* *(d) the presence of a listed threatened species or listed threatened ecological community within the meaning of that Act;* *(e) the presence of a listed migratory species within the meaning of that Act;* *(f) any values and sensitivities that exist in, or in relation to, part or all of:* *(i) a Commonwealth marine area within the meaning of that Act; or* *(ii) Commonwealth land within the meaning of that Act.*	No activity, or part of the activity, undertaken in any part of a declared World Heritage property	**Section 3** **Section 4** **Section 6**
Regulation 10A(g): *(i) the titleholder has carried out the consultations required by Division 2.2A* *(ii) the measures (if any) that the titleholder has adopted, or proposes to adopt, because of the*	Regulation 11A: *Consultation with relevant authorities, persons and organisations, etc.* Regulation 16(b): *A report on all consultations between the titleholder and any relevant person*	Consultation in preparation of the EP	**Section 5**

Criteria for acceptance	Content requirements/relevant regulations	Elements	Section of EP
consultations are appropriate			
Regulation 10A(h): *complies with the Act and the regulations*	Regulation 15: *Details of the Titleholder and liaison person* Regulation 16(c): *Details of all reportable incidents in relation to the proposed activity.*	All contents of the EP must comply with the Offshore Petroleum and Greenhouse Gas Storage Act 2006 and the Environment Regulations	**Section 1.5** **Section 6.6**

1.6 Description of the Titleholder

Woodside is the Titleholder for this activity, on behalf of a Joint Venture comprising Woodside Energy Scarborough Pty Ltd and BHP Petroleum (Australia) Pty Ltd.

Woodside is Australia's leading natural gas producer. Woodside's operations are characterised by strong safety and environmental performance in remote and challenging locations. Wherever Woodside works, it is committed to living its values of integrity, respect, working together ownership, sustainability and courage.

Through collaboration, Woodside leverages its capabilities to progress its growth strategy. Since 1984, the company has been operating the landmark Australian project, the North West Shelf, which is one of the world's premier liquefied natural gas (LNG) facilities. In 2012, Woodside added the Pluto LNG Plant to its onshore operating facilities.

Woodside has an excellent track record of efficient and safe production. Woodside strives for excellence in safety and environmental performance and continues to strengthen relationships with customers, partners, co-venturers, governments, and communities. Further information about Woodside can be found at http://www.woodside.com.au.

1.7 Details of Titleholder and Public Affairs Contact

In accordance with Regulation 15 of the Environment Regulations, details of the titleholder, liaison person and arrangements for the notification of changes are described below.

1.7.1 Titleholder

Woodside Energy Scarborough Limited

11 Mount Street

Perth, Western Australia

T: 08 9348 4000

ACN: 650 177 227

1.7.2 Nominated Liaison Person

Ryan Felton

Senior Corporate Affairs Adviser

11 Mount Street

Perth, Western Australia

Telephone: 08 9348 4000

Email: feedback@woodside.com.au

1.7.3 Arrangement for Notifying Change

Should the titleholder, titleholder's nominated liaison person, or the contact details for either change, NOPSEMA will be notified in writing within two weeks or as soon as practicable.

1.7.4 Offshore Petroleum and Greenhouse Gas Storage Act

The OPGGS Act controls exploration and production activities beyond three nautical miles (nm) of the mainland (and islands) to the outer extent of the Australian Exclusive Economic Zone (EEZ) at 200 nm.

1.8 Woodside Management System

The Woodside Management System (WMS) provides a structured framework of documentation to set common expectations governing how all employees and contractors at Woodside will work. Many of the standards presented in **Section 6** are drawn from the WMS documentation, which comprises four elements: compass and policies, expectations, processes and procedures, and guidelines, as outlined below (and illustrated in **Figure 1-1)**.

- **Compass and Policies**: Set the enterprise-wide direction for Woodside by governing our behaviours, actions, and business decisions and ensuring we meet our legal and other external obligations.
- **Expectations**: Set essential activities or deliverables required to achieve the objectives of the Key Business Activities and provide the basis for developing processes and procedures.
- **Processes and Procedures**: Processes identify the set of interrelated or interacting activities that transform inputs into outputs, to systematically achieve a purpose or specific objective. Procedures specify what steps, by whom, and when required to carry out an activity or a process.
- **Guidelines**: Provide recommended practice and advice on how to perform the steps defined in Procedures, together with supporting information and associated tools. Guidelines provide advice on how activities or tasks may be performed, information that may be taken into consideration, or, how to use tools and systems.

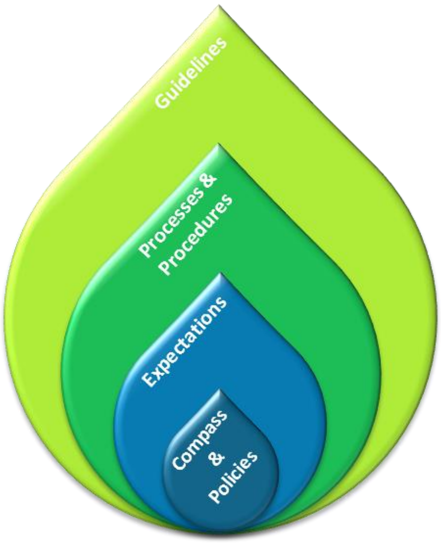


Figure 1-1: The four major elements of the WMS Seed

The WMS is organised within a business process hierarchy based upon key business activities to ensure the system remains independent of organisation structure, is globally applicable and scalable wherever required. These key business activities are grouped into management, support, and value stream activities as shown in **Figure 1-2.** The value stream activities capture, generate and deliver value through the exploration and production lifecycle. The management activities influence all areas of the business, while support activities may influence one or more value stream activities.

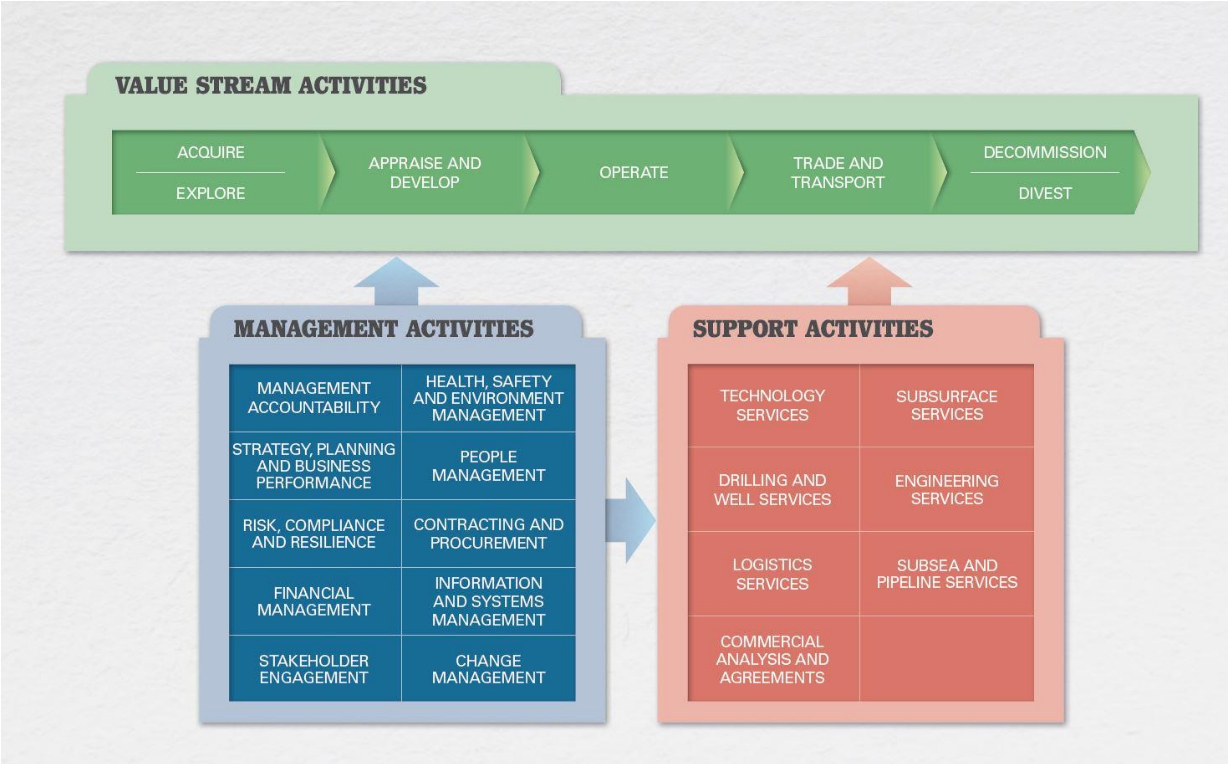


Figure 1-2: The WMS business process hierarchy

1.8.1 Health, Safety and Environment

In accordance with Regulation 16(a) of the Environment Regulations, Woodside's Corporate Health, Safety and Environment Policy is provided in **Appendix A** of this EP.

1.9 Description of Relevant Requirements

In accordance with Regulation 13(4) of the Environment Regulations, a description of requirements, including legislative requirements, that apply to the activity and are relevant to managing risks and impacts of the Petroleum Activities Program are detailed in Appendix B. This EP will not be assessed under the WA Environment Protection Act 1986 as the activity does not occur on State land or within State waters.

1.9.1 Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009

The Environment Regulations apply to petroleum activities in Commonwealth waters and are administered by NOPSEMA. The objective of the Environment Regulations is to ensure petroleum activities are:

- carried out in a manner consistent with the principles of ecological sustainable development
- carried out in a manner by which the environmental impacts and risks of the activity will be reduced to ALARP

- carried out in a manner by which the environmental impacts and risks of the activity will be of an acceptable level.

1.9.2 Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The EPBC Act aims to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places in Australia. These are defined in the Act as Matters of National Environmental Significance (MNES). In respect to offshore petroleum activities in Commonwealth waters, these requirements are implemented by NOPSEMA through the Streamlining Offshore Petroleum Environmental Approvals Program (the Program). The Program provides for the protection of the environment by requiring all offshore petroleum activities authorised by the OPGGS Act to be conducted in accordance with an accepted EP, consistent with the principles of Ecological Sustainable Development (ESD).

Impacts on the environment include those matters protected under Part 3 of the EPBC Act. The definition of 'environment' in the Program is consistent with that used in the EPBC Act - this enables the Program to encompass all matters protected under Part 3 of the EPBC Act.

1.9.2.1 Recovery Plans and Threat Abatement Plans

Under s139(1)(b) of the EPBC Act, the Environment Minister must not act inconsistently with a recovery plan for a listed threatened species or ecological community or a threat abatement plan for a species or community protected under the Act. Similarly, under s268 of the EPBC Act:

"A Commonwealth agency must not take any action that contravenes a recovery plan or a threat abatement plan."

In respect to offshore petroleum activities in Commonwealth waters, these requirements are implemented by NOPSEMA via the commitments included in the Program. Commitments relating to listed threatened species and ecological communities under the Act are included in the Program Report (Commonwealth of Australia, 2014).

1.9.2.2 Australian Marine Parks

Under the EPBC Act, Australian Marine Parks (AMPs), formally known as Commonwealth Marine Reserves, are recognised for conserving marine habitats and the species that live and rely on these habitats. The Director of National Parks (DNP) is responsible for managing AMPs (supported by Parks Australia), and is required to publish management plans for them. Other parts of the Australian Government must not perform functions or exercise powers relating to these parks that are inconsistent with management plans (s362 of the EPBC Act). Relevant AMPs are described in **Section 4.8**. The North-west Marine Parks Network Management Plan (DNP, 2018a) and the South west Marine Parks Network Management Plan (DNP, 2018b) describe the requirements for managing the marine parks that are relevant to this EP.

Specific zones within the AMPs have been allocated conservation objectives as stated below (International Union for Conservation of Nature (IUCN) Protected Area Category) based on the Australian IUCN reserve management principles outlined in Schedule 8 of the EPBC Regulations 2000:

- Special Purpose Zone (IUCN category VI) – managed to allow specific activities through special purpose management arrangements while conserving ecosystems, habitats and native species. The zone allows or prohibits specific activities.
- Sanctuary Zone (IUCN category Ia) – managed to conserve ecosystems, habitats and native species in as natural and undisturbed a state as possible. The zone allows only authorised scientific research and monitoring.

- National Park Zone (IUCN category II) – managed to protect and conserve ecosystems, habitats and native species in as natural a state as possible. The zone only allows non extractive activities unless authorised for research and monitoring.
- Recreational Use Zone (IUCN category IV) – managed to allow recreational use, while conserving ecosystems, habitats and native species in as natural a state as possible. The zone allows for recreational fishing, but not commercial fishing.
- Habitat Protection Zone (IUCN category IV) – managed to allow activities that do not harm or cause destruction to seafloor habitats, while conserving ecosystems, habitats and native species in as natural a state as possible.
- Multiple Use Zone (IUCN category VI) – managed to allow ecologically sustainable use while conserving ecosystems, habitats and native species. The zone allows for a range of sustainable uses, including commercial fishing and mining, where they are consistent with park values.

1.9.2.3 World Heritage Properties

Australian World Heritage management principles are prescribed in Schedule 5 of the EPBC Regulations 2000. No management principles are considered relevant to the scope of this EP given there is no potential impacts to any of these areas.

2. ENVIRONMENT PLAN PROCESS

2.1 Overview

This section outlines the process that Woodside follows to prepare the EP once an activity has been defined as a petroleum activity (refer to **Section 1.1**). This includes a description of the environmental risk management methodology that is used to identify, analyse and evaluate risks to meet ALARP and acceptability requirements and to develop EPOs and EPSs. This section also describes Woodside's risk management methodologies applicable to implementation strategies applied during the activity.

Regulation 13(5) of the Environment Regulations requires environmental impacts and risks of the Petroleum Activities program to be detailed, and evaluated appropriate to the nature and scale of each impact and risk associated with the selected Petroleum Activities Program. The objective of the risk assessment process, described in this section, is to identify the risks and associated impacts of an activity so they can be assessed, appropriate control measures applied to eliminate, control or mitigate the impact or risk to ALARP, then determine if the impact or risk level is acceptable.

Environmental impacts and risks include those directly and indirectly associated with the Petroleum Activities Program and include potential emergency and accidental events:

- Planned activities have the potential for inherent environmental impacts.
- Environmental risks are unplanned events with the potential for impact (termed risk 'consequence').

Herein, potential impact from planned activities are termed 'impacts', and 'risks' are associated with unplanned events with the potential for impact (should the risk be realised), with such impacts termed potential 'consequence'.

2.2 Environmental Risk Management Methodology

Woodside recognises that risk is inherent to its business and effectively managing risk is vital to delivering on company objectives, success and continued growth. Woodside is committed to managing all risks proactively and effectively. The objective of Woodside's risk management system is to provide a consistent process for recognising and managing risks across its business. Achieving this objective includes ensuring risks consider impacts across the key areas of exposure: health and safety, environment, finance, reputation and brand, legal and compliance, and social and cultural. A copy of Woodside's Risk Management Policy is provided in **Appendix A.**

The environmental risk management methodology used in this EP is based on Woodside's Risk Management Procedure. This procedure aligns to industry standards such as international standard ISO 31000:2018. The WMS risk management procedure, guidelines and tools provide guidance on specific techniques for managing risk, tailored for particular areas of risk within certain business processes. Procedures applied for environmental risk management include:

- Health Safety and Environment Management Procedure
- Impact Assessment Procedure
- Process Safety Management Procedure.

The risk management methodology provides a framework to demonstrate that the risks and impacts are continually identified, reduced to ALARP and assessed to be at an acceptable level, as required by the Environment Regulations. The key steps of Woodside's Risk Management Process are shown in **Figure 2-1**. Each step and how it is applied to the scopes of this activity is described in **Sections 2.3 to 2.11.**

Figure 2-1: Woodside's risk management process

2.2.1 Healthy, Safety and Environment Management Procedure

Woodside's Health, Safety and Environment Management Procedure provides the structure for managing health, safety and environment (HSE) risks and impacts across Woodside. It defines the decision authorities for company-wide HSE management activities and deliverables, and to support continuous improvement in HSE management.

2.2.2 Impact Assessment Procedure

To support effective environmental risk assessment, Woodside's Impact Assessment Procedure (**Figure 2-2**) provides the steps needed to meet required environment, health and social standards by ensuring impacts are assessed appropriate to the nature and scale of the activity, the regulatory context, the receiving environment, interests, concerns and rights of stakeholders, and the applicable framework of standards and practices.

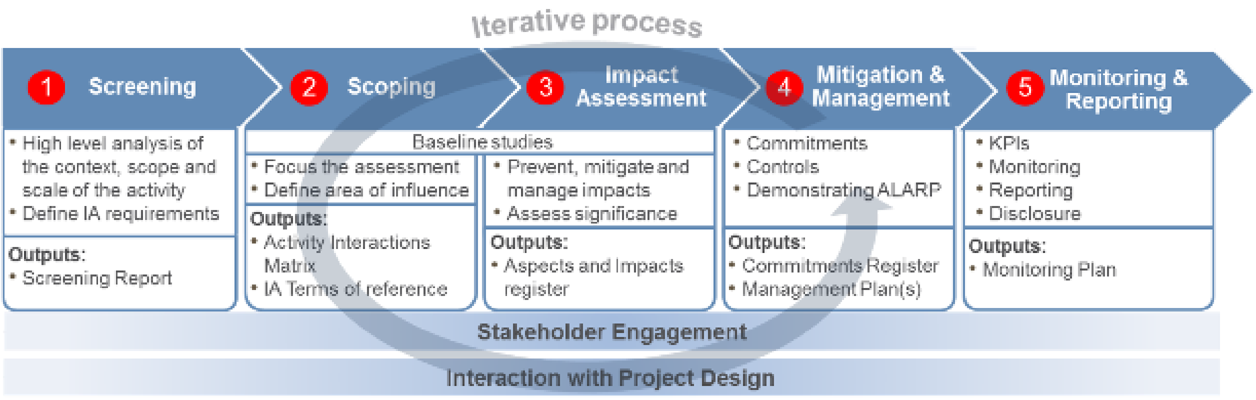


Figure 2-2: Woodside's impact assessment process

2.3 Environmental Plan Process

Figure 2-3 illustrates the EP development process. Each element of this process is discussed further in **Sections 2.3** to **2.11**.

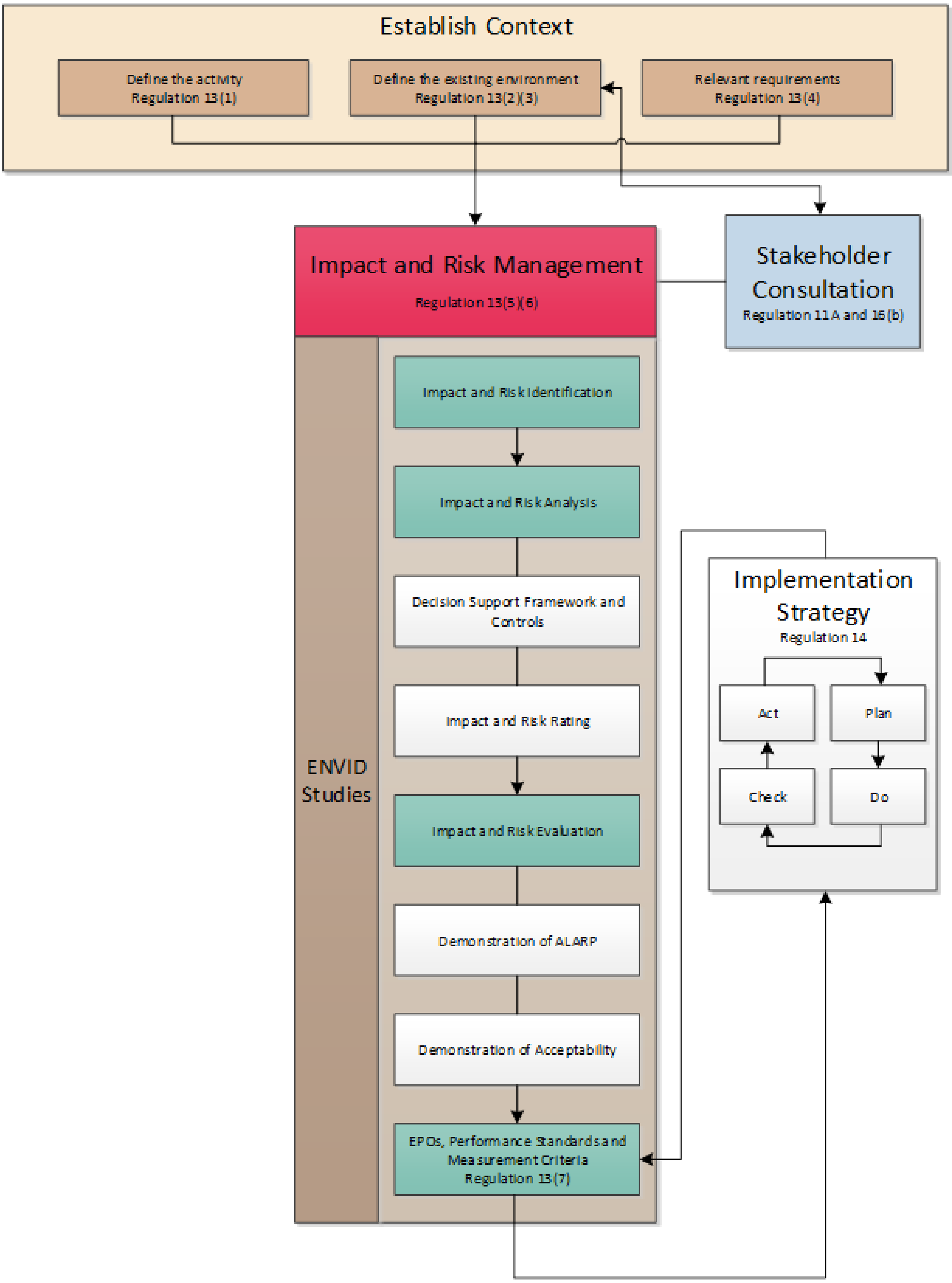


Figure 2-3: Environment Plan development process

2.4 Establish the Context

2.4.1 Define the Activity

This first stage involves evaluating whether the activity meets the definition of a 'petroleum activity' as defined in the Environment Regulations.

The activity is then described in relation to:

- the location
- what is to be performed
- how it is planned to be performed, including outlining operational details of the activity, and proposed timeframes.

The 'what' and 'how' are described in the context of 'environmental aspects' to inform the risk and impact assessment for planned (routine and non-routine) and unplanned (accidents, incidents and emergency conditions) activities.

The activity is described in **Section 3** and referred to as the Petroleum Activities Program.

2.4.2 Defining the Existing Environment

The context of the existing environment is described and determined by considering the nature and scale of the activity (size, type, timing, duration, complexity, and intensity of the activity), as described in **Section 3**. The purpose is to describe the existing environment that may be impacted by the activity, directly or indirectly, by planned or unplanned events.

The existing environment section (**Section 4**) is structured to define the physical, biological, socio economic and cultural attributes of the area of interest, in accordance with the definition of 'environment' in Regulation 4(a) of the Environment Regulations. These sub-sections make particular reference to:

- The environmental, and social and cultural consequences as defined by Woodside (refer to **Table 2-1**), which address key physical and biological attributes, as well as social and cultural values of the existing environment. These consequence definitions are applied to the impact and risk analysis (refer **Section 2.6.2**) and rated for all planned and unplanned activities. Additional detail is provided for evaluating unplanned hydrocarbon spill risk.
- EPBC Act Matters of National Environmental Significance (MNES), including listed threatened species and ecological communities and listed migratory species. Defining the spatial extent of the existing environment is guided by the nature and scale of the Petroleum Activities Program (and associated sources of environmental risk). This considers the Operational Area and wider environment that may be affected (EMBA), as determined by the hydrocarbon spill risk assessments presented in **Section 6.6.1**. MNES, as defined within the EPBC Act, are addressed through Woodside's impact and risk assessment (**Section 6**).
- Relevant values and sensitivities, which may include world or national Heritage Listed areas, Ramsar wetlands, listed threatened species or ecological communities, listed migratory species, and sensitive values that exist in or in relation to Commonwealth marine area or land.
- In categorising the environmental values potentially impacted by the Petroleum Activities Program (as presented in **Table 2-1**), there is standardisation of information relevant to understanding the receiving environment. Potential impacts to these environmental values are evaluated in the risk analysis (refer **Section 2.7**), and risk-rated for all planned and unplanned activities. This provides a robust approach to the overall environmental risk evaluation and its documentation in the EP.

By grouping potentially impacted environmental values by aspect (as presented in **Table 2-1**), the presentation of information about the receiving environment is standardised. This information is then consistently applied to the risk evaluation section to provide a robust approach to the overall environmental risk evaluation and its documentation in the EP.

Table 2-1: Environmental values potentially impacted by the Petroleum Activities Program which are assessed within the EP

Environmental value potentially impacted Regulations 13(2)(3)					
Marine Sediment	***Water Quality***	***Air Quality***	***Ecosystems/ Habitats***	***Species***	***Socio-Economic***

2.4.3 Relevant Requirements

The relevant requirements in the context of legislation, other environmental approval requirements, conditions and standards that apply to the Petroleum Activities Program have been identified and reviewed. Relevant requirements are presented in **Appendix B** and **Section 1.9**.

Woodside's Corporate Health, Safety and Environment Policy is presented in **Appendix A**.

2.5 Impact and Risk Identification

Relevant environmental aspects and hazards have been identified to support the process to define environmental impacts and risks associated with an activity.

The environmental impact and risk assessment presented in this EP has been informed by recent and historic hazard identification studies and workshops (e.g. HAZID/Environmental Hazard Identification [ENVID]), Process Safety Risk Assessment processes, reviews and associated desktop studies associated with the Petroleum Activities Program. Risks are identified based on planned and potential interaction with the activity (based on the description in Section 3), the existing environment (Section 3) and the outcomes of Woodside's stakeholder engagement process (Section 5). The environmental outputs of applicable risk and impact workshops and associated studies are referred to as 'ENVID' hereafter in this EP.

An ENVID workshop was conducted for the marine seismic survey on 20 January 2021. Participants included project environmental advisors, development coordinator, and engineers. The participants' breadth of knowledge, training and experience was sufficient to reasonably assure that the hazards that may arise in connection with the Petroleum Activities Program in this EP were identified.

Impacts and risks were identified during the ENVID for both planned (routine and non-routine) activities and unplanned (accidents, incidents and emergency conditions) events. During this process, risks that are identified as not applicable (not credible) are removed from the assessment. This is done by defining the activity and identifying that an aspect is not applicable.

The impact and risk information is then classified, evaluated and tabulated for each planned activity and unplanned event. Environmental impacts and risk are recorded in an environmental impacts and risk register. The output of the ENVID is used to present the risk assessment and forms the basis to develop performance outcomes, standards and MC. This information is presented in **Section 6**, using the format presented in **Table 2-2**.

Table 2-2: Example of layout of identification of risks and impacts in relation to risk sources

Source of risk	***Evaluation***											
	Marine Sediment	Water Quality	Air Quality (incl Odour)	Ecosystems/Habitat	Species	Socioeconomic	Decision Type	Consequence / Impact	Likelihood	Risk Rating	ALARP Tools	Acceptability
Summary of source of impact/risk												

2.6 Impact and Risk Analysis

Risk analysis further develops the understanding of a risk by defining the impacts and assessing appropriate controls. Risk analysis considered previous risk assessments for similar activities, reviews of relevant studies, reviews of past performance, external stakeholder consultation feedback and a review of the existing environment.

The key steps performed for each risk identified during the risk assessment were:

1. Identify the decision type in accordance with the decision support framework.
2. Identify appropriate control measures (preventative and mitigative) aligned with the decision type.
3. Assess the risk rating or impact.

2.6.1 Decision Support Framework

To support the risk assessment process and Woodside's determination of acceptability (**Section 2.7.2**), Woodside's HSE risk management procedures include using a decision support framework based on principles set out in the Guidance on Risk Related Decision Making (Oil and Gas UK, 2014). This concept is applied during the ENVID, or equivalent preceding processes during historical design decisions, to determine the level of supporting evidence that may be required to draw sound conclusions about risk level and whether the risk is ALARP and acceptable (**Table 2-4**). This is to confirm:

- Activities do not pose an unacceptable environmental risk.
- Appropriate focus is placed on activities where the risk is anticipated to be acceptable and demonstrated to be ALARP.
- Appropriate effort is applied to manage risks based on the uncertainty of the risk, the complexity and risk rating (i.e. potential higher order environmental impacts are subject to further evaluation/assessment).

The framework provides appropriate tools, commensurate to the level of uncertainty or novelty associated with the risk (referred to as Decision Type A, B or C). The decision type is selected based on an informed discussion about the uncertainty of the risk, and documented in ENVID output.

This framework enables Woodside to appropriately understand a risk and determine if the risk is acceptable and can be demonstrated to be ALARP.

2.6.1.1 Decision Type A

Risks classified as a Decision Type A are well understood and established practice. They generally consider recognised good industry practice, which is often embodied in legislation, codes and standards, and use professional judgement.

2.6.1.2 Decision Type B

Risks classified as Decision Type B typically involve greater uncertainty and complexity (and can include potential higher order impacts/risks). These risks may deviate from established practice or have some lifecycle implications, and therefore require further engineering risk assessment to support the decision and ensure the risk is ALARP. Engineering risk assessment tools may include:

- risk-based tools such as cost based analysis or modelling
- consequence modelling
- reliability analysis
- company values.

2.6.1.3 Decision Type C

Risks classified as a Decision Type C typically have significant risks related to environmental performance. Such risks typically involve greater complexity and uncertainty; therefore, requiring adoption of a precautionary approach. The risks may result in significant environmental impact, significant project risk/exposure, or may elicit stakeholder concerns. For these risks, in addition to Decision Type A and B tools, company and societal values need to be considered by performing broader internal and external stakeholder consultation as part of the risk assessment process.

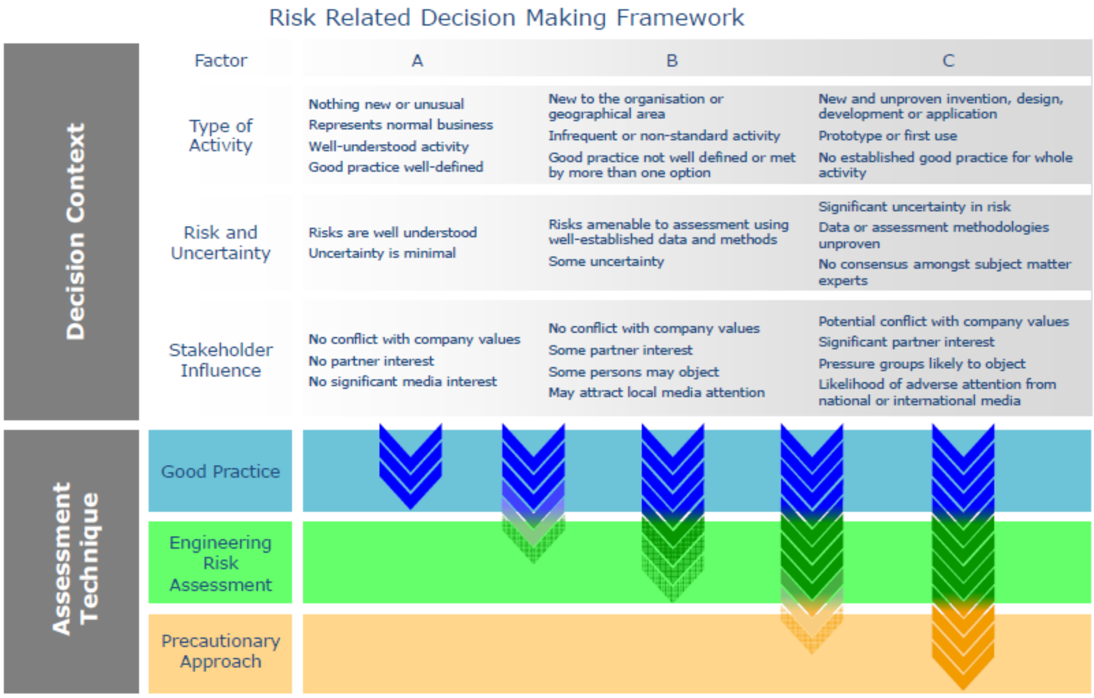


Figure 2-4: Risk-related decision-making framework (Oil and Gas UK 2014)

2.6.2 Decision Support Framework Tools

The following framework tools are applied, as appropriate, to help identify control measures based on the decision type described above:

- **Legislation, Codes and Standards (LCS)** – identifies the requirements of legislation, codes and standards which must be complied with for the activity.
- **Good Industry Practice (GP)** – identifies further engineering control standards and guidelines that may be applied by Woodside above those required to meet the LCS.
- **Professional Judgement (PJ)** – uses relevant personnel with the knowledge and experience to identify alternative controls. Woodside applies the hierarchy of control as part of the risk assessment to identify any alternative measures to control the risk.
- **Risk Based Analysis (RBA)** – assesses the results of probabilistic analyses such as modelling, quantitative risk assessment and/or cost benefit analysis to support the selection of control measures identified during the risk assessment process.
- **Company Values (CV)** – identifies values identified in Woodside's code of conduct, policies and the Woodside compass. Views, concerns and perceptions are to be considered from internal Woodside stakeholders directly affected by the planned impact or potential risk.
- **Societal Values (SV)** – identifies the views, concerns and perceptions of relevant stakeholders and addresses relevant stakeholder views, concerns and perceptions.

2.6.3 Decision Calibration

To determine that alternatives selected and the control measures applied are suitable, the following tools may be used for calibration (i.e. checking) where required:

- **Legislation, Codes and Standards/Verification of Predictions** – verification of compliance with applicable LCS and/or good industry practice.
- **Peer Review** – independent peer review of PJs, supported by risk-based analysis, where appropriate.
- **Benchmarking** – where appropriate, benchmarking against a similar facility or activity type or situation that has been accepted to represent acceptable risk.
- **Internal Stakeholder Consultation** – consultation performed within Woodside to inform the decision and verify CVs are met.
- **External Stakeholder Consultation** – consultation performed to inform the decision and verify societal values are considered.

Where appropriate, additional calibration tools may be selected specific to the decision type and the activity.

2.6.3.1 Control Measures (Hierarchy of Controls)

Risk reduction measures are prioritised and categorised in accordance with the hierarchy of controls, where risk reduction measures at the top of the hierarchy take precedence over risk reduction measures further down:

- **Elimination** of the risk by removing the hazard.
- **Substitution** of a hazard with a less hazardous one.

- **Engineering Controls** include design measures to prevent or reduce the frequency of the risk event, or detect or control the risk event (limiting the magnitude, intensity and duration) such as:
  - Prevention: design measures that reduce the likelihood of a hazardous event occurring.
  - Detection: design measures that facilitate early detection of a hazardous event.
  - Control: design measures that limit the extent/escalation potential of a hazardous event.
  - Mitigation: design measures that protect the environment if a hazardous event occurs.
  - Response Equipment: design measures or safeguards that enable clean up/response after a hazardous event occurs.
- **Procedures and Administration** includes management systems and work instructions used to prevent or mitigate environmental exposure to hazards.
- **Emergency Response and Contingency Planning** includes methods to enable recovery from the impact of an event (e.g. protection barriers deployed near the sensitive receptor).

2.6.4 Impact and Risk Classification

Environmental impacts and risks are assessed to determine their potential significance or consequence. The impact significance or consequence considers the magnitude of the impact or risk and the sensitivity of the potentially impacted receptor (represented by **Figure 2-5**).

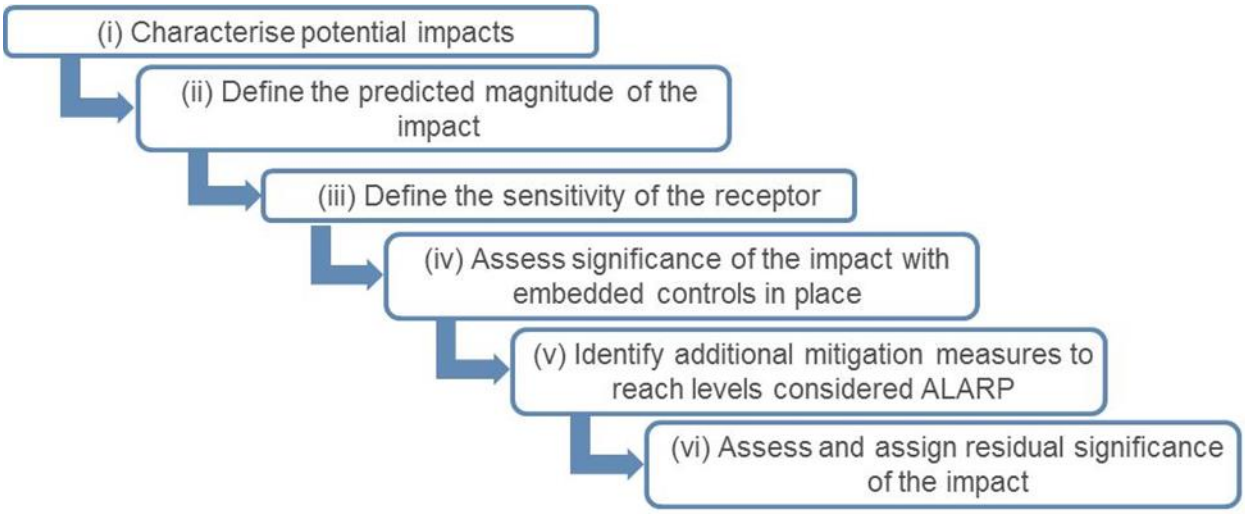


Figure 2-5: Environmental impact and risk analysis

Impacts are classified in accordance with the consequence (**Section 2.4**) outlined in the Woodside Risk Management Procedure and Risk Matrix.

Risks are assessed qualitatively and/or quantitatively in terms of both likelihood and consequence in accordance with the Woodside Risk Management Procedure and Risk Matrix.

The impact and risk information is summarised, including classification, and evaluation information, as shown in the example in **Table 2-2**, evaluated for each planned activity and unplanned event.

Table 2-3: Woodside risk matrix (environment and social and cultural) consequence descriptions

Environment	Social and Cultural	Consequence Level
Catastrophic, long-term impact (more than 50 years) on highly valued ecosystems, species, habitat or physical or biological attributes	Catastrophic, long-term impact (more than 20 years) to a community, social infrastructure or highly valued areas/items of international cultural significance	*A*
Major, long-term impact (ten to 50 years) on highly valued ecosystems, species, habitat or physical or biological attributes	Major, long-term impact (five to 20 years) to a community, social infrastructure or highly valued areas/items of national cultural significance	*B*
Moderate, medium-term impact (two to ten years) on ecosystems, species, habitat or physical or biological attributes	Moderate, medium term Impact (two to five years) to a community, social infrastructure or highly valued areas/items of national cultural significance	*C*
Minor, short-term impact (one to two years) on species, habitat (but not affecting ecosystems function), physical or biological attributes	Minor, short-term impact (one to two years) to a community or highly valued areas/items of cultural significance	*D*
Slight, short-term impact (less than one year) on species, habitat (but not affecting ecosystems function), physical or biological attributes	Slight, short-term impact (less than one year) to a community or areas/items of cultural significance	*E*
No lasting effect (less than one month); localised impact not significant to environmental receptors	No lasting effect (less than one month); localised impact not significant to areas/items of cultural significance	*F*

2.6.5 Risk Rating Process

The risk rating process is performed to assign a level of risk to each risk event, measured in terms of consequence and likelihood. The assigned risk level is therefore determined after identifying the decision type and appropriate control measures.

The risk rating process considers the potential environmental consequences and, where applicable, the social and cultural consequences of the risk. The risk ratings are assigned using the Woodside risk matrix (**Figure 2-6**).

The risk rating process is performed using the following steps:

2.6.5.1 Select the Consequence Level

Determine the worst-case credible consequence associated with the selected event, assuming all controls (preventative and mitigative) are absent or have failed (**Table 2-3**). Where more than one potential consequence applies, select the highest severity consequence level.

2.6.5.2 Select the Likelihood Level

Determine the description that best fits the chance of the selected consequence occurring, assuming reasonable effectiveness of the preventative and mitigative controls (**Table 2-4**).

Table 2-4: Woodside risk matrix likelihood levels

Likelihood Description						
Frequency	1 in 100,000–1,000,000 years	1 in 10,000–100,000 years	1 in 1000–10,000 years	1 in 100–1,000 years	1 in 10–100 years	>1 in 10 years
Experience	**Remote**: Unheard of in the industry	**Highly Unlikely**: Has occurred once or twice in the industry	**Unlikely**: Has occurred many times in the industry but not at Woodside	**Possible**: Has occurred once or twice in Woodside or may possibly occur	**Likely**: Has occurred frequently at Woodside or is likely to occur	**Highly Likely**: Has occurred frequently at the location or is expected to occur
Likelihood Level	0	1	2	3	4	5

2.6.5.3 Calculate the Risk Rating

The risk level is derived from the consequence and likelihood levels determined above in accordance with the risk matrix shown in **Figure 2-6**. A likelihood and risk rating is only applied to environmental risks using the Woodside risk matrix.

This risk level is used as an input into the risk evaluation process and ultimately for prioritising further risk reduction measures. Once each risk is treated to ALARP, the risk rating articulates the ALARP baseline risk as an output of the ENVID studies.

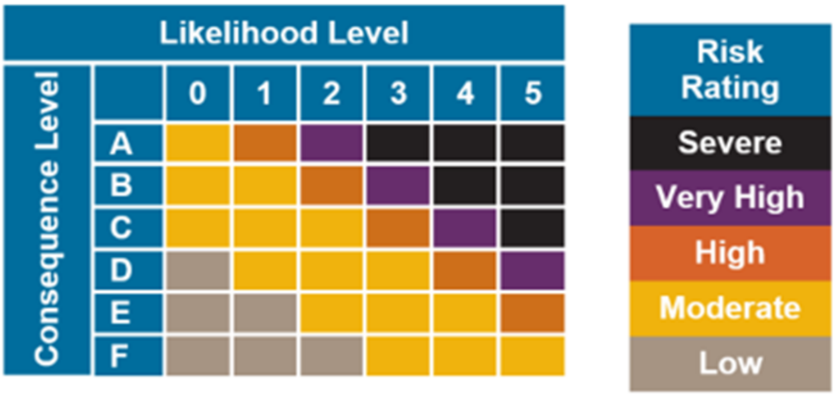


Figure 2-6: Woodside risk matrix – risk level

To support ongoing risk management (a key component of Woodside's Process Safety Management Framework – refer to Implementation Strategy (**Section 7**)), Woodside uses the concept of 'current risk' and applies a current risk rating to indicate the current or 'live' level of risk, considering the controls that are currently in place and regularly effective. Current risk rating is effective in articulating potential divergence from baseline risk, such as if certain controls fail or could potentially be compromised. Current risk ratings aid in the communication and visibility of the risk events, and ensures risk is continually managed to ALARP by identifying risk reduction measures and assessing acceptability.

2.7 Impact and Risk Evaluation

Environmental impacts and risks cover a wider range of issues, differing species, persistence, reversibility, resilience, cumulative effects, and variability in severity than safety risks. Determining the degree of environmental risk, and the corresponding threshold for whether a risk/impact has been reduced to ALARP and is acceptable, is evaluated to a level appropriate to the nature and scale of each impact or risk. Evaluation includes considering the:

- Decision Type.
- Principles of ESD – as defined under the EPBC Act.
- Internal context – ensuring the proposed controls and risk level are consistent with Woodside policies, procedures and standards (**Section 6** and **Appendix A**).
- External context – the environment consequence (**Section 6**) and stakeholder acceptability (**Section 5**).
- Other requirements – ensuring the proposed controls and risk level are consistent with national and international standards, laws and policies.

In accordance with Environment Regulation 10A(a), 10A(b), 10A(c) and 13(5)(b), Woodside applies the process described in the subsections below to demonstrate ALARP and acceptability for environmental impacts and risks, appropriate to the nature and scale of each impact or risk.

2.7.1 Demonstration of ALARP

Descriptions have been provided in **Table 2-5** to articulate how Woodside demonstrates that different risks, impacts and Decision Types identified within the EP are ALARP.

Table 2-5: Summary of Woodside's criteria for ALARP demonstration

Risk	Impact	Decision type
Low and moderate (below C level consequences)	***Negligible, slight, or minor (D, E or F)***	***A***
Woodside demonstrates these risks, impacts and decision types are reduced to ALARP if: • controls identified meet legislative requirements, industry codes and standards, applicable company requirements and industry guidelines • further effort towards impact/risk reduction (beyond employing opportunistic measures) is not reasonably practicable without sacrifices grossly disproportionate to the benefit gained.		
High, very high or severe (C+ consequence risks)	***Moderate and above (A, B or C)***	***B and C***
Woodside demonstrates these higher order risks, impacts and decision types are reduced to ALARP (where it can be demonstrated using good industry practice and risk-based analysis) that: • legislative requirements, applicable company requirements and industry codes and standards are met • societal concerns are accounted for • the alternative control measures are grossly disproportionate to the benefit gained.		

2.7.2 Demonstration of Acceptability

Descriptions have been provided in **Table 2-6** to articulate how Woodside demonstrates that different risks, impacts and Decision Types identified within the EP are Acceptable.

Table 2-6: Summary of Woodside's criteria for acceptability

Risk	Impact	Decision type
Low and moderate	***Negligible, slight, or minor (D, E or F)***	***A***
Woodside demonstrates these lower order risks, impacts and decision types are 'Broadly Acceptable' if they meet: • legislative requirements • industry codes and standards • applicable company requirements and where further effort towards reducing risk (beyond employing opportunistic measures) is not reasonably practicable without sacrifices grossly disproportionate to the benefit gained.		

<table>
<tr><th>Risk</th><th>Impact</th><th>Decision type</th></tr>
<tr><td>High, very high or severe</td><td>Moderate and above (D, E or F)</td><td>B and C</td></tr>
<tr><td colspan="3">Woodside demonstrates these higher order risks, impacts and decision types are of an ‘Acceptable’ level if it can be demonstrated that the predicted levels of impact and/or residual risk, are:
• managed to ALARP (as described in Section 2.7.1); and
• meet the following criteria, appropriate to the nature and scale of each impact and risk:
- Impact/risk does not contravene relevant principles of ESD, as defined under the EPBC Act.
- Internal context – the proposed controls and consequence/risk level are consistent with Woodside policies, procedures and standards.
- External context – stakeholder expectations and feedback have been considered (Section 5).
- Other requirements – the proposed controls and consequence/risk level are consistent with national and international industry standards, laws and policies, and applicable plans for management and conservation advices, conventions, and significant impact guidelines (e.g. for MNES) have been considered.
Where there are significant complexities in assessing and managing impacts to different receptors and for demonstrating how these impacts are acceptable (e.g. significant stakeholder concern for specific receptors, lack of consensus of appropriate controls or standards), acceptability may be demonstrated separately for key receptors. This is not applicable for risks, given the consequence of an unplanned risk event occurring may not be acceptable and, therefore, acceptability is demonstrated in the context of the residual likelihood of an event occurring.</td></tr>
</table>

2.8 Recovery Plan and Threat Abatement Plan Assessment

To support the demonstration of acceptability, a separate assessment is undertaken to demonstrate that the EP is not inconsistent with any relevant recovery plans or threat abatement plans (refer **Section 1.9.2.1.** The steps in this process are:

- Identify relevant listed threatened species and ecological communities (**Section 4.6**).
- Identify relevant recovery plans and threat abatement plans (**Section 6.7**).
- List all objectives and (where relevant) the action areas of these plans, and assess whether these objectives/action areas apply to government, the Titleholder, and the Petroleum Activities Program (**Section 6.7**).
- For those objectives/action areas applicable to the Petroleum Activities Program, identify the relevant actions of each plan, and evaluate whether impacts and risks resulting from the activity are clearly not inconsistent with that action (**Section 6.7**).

2.9 Environmental Performance Outcomes, Standards and Measurement Criteria

EPOs, EPSs and MC have been defined to address the potential environmental impacts and risks and are presented in **Section 6**.

2.10 Implementation, Monitoring, Review and Reporting

An implementation strategy for the Petroleum Activities Program describes the specific measures and arrangements to be implemented for the duration of the Petroleum Activities Program. The implementation strategy is based on the principles of AS/NZS ISO 14001:2016 Environmental Management Systems, and demonstrates:

- control measures are effective in reducing the environmental impacts and risks of the Petroleum Activities Program to ALARP and acceptable levels.
- EPOs and standards set out in the EP are met through monitoring, recording, audit, management of non-conformance and review.
- all environmental impacts and risks of the Petroleum Activities Program are periodically reviewed in accordance with Woodside’s risk management procedures.

- roles and responsibilities are clearly defined, and personnel are competent and appropriately trained to implement the requirements set out in this EP, including in emergencies or potential emergencies.
- arrangements are in place to respond to and monitor impacts from oil pollution emergencies.
- environmental reporting requirements, including 'reportable incidents', are met.
- appropriate stakeholder consultation is performed throughout the activity.

The implementation strategy is presented in **Section 7**.

2.11 Stakeholder Consultation

A stakeholder assessment is performed to identify relevant persons (as defined under Regulation 11A of the Environment Regulations). An activity update is issued electronically to relevant stakeholders to provide a reasonable consultation period. Further details and information are provided to any stakeholder if requested.

Each stakeholder response is summarised and assessed and a response, where appropriate, is provided by Woodside.

The stakeholder consultation, along with the process for ongoing engagement and consultation throughout the activity, is presented in **Section 5.** A copy of the full text correspondence with relevant people is provided in **Appendix F.**

3. DESCRIPTION OF THE ACTIVITY

3.1 Overview

This section has been prepared in accordance with Regulation 13(1) of the Environment Regulations, and describes the activities to be performed as part of the Petroleum Activities Program under this EP.

3.2 Project Overview

The proposed Petroleum Activities Program comprises a marine seismic survey (MSS) of the Scarborough field, the ‘Scarborough 4D Baseline (B1) MSS’, which will be acquired in the Northern Carnarvon Basin on the Exmouth Plateau within Woodside’s permit areas WA-61-L, WA-62-L, WA-61-R, as well as surrounding permit areas WA-63-R, WA-530-P, WA-66-R, WA-67-R, WA-68-R, WA-83-R, WA-89-R, WA-268-P, WA-365-P, WA-365-P LL, WA-365-P LK, WA-383-P, WA-474-P, WA-474-P LS, WA-518-P and gazettal block W19-35. Additionally, the proposed activity includes a potential extension to cover the Jupiter field to the north-east, within permit area WA-61-R.

Table 3-1 provides an overview of the key characteristics for the survey. The commencement of the activities is subject to approvals, vessel availability and weather constraints.

Table 3-1: Petroleum Activities Program overview

Item	Description
Petroleum titles	WA-61-L, WA-62-L and WA-61-R
Location	North Carnarvon Basin
Active Source Area	~5650 km²
Operational Area	~9200 km²
Water depths in Active Source Area	~800–1150 m
Vessels	Three – one seismic survey vessel, one support vessel and one chase vessel.

3.3 Purpose of the Activity

The objective for the Petroleum Activities Program is to acquire a new marine 3D / Baseline 4D seismic survey over the Scarborough and Jupiter fields, as part of an appraisal program for reservoir management. This new 3D survey will provide an uplift in seismic imaging for the Scarborough field from the 2004 vintage seismic data (HEX-003) and ultimately be used as the baseline for time lapse data in the event of acquisition of future monitoring seismic surveys.

3.4 Location

The proposed survey is located in Commonwealth waters in north-west Australia (denoted as polygons in **Figure 3-1**). For the purposes of this EP, two areas have been defined for the survey based on the type of activities that will be undertaken and the discharge of the seismic source. The following areas apply:

- Active Source Area.
- Operational Area.

Table 3-3 provides the boundary coordinates for the two areas.

The Operational Area for the Scarborough 4D B1 MSS, located in the North Carnarvon Basin, is approximately:

- 201 km WNW of the Montebello Islands and Barrow Island.
- 188 km north-west of North-west Cape.
- 245 km north-west of Onslow.
- 167 km NNW of the Ningaloo Coast World Heritage Property (WHP).

The southern corner of the Operational Area is located about 33 km from the boundary of the Gascoyne Marine Park (**Figure 4-11**).

3.4.1 Active Source Area

The Active Source Area is defined as the maximum potential area within which seismic acoustic emissions may occur for the purpose of acquiring data. Discharge of the seismic source during vessel run-ins, run-outs, soft starts and full-fold seismic data acquisition will occur within the Active Source Area. Seismic source testing (i.e. bubble tests) will also occur within the Active Source Area. The seismic source will not be discharged outside of the Active Source Area.

It is important to note that the full-power discharge of the source for full-fold seismic data acquisition will take place over smaller, more discrete areas within the Active Source Area. The larger Active Source Area provides Woodside with flexibility as the survey scope is still being defined.

The extent of the Active Source Area is approximately 5650 km^2. Water depths within the Active Source Area range from~ 800 m to 1150 m.

3.4.2 Operational Area

The Operational Area includes both the Active Source Area and a surrounding buffer for the purpose of vessel line turns and other vessel manoeuvres. The seismic source will not be discharged within this buffer.

The extent of the Operational Area is approximately 9200 km^2. Water depths within the Operational Area range from ~800 m to 1150 m.

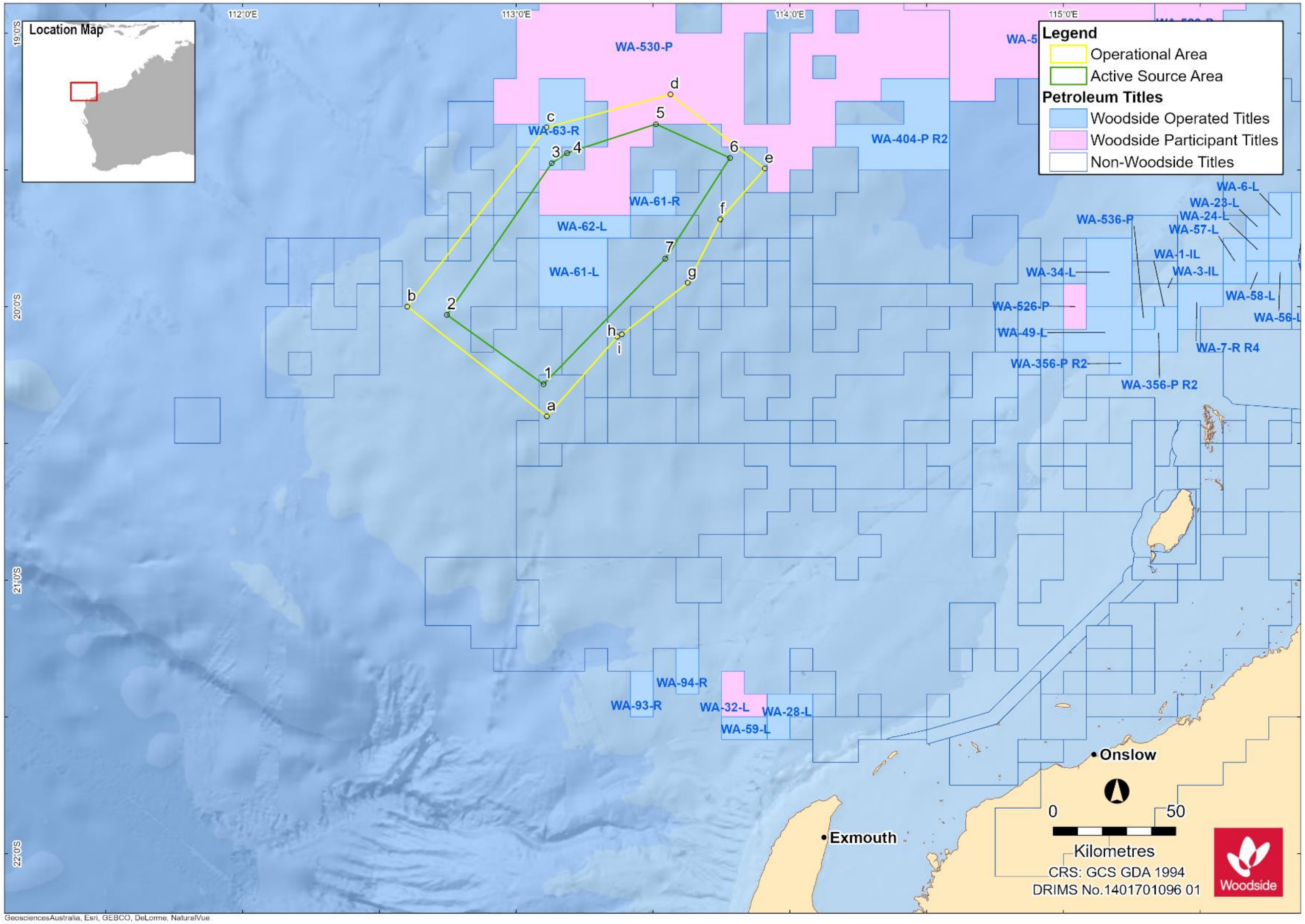


Figure 3-1: Scarborough 4D B1 MSS Areas, including the Jupiter Extension

Table 3-2: Indicative boundary coordinates for the Petroleum Activities Program Active Source Area and Operational Area

Location point (GDA94 Degrees minutes seconds)	Latitude	Longitude
Active Source Area		
1	20°16'59.043"S	113°6'0.387"E
2	20°1'47.096"S	112°44'50.156"E
3	19°28'31.503"S	113°7'47.431"E
4	19°26'15.236"S	113°11'12.497"E
5	19°19'55.308"S	113°30'40.293"E
6	19°27'20.645"S	113°46'53.197"E
7	19°49'26.264"S	113°32'44.0"E
Operational Area		
a	20°24'2.0"S	113°6'45.162"E
b	19°59'57.873"S	112°36'7.851"E
c	19°20'39.38"S	113°6'41.252"E
d	19°13'25.19"S	113°33'49.172"E
e	19°29'41.467"S	113°54'32.011"E
f	19°40'50.544"S	113°44'44.882"E
g	19°54'42.118"S	113°37'40.185"E
h	20°6'2.873"S	113°23'11.168"E
i	20°6'31.786"S	113°22'13.473"E

[1] The final Active Source Area may be subject to slight modifications as the survey scopes become better defined; however, no changes will exceed the Operational Area as defined in this EP.

3.5 Timing

The planned duration for the survey is 80 days. The planned duration includes a maximum of 70 days of seismic data acquisition, plus 10 days of contingency for potential vessel or equipment down time and adverse weather conditions. The exact survey duration is dependent upon the final 4D activity scope.

The survey duration relates to the time that the seismic survey vessel is in the Operational Area with the towed seismic source array and streamers deployed for the purpose of undertaking the Petroleum Activities Program. In the event that the seismic vessel needs to demobilise from the Operational Area (for example, for cyclone avoidance), any time that the vessel is demobilised from the Operational Area will not be counted towards the survey duration. Time that is counted towards the specified survey duration will commence again once the seismic vessel has returned to the Operational Area and the equipment is deployed for the purpose of resuming the Petroleum Activities Program.

The earliest potential commencement date for the survey is 1 January 2022 and it is anticipated that acquisition will be completed in 2022. However, this is subject to the EP acceptance timeline, vessel availability, operational constraints and prevailing weather conditions. Therefore, to manage these potential uncertainties, the latest date that the Scarborough 4D B1 MSS will be completed by is 31 December 2023.

The exact start and end dates of the survey will be communicated to stakeholders once confirmed, in accordance with the ongoing stakeholder consultation process described in **Section 5.**

3.6 Activity Components

3.6.1 Survey Method

The marine seismic surveys proposed are typical seismic surveys similar to most others conducted in Australian marine waters (in terms of technical methods and procedures). The surveys will be conducted using a purpose-built seismic vessel.

During the proposed activities, the survey vessel will traverse a series of pre-determined sail lines within the Active Source area at a speed of about 4-5 knots. As the vessel travels along the survey lines, regular pulses of sound will be emitted from a seismic source array and directed down through the water column and seabed. The produced sound waves are attenuated and reflected at geological boundaries and the reflected signals are detected using sensitive hydrophone microphones and potentially micro electro-mechanical system (MEMS) accelerometers arranged along cables (called ‘streamers’) which are towed behind the survey vessel. In addition, automated underwater vehicle (AUV) seismic nodes or commercial nodes may be deployed to detect the signal from the seabed. The reflected sound is then processed to provide 3D data about the structure and composition of geological formations below the seabed. A summary of the seismic survey parameters is provided in **Table 3-2**.

3.6.2 Seismic Data Acquisition

The seismic vessel will typically acquire the data along a series of adjacent and parallel lines in a “racetrack”-like pattern. At the end of the first line, the vessel will turn in a wide arc to position for another parallel line in the opposite direction, offset several kilometres away from the previous line. Once this next line is complete, the vessel will turn again to position for a line adjacent to the first line and offset by approximately 450 m, being the next sail line separation. This pattern is repeated until the required coverage is completed. The time required to complete each sail line is dependent on the line length, vessel speed and currents. The orientation and length of the sail lines are dependent on the final 4D survey design but will be either orientated 25°/205° or 038.5°/218.5°, with a maximum sail line length of up to 105 km.

As the vessel travels along the sail lines, the seismic source will emit regular acoustic pulses (approximately every 5 seconds with a shot point interval of 12.5 m) (refer to **Table 3-3**).

The 3D seismic data acquired during the survey will serve as a 4D baseline for potential future monitoring surveys, to be acquired at a later date (refer to **Section 3.3**). Measuring the subtle, but time-dependent changes in the reservoir fluid properties on the basis of the seismic signals from the repeat 3D surveys requires very accurate positioning of the acoustic source (shot point) and streamers (receiver points).

3.6.3 Seismic Source

The proposed Petroleum Activities Program will use a seismic source array within the Active Source Area. This consists of a towed configuration of air-powered sources to generate acoustic pulses by periodically discharging compressed air into the water column. Energy from these pulses reflects from the boundaries between geological layers in the sub-surface; the reflected energy of seismic traces is recorded by the receivers located along the towed streamers.

The seismic source will comprise an airgun array with a total volume of up to 3150 in^3 (refer to **Table 3-3**) with an operating pressure of about 13,800 kPa (2000 psi).

The source array will be towed at a depth of 6–8 m (±1 m). The source arrays will be discharged with a shot point interval of 12.5 m horizontal distance (equivalent to approximately every 5 – 6 seconds) (refer to **Table 3-3**). The Scarborough 4D B1 MSS will most likely use a triple source configuration ('flip-flop-flap' discharge).

Table 3-3: Survey acquisition parameters

	Parameter	Scarborough 4D B1 MSS		
General parameters	Active Source Area	~5650 km²		
	Operational Area	~9200 km²		
	Max. sail line length	~105 km		
	Line separation (nominal)	450 m		
	Line Orientation	25 – 38.5° / 205 – 218.5° North East - South West		
	Water depths in Acquistion Area	~800–1150 m		
	Planned survey duration[1]	80-days		
Acoustic emissions	Source configuration	Triple source (flip/flop/flap) or dual source (flip/flop)		
	Airgun array capacity (approximate)	3150 in³		
	Operating pressure	2000 psi		
	Airgun array tow depth	6–8 m (±1 m)		
	Shot point interval	12.5 m (triple source) or 18.75 m (dual source)		
	Peak frequency range	2-200 Hz		
	Modelled far-field source levels (Koessler *et al*. 2021)	**Peak source pressure $L_{S,pk}$ (dB re 1 µPa m)**	**Per-pulse source SEL ($L_{S,E}$) (dB 1 µPa^{2}m^{2}s)**	
			10-2000 Hz	**2000-25,000 Hz**
	Broadside	248.1	224.1	183.9
	Endfire	246.3	223.2	183.9
	Vertical	254.4	227.4	193.5
	Vertical (surface affected)	254.4	230.2	196.5
Acoustic reception	No. of streamers (approximate)	Up to 14		
	Streamer length (approximate)	Approximatley 8000 m		
	Streamer spacing (approximate)	50 to 100 m		
	Maximum width of streamer array (approximate)	Approximately to 1.5 km		
	Streamer tow depth (approximate)	From ~15m to 25 m		

[1] *The acquisition duration for the Petroleum Activities Program is subject to EP acceptance, business approval to commence, vessel availability, operational constraints and prevailing weather conditions.*

3.6.4 Receiver Technology

3.6.4.1 Solid Streamers

The proposed Petroleum Activities Program will use a seismic vessel to tow up to 14 solid streamers (**Table 3-3**). The streamers will be towed at a depth of about 15 – 25 m, with streamer spacing (separations) of 50 to 100 m. The streamer lengths will be approximately 8000 m, towed approximately 500 m behind the seismic vessel and, therefore, extending approximately 8.5 km behind the vessel. Solid streamers will be used instead of traditional fluid-filled streamers so as to reduce the potential risk of damaged streamers releasing fluid to the environment.

The streamers contain steering devices in the form of remote controlled wings, which enable both precise depth control and horizontal steering. Horizontal streamer steering reduces feathering (where the streamer tends to veer offline due to wind and currents) and enables safe streamer separation control and active steering. Streamer recovery devices (SRDs) will be fitted to the streamers. If the streamers go below about 50 m depth, the SRDs automatically deploy inflatable air bags / buoys to raise the streamer to the surface for retrieval.

3.6.4.2 AUV and Commercial Nodes

The use of nodes in seismic surveys is common practice in the global petroleum industry and this technology is not new to Australia. A recent advancement in this technology is the novel use of AUV seismic nodes that removes the need for deep-water surveys to require ROV's for seafloor placement as per conventional node deployment. This significantly reduces deploy/retrieval times, shortening survey durations and the potential displacement of other marine users in the area.

As part of the survey design an option will be inclusion of up to 50 seismic nodes (combined AUV nodes and conventional commercial seismic nodes) to enhance survey coverage. At the start of the streamer survey the nodes will be laid out in a grid of approximately 500 m x 500 m in a 10 km^2 area within the Active Source Area. This combined use of the commercial nodes is to 'ground truth' the AUV node technology by verifying the quality of the seismic data recorded. The AUV and commercial node deployment/retrieval will be from a support/chase vessel.

The AUV nodes are based on current autonomous technology as developed with gliders (e.g. Slocum) that move through the water column by changing buoyancy. The AUV nodes, however, are adapted to settle for periods of time on the seabed to record the seismic signal. During the survey, the AUV nodes will relocate autonomously up to five times, each time landing near a commercial node.

The proposed AUV nodes are cylindrical in shape with short wings on the sides for flight stabilisation and steering. They are approximately 1000 millimetres (mm) long and 300 mm in diameter (weights approximately 30 kilograms (kg) in air and 10 kg in sea water). As a control the AUV nodes will be fitted with thrusters to be periodically used for propulsion, navigation assistance, managing low impact landings and to assist with take-offs as required.

The commercial nodes are deployed to the seabed via gravity. The proposed commercial nodes weigh approximately 68.2 kg (10.2 kg in sea water) and measure approximately 450 mm (H), by 350 mm (L) and 300 mm (W). They are weighted to the seafloor by a biodegradable concrete pad, approximately 450 mm (L), by 500 mm (W) and 50 mm (H) (weights approximately 25 kg in air and 16 kg in seawater). The concrete is made of a mixture of aggregate (rock fragments and sand) and Portland cement. Commercial nodes are recovered via positive buoyancy leaving the concrete pads to biodegrade on the seabed. AUV nodes are fitted with self-recovery devices (SRD) that activate an inflatable air bag-type devices to raise them to the surface if unable to do so with its normal functioning.

The AUV nodes will have all movements pre-programed prior to deployment and will be supported during subsea deployment by ultra-short baseline (USBL) acoustic positioning updates from the surface vessels. When at the surface, the AUV nodes GNSS positioning systems communicate via radio link and Iridium satellite. The AUV nodes will have onboard "Health check" diagnostic capability to confirm all sensors are working as expected and where found to be in fault the AUV node will surface and message the supporting vessels for retrieval.

3.6.5 Project Vessels

Up to three project vessels (seismic, support and a chase vessel) are expected to be required for Scarborough 4D B1 MSS.

The survey will be conducted using a single seismic vessel. A support vessel, capable of AUV seismic node deployment/retrieval, will accompany the seismic vessel to re-supply it with fuel and other logistical and operational supplies (including taking the seismic vessel under tow, if required). Alternatively, a chase vessel may be used for the AUV/Commercial Node deployment, positioning and recovery and an additional chase vessel may be used to manage interactions with shipping and fishing activities, if required. Therefore in this instance, two chase vessels will be required.

Table 3-4 outlines typical parameters of the vessels that will be used during the seismic survey.

The seismic vessel and towed arrays, comprising the acoustic source array and streamer array (including the streamer header buoys, starboard and port deflectors or baravanes, streamers and tail buoys), are surrounded by a Safe Navigation Area (SNA). The SNA will extend to a distance of 3 Nautical miles (Nm) around the seismic vessel and towed equipment (refer to **Figure 3-2**). The support/chase vessel will be used to ensure third party vessels are prevented from entering the SNA.

Note that in addition to the three main project vessels, small work boat(s) and fast rescue craft (FRC) will be launched from the seismic vessel for in-water streamer maintenance. A typical workboat is less than 5 m in length and mainly assists with the deployment, positioning, cleaning and maintenance and recovery of the towed arrays.

Table 3-4: Representative vessel specifications

Specification	Seismic vessel	Support vessel	Chase vessel
Gross Registered Tonnage (GRT)	~13,000–15,000	~3000	<400
Length overall	~110 m	~65 m	~22 m
Breadth	~40 m	~20 m	~6 m
Draft (max)	8 m	7 m	~2 m
Persons on board	80	50	4–12
Fuel type	Marine diesel oil (MDO)	MDO	MDO

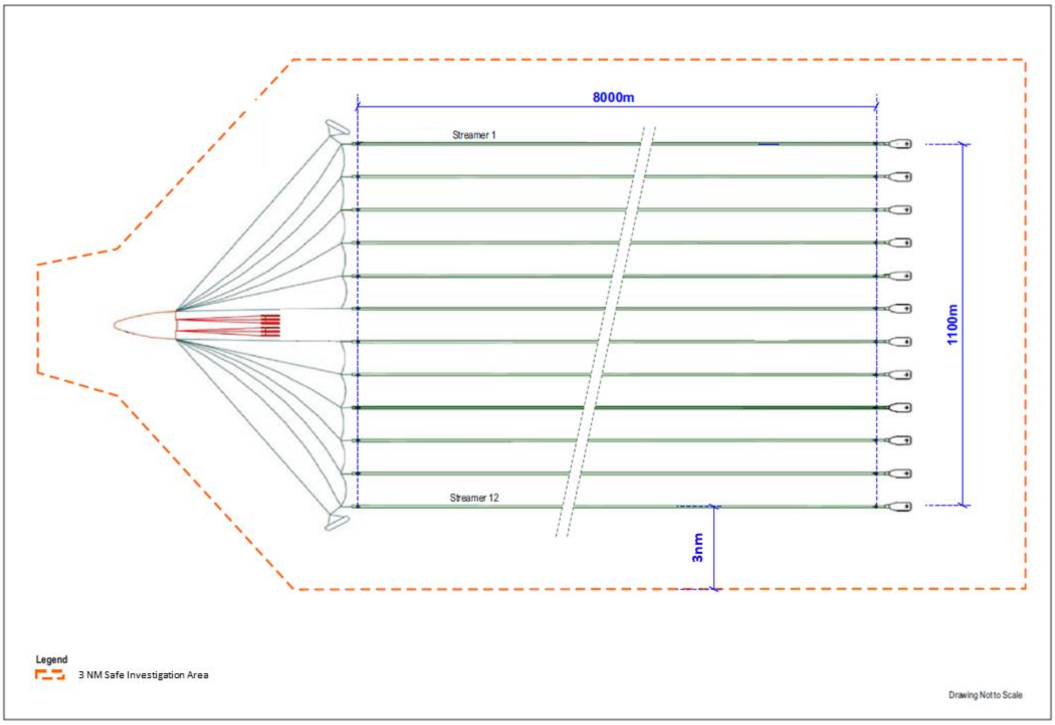


Figure 3-2: Safe Navigation Area surround the seismic vessel and towed arrays (note that streamer lengths and spreads are indicative and may vary)

Potable water, primarily for accommodation and associated domestic areas, will be generated on the seismic and support/chase vessels using a reverse osmosis system. This process will produce brine, which is diluted and discharged at the sea surface in accordance with the controls detailed in **Section 6.5.6**.

The project vessels will also discharge deck drainage from open drainage areas, bilge water from closed drainage areas, putrescible waste and treated sewage and grey water. Any hazardous and non-hazardous waste will be appropriately stored and transported to shore for disposal.

3.6.6 Helicopters

Due to the distance from the coast, if required crew changes will most likely be via a support or chase vessel from the nearest port(s) of call. If required during the seismic survey–(in event of an emergency), helicopters may be used and operated out of the Karratha heliport or Exmouth Aerodrome.

3.6.7 Refuelling

At-sea refuelling (bunkering) of the seismic vessel may occur, depending on fuel consumption during the survey. At-sea refuelling operations will occur within the Operational Area, and in accordance with contractor operational procedures and the control measures outlined in **Section 6.6.3**.

4. DESCRIPTION OF THE EXISTING ENVIRONMENT

4.1 Overview

In accordance with Regulations 13(2) and 13(3) of the Environment Regulations, this section describes the existing environment that may be affected by the activity (planned and unplanned, as described in **Section 3**), including details of the particular relevant values and sensitivities of the environment, which were used for the risk assessment.

The Environment that May Be Affected (EMBA) is the largest spatial extent where unplanned events could have an environmental consequence on the surrounding environment. For this EP, the EMBA is the potential spatial extent of surface and in-water hydrocarbons at concentrations above ecological impact thresholds, in the event of the worst-case credible spill, ecological impact thresholds used to delineate the EMBA are defined in **Section 6.6.1.2**. The worst-case credible spill scenario for this EP is a vessel collision resulting in hydrocarbon release. Note, no shoreline accumulation of hydrocarbons above threshold concentrations (100 g/m^2) resulted from the modelled worst-case credible spill.

Woodside recognises that hydrocarbons may be visible beyond the EMBA at lower concentrations than the ecological impact thresholds defined in **Section 6.6.1.2**. These visible hydrocarbons are not expected to cause ecological impacts. In respect of this, an additional socio-cultural EMBA is defined, as the potential spatial extent within which social-cultural impacts may occur from changes to the visual amenity of the marine environment. Receptors relevant to the socio-cultural EMBA include Commonwealth and State marine protected areas (MPAs), National and Commonwealth Heritage Listed places, areas of tourism and recreation, and commercial and traditional fisheries. For this EP, the socio-cultural threshold for surface hydrocarbons encompasses an area fully within the boundaries of the EMBA for ecological impacts. The EMBA and socio-economic EMBA are described in **Table 4-1**.

The EMBA presented does not represent the predicted coverage of any one hydrocarbon spill or a depiction of a slick or plume at any particular point in time. Rather, the areas are a composite of a large number of theoretical paths, integrated over the full duration of the simulations under various metocean conditions.

Table 4-1: Hydrocarbon spill thresholds used to define EMBA for surface and in-water hydrocarbons

<table>
<tr><th>Hydrocarbon type</th><th>EMBA[1]</th><th>Socio-cultural EMBA[1]</th><th>Planning area for scientific monitoring</th></tr>
<tr><td>Surface</td><td>10 g/m^2
This represents the minimum oil thickness (0.01 mm) at which ecological impacts (e.g. to birds and marine mammals) are expected to occur.</td><td colspan="2">1 g/m^2
This represents a wider area where a visible sheen may be present on the surface and, therefore, the concentration at which socio-cultural impacts to the visual amenity of the marine environment may occur. However, it is below concentrations at which ecological impacts are expected to occur.
This low exposure value also establishes the planning area for scientific monitoring (NOPSEMA guidance note: A652993, April 2019).</td></tr>
<tr><td>Dissolved</td><td colspan="2">50 ppb
This represents potential toxic effects, particularly sub-lethal effects to highly sensitive species (NOPSEMA guidance note: A652993, April 2019). As dissolved hydrocarbons are within the water column and not visible, impacts to socio-cultural receptors are associated with ecological impacts. Therefore, dissolved hydrocarbons at this threshold also represent the level at which socio-cultural impacts may occur. The review and results are presented in Section 6.6.1.</td><td rowspan="2">10 ppb
This low exposure value establishes the planning area for scientific monitoring (based on potential for exceedance of water quality triggers) (NOPSEMA guidance note: A652993, April 2019). This area is described further in Appendix D.
In the event of a spill, DNP will be notified of Australian Marine Parks (AMPs) which may be contacted by</td></tr>
<tr><td>Entrained</td><td colspan="2">100 ppb</td></tr>
</table>

Hydrocarbon type	EMBA[1]	Socio-cultural EMBA[1]	Planning area for scientific monitoring
	This represents potential toxic effects, particularly sub-lethal effects to highly sensitive species (NOPSEMA guidance note: A652993, April 2019). As entrained hydrocarbons are within the water column and not visible, impacts to socio-cultural receptors are associated with ecological impacts. Therefore, entrained hydrocarbons at this threshold also represent the level at which socio-cultural impacts may occur.		hydrocarbons at this threshold **Table 7-3**.
Shoreline	100 g/m^2 This represents the threshold that could impact the survival and reproductive capacity of benthic epifaunal invertebrates living in intertidal habitat.	10 g/m^2 This represents the volume where hydrocarbons may be visible on the shoreline but is below concentrations at which ecological impacts are expected to occur.	N/A

[1] *Further details including the source of the thresholds used to define the EMBA in this table are provided in **Section 6.6.1.2**.*

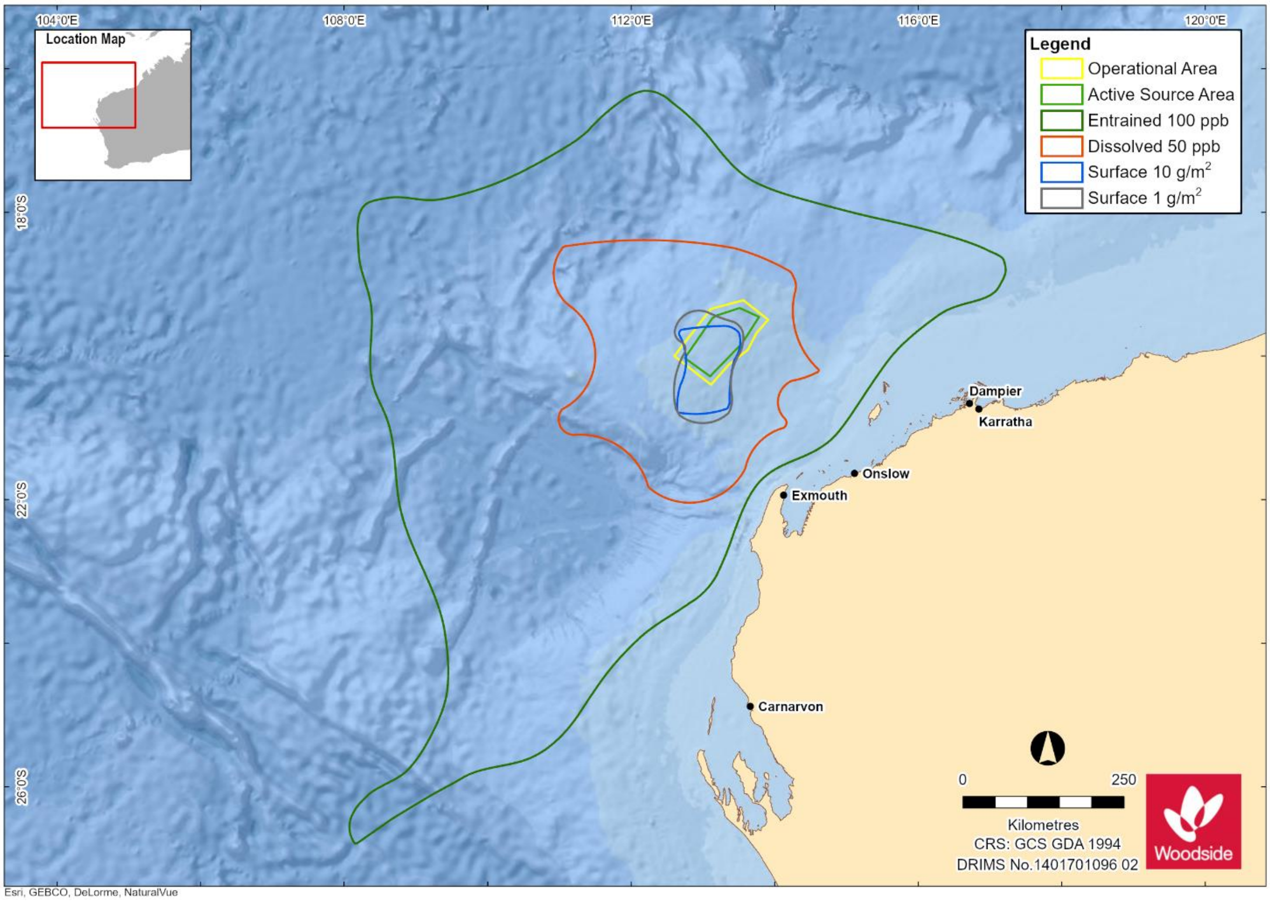


Figure 4-1: Environment that May Be Affected (EMBA) by the Petroleum Activities Program

4.2 Regional Context

The Operational Area is located in Commonwealth waters within the North-west marine region (NWMR), as defined under the Integrated Marine and Coastal Regionalisation of Australia (IMCRA v4.0) (Commonwealth of Australia, 2006), in water depths of about 800-1150 m. Within the NWMR, the Operational Area lies within the Northwest Province (**Figure 4-2**). The EMBA partially overlaps with additional provincial bioregions of the NWMR including the Northwest Transition, Central Western Transition, Northwest Shelf Province and Central Western Shelf Transition. The southern tip of the EMBA enters the South-west Marine Region (SWMR), and Central Western Province provincial bioregion. Woodside's Description of Existing Environment (**Appendix H**) summarised the characteristics for the relevant marine bioregions.

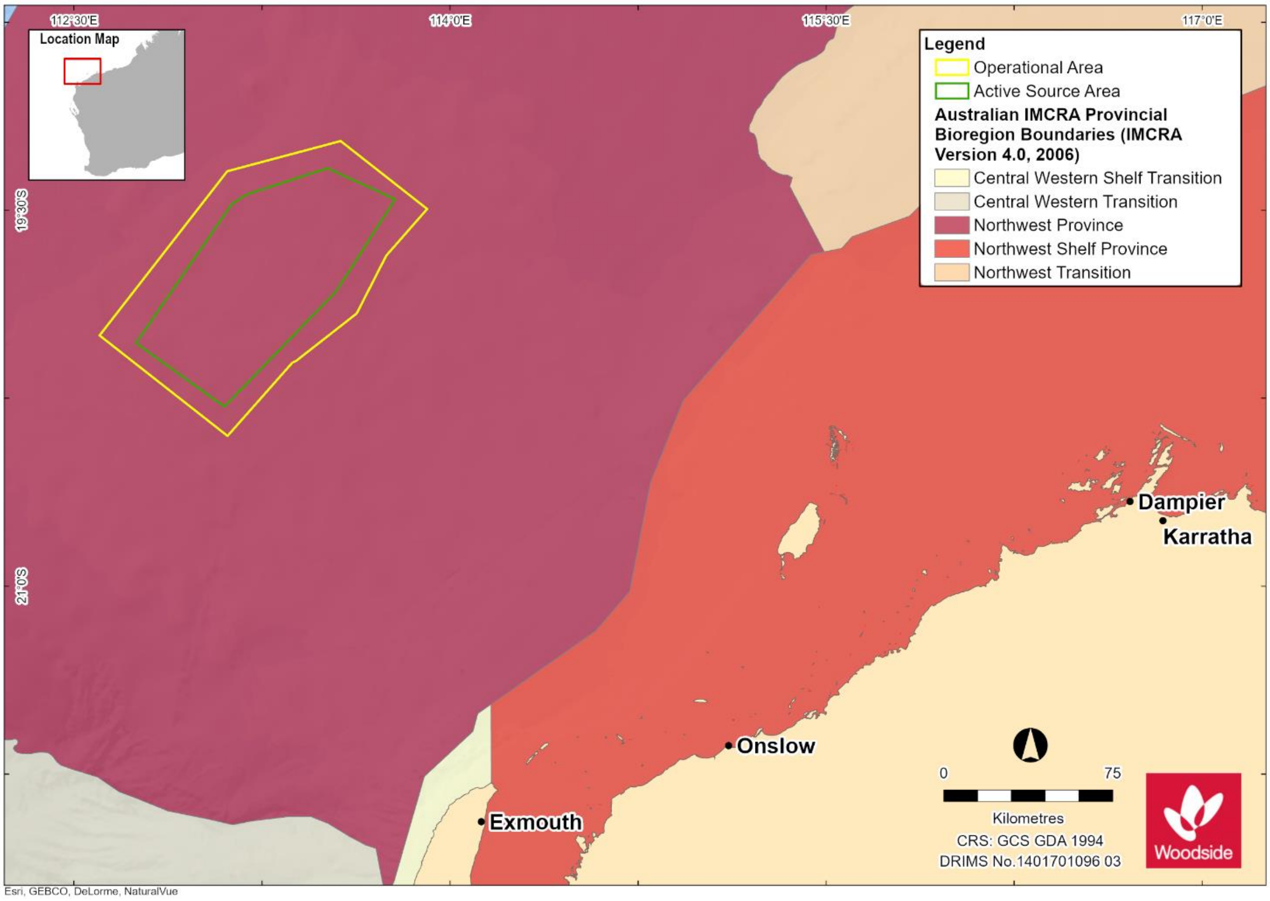


Figure 4-2: Location of the Operational Area and relevant marine bio-regions

4.3 Matters of National Environmental Significance

Table 4-2 and **Table 4-3** summarise the matters of national environmental significance (MNES) overlapping the Operational Area and EMBA, respectively, according to Protected Matters Search Tool (PMST) results (**Appendix C**). It should be noted that the EPBC Act PMST is a general database that conservatively identifies areas in which protected species have the potential to occur.

Additional information on these MNES are provided in subsequent sections of this chapter and described in detail in **Appendix H.**

Table 4-2: Summary of MNES identified by the EPBC Act PMST as potentially occurring within the Operational Area

MNES	Number	Description
World Heritage Properties	None	The closest World Heritage Property is the Ningaloo Coast World Heritage Property, located approximately 168 km SSE of the Operational Area.
National Heritage Places	None	The closest National Heritage Place is the Ningaloo Coast, located approximately 168 km SSE of the Operational Area.
Wetlands of International Importance (Ramsar)	None	The closest Ramsar wetland is Eighty Mile Beach, located approximately 615 km east of the Operational Area.
Commonwealth Marine Area	1	Generally, the Commonwealth Marine Area stretches from 3 nm to 200 nm from the coast. The Operational Area is located within the NWMR.
Listed Threatened Ecological Communities	None	No Threatened Ecological Communities (TECs) as listed under the EPBC Act are known to occur within the marine waters of the NWMR (**Appendix H: Section 10.6**).
Listed Threatened Species	12	Threatened species that were identified by the PMST as potentially occurring within the Operational Area are identified in **Section 4.6.1** to **Section 4.6.4** and described in **Appendix H: Section 5 – Section 8.**
Listed Migratory Species	25	Migratory species that were identified by the PMST as potentially occurring within the Operational Area are identified in **Section 4.6.1** to **Section 4.6.4** and described in **Appendix H: Section 5 – Section 8.**

Table 4-3: Summary of MNES identified by the EPBC Act PMST as potentially occurring within the EMBA

MNES	Number	Description
World Heritage Properties	None	There are no World Heritage Properties located within the EMBA.
National Heritage Places	None	There are no National Heritage Places located within the EMBA.
Wetlands of International Importance (Ramsar)	None	There are no Ramsar wetlands located within the EMBA.
Commonwealth Marine Area	2	The EMBA overlaps with the NWMR and SWMR.
Listed Threatened Ecological Communities	None	No Threatened Ecological Communities (TECs) as listed under the EPBC Act are known to occur within the marine waters of the NWMR (**Appendix H: Section 10.6**).
Listed Threatened Species	31	Threatened species that were identified by the PMST as potentially occurring within the EMBA are identified in **Section 4.6.1** to **Section 4.6.4** and described in **Appendix H: Section 5 – Section 8.**
Listed Migratory Species	50	Migratory species that were identified by the PMST as potentially occurring within the EMBA are identified in **Section 4.6.1** to **Section 4.6.4** and described in **Appendix H: Section 5 – Section 8.**

4.4 Physical Environment

The Operational Area is located entirely on the ‘Exmouth Plateau’ Key Ecological Feature (KEF), in water depths ranging from about 800 to 1150 m (**Figure 4-3**). The Exmouth Plateau is a distinctive geomorphic feature containing topographic features including terraces, canyons and pinnacles (DEWHA, 2008). The topography of the Exmouth Plateau is thought to modify deep water flow and contribute to upwelling of deep nutrient-rich waters, as well as provide conduits for moving sediment from the plateau surface to the abyss (DoEE n.d.).

Appendix H: Section 2 provides a summary of the physical characteristics of the environment within the Operational Area. The Operational Area is influenced by ocean currents as described in **Appendix H: Section 2.3**, which also provides a summary of the physical characteristics of the environment within the wider EMBA.

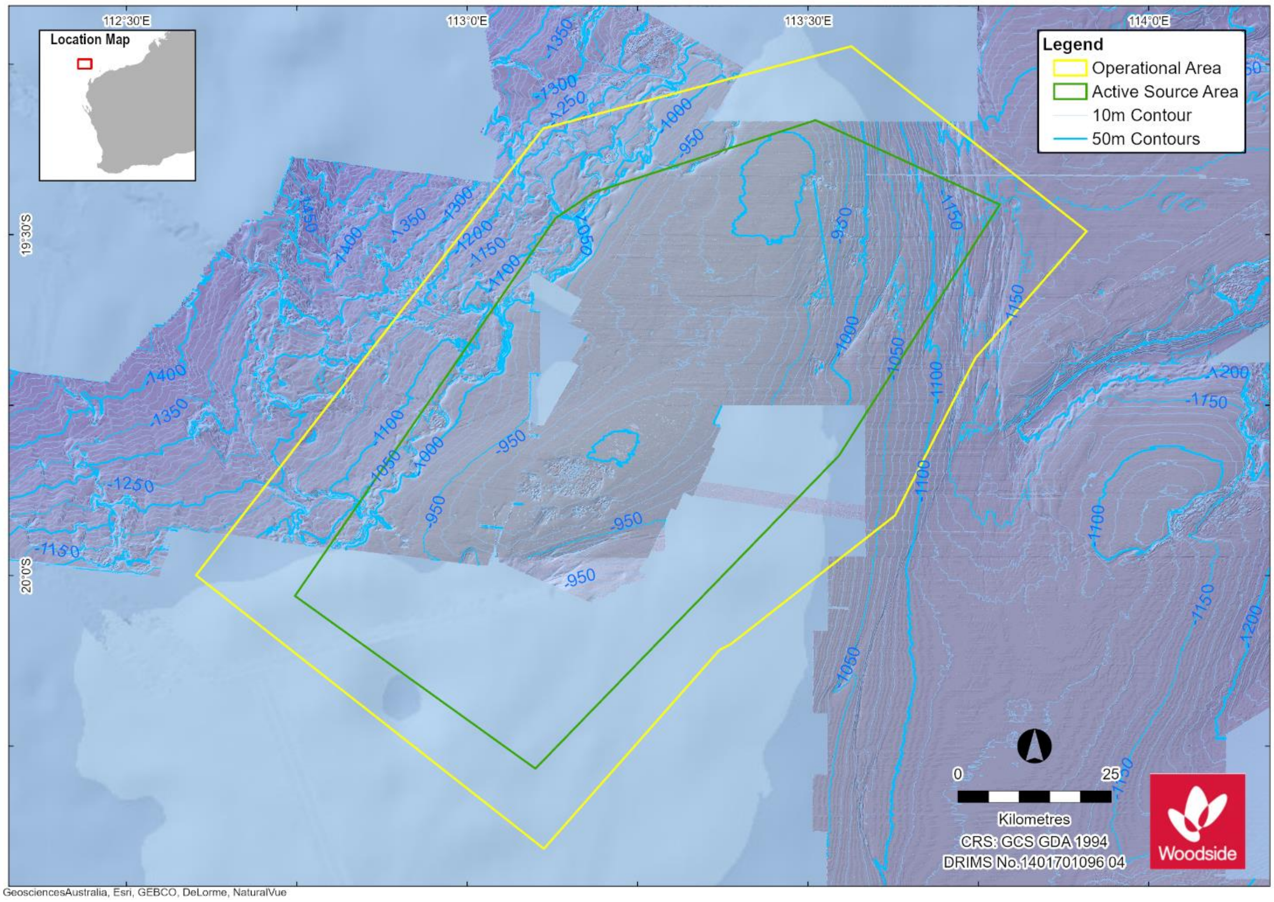


Figure 4-3: Bathymetry of the Operational Area

4.5 Habitats and Biological Communities

The benthic habitat associated with the deep water (>800 m), fine grain soft sediments in the Operational Area include fauna living within the sediments (infauna) and those living on or above the seabed (sessile and mobile epifauna). A remotely operated vehicle (ROV) survey conducted by Woodside at four well-sites (Toro-1, Steel Dragon-1, Hanover South and Anhalt-1) in waters between 821 and 2038 m depths off the coast of WA identified benthic associated species across the four distinct sites (Bryce et al., 2015). At the ROV survey location (Toro-1, located around 115 km SSE of the Operational Area) most consistent with the depths, sediment and geomorphology of the Operational Area, benthic fauna encountered were mostly echinoderms (e.g. sea cucumbers and sea stars), with distinct signs of infaunal bioturbators and potential mounds created by burrowing fish also noted, however abundance was found to be generally low. Benthic filter feeders and other epifauna and infauna are likely to inhabit the Operational Area, however the deep water depths and the presence of mostly fine grained sediments with a lack of hard substrate suggest abundances and diversity will be low, and consistent with much of the broader Northwest Province.

The Operational Area lies within the Exmouth Plateau KEF, an area that contributes to the productivity of the region driven by upwelling of deep nutrient-rich waters. The plateau's surface is rough and undulating at 900–1000 m depth (DoEE, n.d.). 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 1000 m (DOEE, n.d.). Additionally, the Operational Area overlaps entirely with the Northwest Province, which typically supports a low abundance, richness and diversity of benthic communities (Heyward et al., 2001).

No Critical Habitats or Threatened Ecological Communities as listed under the EPBC Act are known to occur within the Operational Area.

Key habitats and ecological communities within the EMBA are identified in **Table 4-4** and described in **Appendix H**.

Table 4-4: Key Habitats within the EMBA

Habitat/Community	Key locations within the EMBA
Marine primary producers	
Coral	Key locations for coral/habitat communities within the EMBA are at Rankin Bank, approximately 180 km east of the Operational Area. Refer to **Appendix H: Section 4** for a description of coral communities in the NWMR.
Seagrass beds and macroalgae	There are no recognised key locations for seagrass beds and macroalgae habitat/communities within the EMBA.
Mangroves	Shoreline accumulation of hydrocarbons is not expected above ecological thresholds and therefore no mangrove systems occur within the EMBA.
Sandy beaches	Shoreline accumulation of hydrocarbons is not expected above ecological thresholds and therefore no sandy beaches occur within the EMBA.
Salt marshes	Shoreline accumulation of hydrocarbons is not expected above ecological thresholds and therefore no salt marshes occur within the EMBA.
Other communities and habitats	
Plankton	Plankton within the Operational Area is expected to reflect the conditions of the NWMR. Primary productivity of the NWMR appears to be largely driven by offshore influences, with periodic upwelling events and cyclonic influences driving coastal productivity with nutrient recycling and advection. Refer to **Appendix H: Section 4.3** for a description of planktonic communities in the NWMR.
Pelagic and demersal fish populations	In the EMBA, fish diversity and abundance is typically correlated with habitat distribution, with complex habitats, such as coral and rocky reefs, hosting more diverse and abundant assemblages. Notable habitats hosting diverse fish assemblages include the Continental slope demersal fish communities KEF. Refer to **Appendix H: Section 5.5** for a description of pelagic and demersal fish populations in the NWMR.
Epifauna and infauna	The EMBA contains deep water habitats dominated by soft, fine grain sediments and sparse benthic biota. The benthic communities are characterised by benthic filter feeders and other epifauna, and infaunal bioturbators. Refer to **Appendix H: Section 5.5** for a description of epifauna and infauna in the NWMR.

4.6 Protected Species

A total of 55 EPBC Act listed species considered to be MNES were identified as potentially occurring within the EMBA, of which a subset of 25 species were identified as potentially occurring within the Operational Area. The full list of marine species identified from the PMST reports is provided in **Appendix C**, including several MNES that are not considered to be credibly impacted (e.g. terrestrial species within the EMBA). Criteria for determining species to be considered for impact assessment is outlined in **Appendix H: Section 3.2**. Two conservation dependent species have also been identified with a potential to occur within the Operational Area and EMBA; the scalloped hammerhead shark and the southern bluefin tuna. Species identified as potentially occurring within the Operational Area and EMBA and Biologically Important Areas (BIAs) or Habitat Critical to their Survival (Habitat Critical) that overlap the EMBA are listed in **Table 4-5** to **Table 4-13**, and a description of species is included in **Appendix H. Figure 4-4** to **Figure 4-8** show the spatial overlap with relevant BIAs and Habitat Critical areas and the EMBA.

4.6.1 Fish, Sharks and Rays

Table 4-5: Threatened and Migratory fish, shark and ray species predicted to occur within the Operational Area and EMBA

Species name	Common name	Threatened status	Migratory status	Potential for interaction	
				Operational Area	***EMBA***
Anoxypristis cuspidata	Narrow sawfish	N/A	Migratory	N/A	Species or species habitat known to occur
Carcharias taurus	Grey nurse shark	Vulnerable	N/A	N/A	Species or species habitat known to occur
Carcharhinus longimanus	Oceanic whitetip shark	N/A	Migratory	Species or species habitat may occur	Species or species habitat likely to occur
Carcharodon carcharias	Great white shark	Vulnerable	Migratory	Species or species habitat may occur	Species or species habitat known to occur
Isurus oxyrinchus	Shortfin mako	N/A	Migratory	Species or species habitat likely to occur	Species or species habitat likely to occur
Isurus paucus	Longfin mako	N/A	Migratory	Species or species habitat likely to occur	Species or species habitat likely to occur
Lamna nasus	Mackerel shark	N/A	Migratory	N/A	Species or species habitat may occur
Manta alfredi	Reef manta ray	N/A	Migratory	N/A	Species or species habitat known to occur
Manta birostris	Giant manta ray	N/A	Migratory	Species or species habitat may occur	Species or species habitat known to occur
Pristis clavata	Dwarf sawfish	Vulnerable	Migratory	N/A	Species or species habitat known to occur
Pristis zijsron	Green sawfish	Vulnerable	Migratory	N/A	Species or species habitat known to occur
Rhincodon typus	Whale shark	Vulnerable	Migratory	N/A	Foraging, feeding or related behaviour known to occur

Table 4-6: Fish, shark and ray BIAs within the EMBA

Species	BIA type	Approximate distance and direction of BIA from Operational Area (km)
Whale shark	Foraging (northward from Ningaloo along 200 m isobath)	136 km south-east

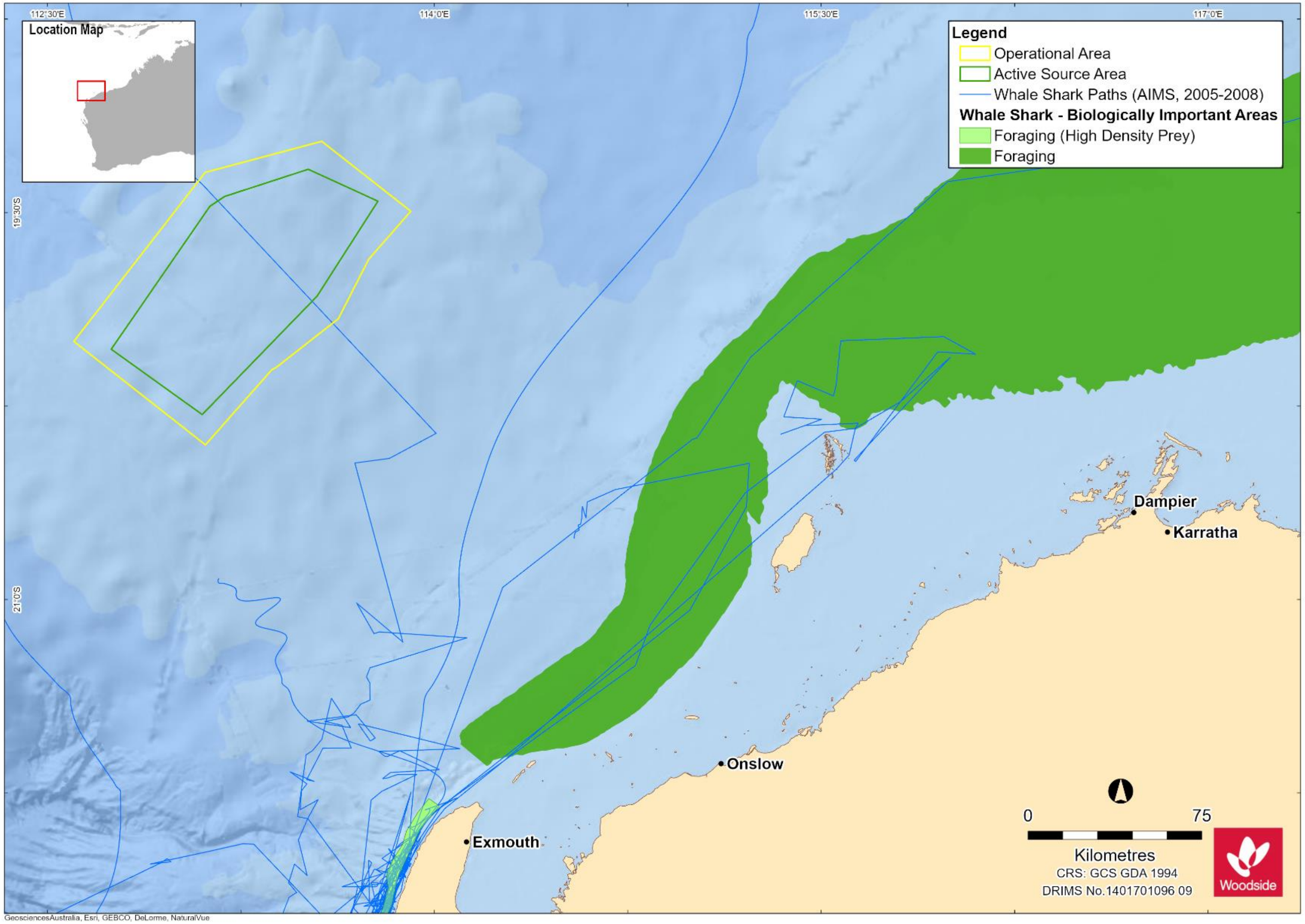


Figure 4-4: Whale shark BIAs and satellite tracks of whale sharks tagged between 2005 and 2008 (Meekan and Radford, 2010)

4.6.2 Marine Reptiles

Table 4-7: Threatened and Migratory marine reptile species predicted to occur within the Operational Area and EMBA

Species name	Common name	Threatened status	Migratory status	Potential for interaction	
				Operational Area	***EMBA***
Aipysurus apraefrontalis	Short-nosed sea snake	Critically Endangered	N/A	N/A	Species or species habitat likely to occur
Caretta caretta	Loggerhead turtle	Endangered	Migratory	Species or species habitat likely to occur	Species or species habitat known to occur
Chelonia mydas	Green turtle	Vulnerable	Migratory	Species or species habitat likely to occur	Species or species habitat known to occur
Dermochelys coriacea	Leatherback turtle	Endangered	Migratory	Species or species habitat likely to occur	Species or species habitat known to occur
Eretmochelys imbricata	Hawksbill turtle	Vulnerable	Migratory	Species or species habitat likely to occur	Species or species habitat known to occur
Natator depressus	Flatback turtle	Vulnerable	Migratory	Species or species habitat likely to occur	Congregation or aggregation known to occur

Table 4-8: Marine turtle BIAs within the EMBA

Species	BIA type	Approximate distance and direction of BIA from Operational Area
Flatback turtle	Internesting buffer (Montebello Island, Hermite Island, NW Island, Trimouille Island)	135 km south-east
	Internesting buffer (Thevenard Island – South coast)	149 km south-east
Green turtle	Internesting buffer (Montebello Islands)	170 km south-east
	Internesting buffer (north and south Muiron Island)	170 km south-east
	Internesting buffer (Montebello Island, Hermite Island, NW Island, Trimouille Island)	174 km south-east
	Internesting buffer (Middle Island, west coast Barrow Island, west coast and north coast)	181 km south-east
Hawksbill turtle	Internesting buffer (Montebello Island, Hermite Island, NW Island, Trimouille Island)	174 km south-east

Species	BIA type	Approximate distance and direction of BIA from Operational Area
	Internesting buffer (Barrow Island)	181 km south-east
Loggerhead turtle	Internesting buffer (Montebello Islands)	187 km east

Table 4-9: Internesting Habitat Critical to the survival of marine turtle species predicted to occur within the EMBA

Species	Genetic stock	Nesting locations	Approximate distance and direction from Operational Area	Inter-nesting buffer	Nesting period	Hatching period
Green turtle	North West Shelf	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	175 km south-east	20 km	Nov–Mar	Jan–May (peak: Feb–Mar)
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.	147 km south-east	60 km	Oct–Mar (peak: Feb-Mar)	Oct–Mar
Hawksbill turtle	Western Australia	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	175 km south-east	20 km	All year (peak: Oct–Feb)	All year (peak: Dec–Feb)
Loggerhead turtle	No overlap within EMBA					
Leatherback turtle	No overlap – nesting located in Northern Territory and North Queensland					
Olive Ridley turtle	No overlap – nesting located in Northern Australia and North Queensland					

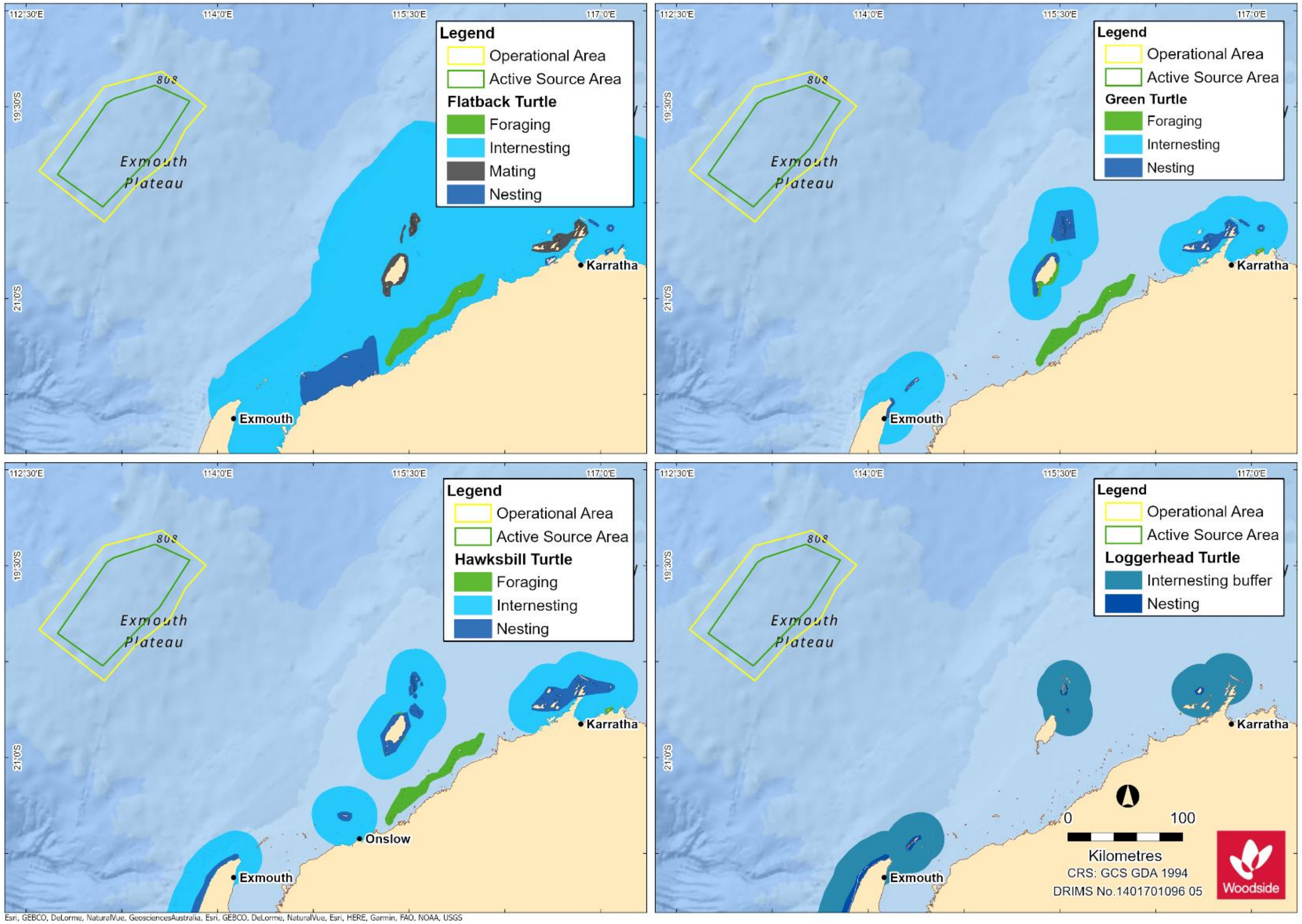


Figure 4-5: Marine reptile BIAs

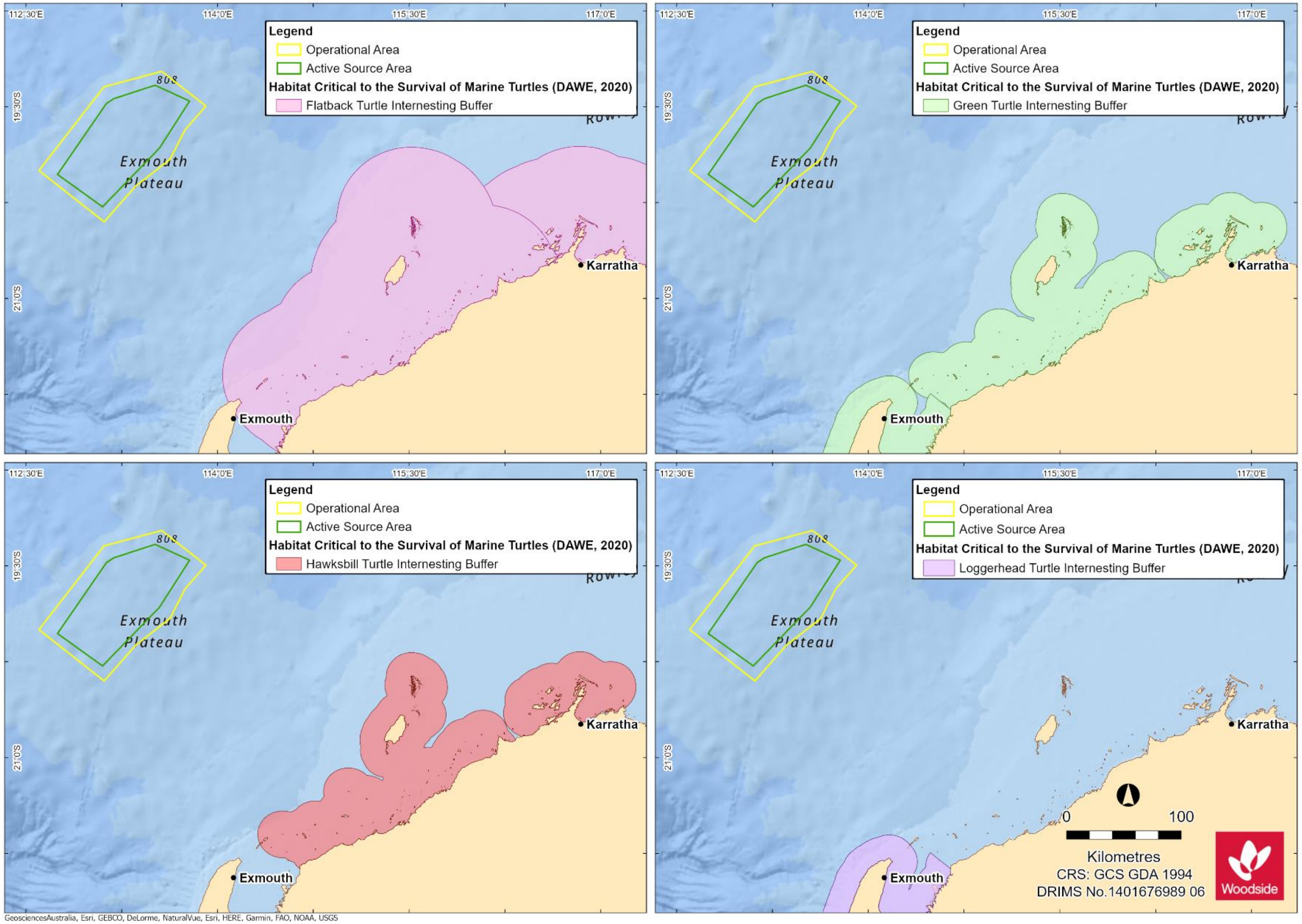


Figure 4-6: Habitat Critical to the survival of marine turtles

4.6.3 Marine Mammals

Table 4-10: Threatened and Migratory marine mammal species predicted to occur within the Operational Area and EMBA

Species name	Common name	Threatened status	Migratory status	Potential for interaction	
				Operational Area	***EMBA***
Balaenoptera bonaerensis	Antarctic minke whale	N/A	Migratory	Species or species habitat likely to occur	Species or species habitat likely to occur
Balaenoptera borealis	Sei whale	Vulnerable	Migratory	Species or species habitat likely to occur	Foraging, feeding or related behaviour likely to occur
Balaenoptera edeni	Bryde's whale	N/A	Migratory	Species or species habitat likely to occur	Species or species habitat likely to occur
Balaenoptera musculus	Blue whale	Endangered	Migratory	Species or species habitat likely to occur	Migration route known to occur
Balaenoptera physalus	Fin whale	Vulnerable	Migratory	Species or species habitat likely to occur	Foraging, feeding or related behaviour likely to occur
Dugong dugon	Dugong	N/A	Migratory	N/A	Species or species habitat likely to occur
Eubalaena australis	Southern right whale	Endangered	Migratory	N/A	Species or species habitat likely to occur
Megaptera novaeangliae	Humpback whale	Vulnerable	Migratory	Species or species habitat may occur	Breeding known to occur
Orcinus orca	Killer whale	N/A	Migratory	Species or species habitat may occur	Species or species habitat may occur
Physeter macrocephalus	Sperm whale	N/A	Migratory	Species or species habitat may occur	Species or species habitat may occur
Sousa chinensis	Indo-Pacific humpback dolphin	N/A	Migratory	N/A	Species or species habitat may occur
Tursiops aduncus	Spotted bottlenose dolphin (Arafura/Timor Sea)	N/A	Migratory	N/A	Species or species habitat known to occur

Table 4-11: Marine mammal BIAs within the EMBA

Species	BIA type	Approximate distance and direction from Operational Area
Pygmy blue whale	Migration (Augusta to Derby, tend to pass along the shelf edge at depths of 500 m to 1000 m; appear close to coast in the Exmouth-Montebello Islands area on southern migration).	14 km south-east
	Foraging (Ningaloo)	154 km south
Humpback whale	Migration (Extends from the coast to out to approximately 10 0km off shore in the Kimberley region extending south to North-west Cape. From North-west Cape to south of Shark Bay the migration corridor is reduced to approximately 50 km).	138 km south-east

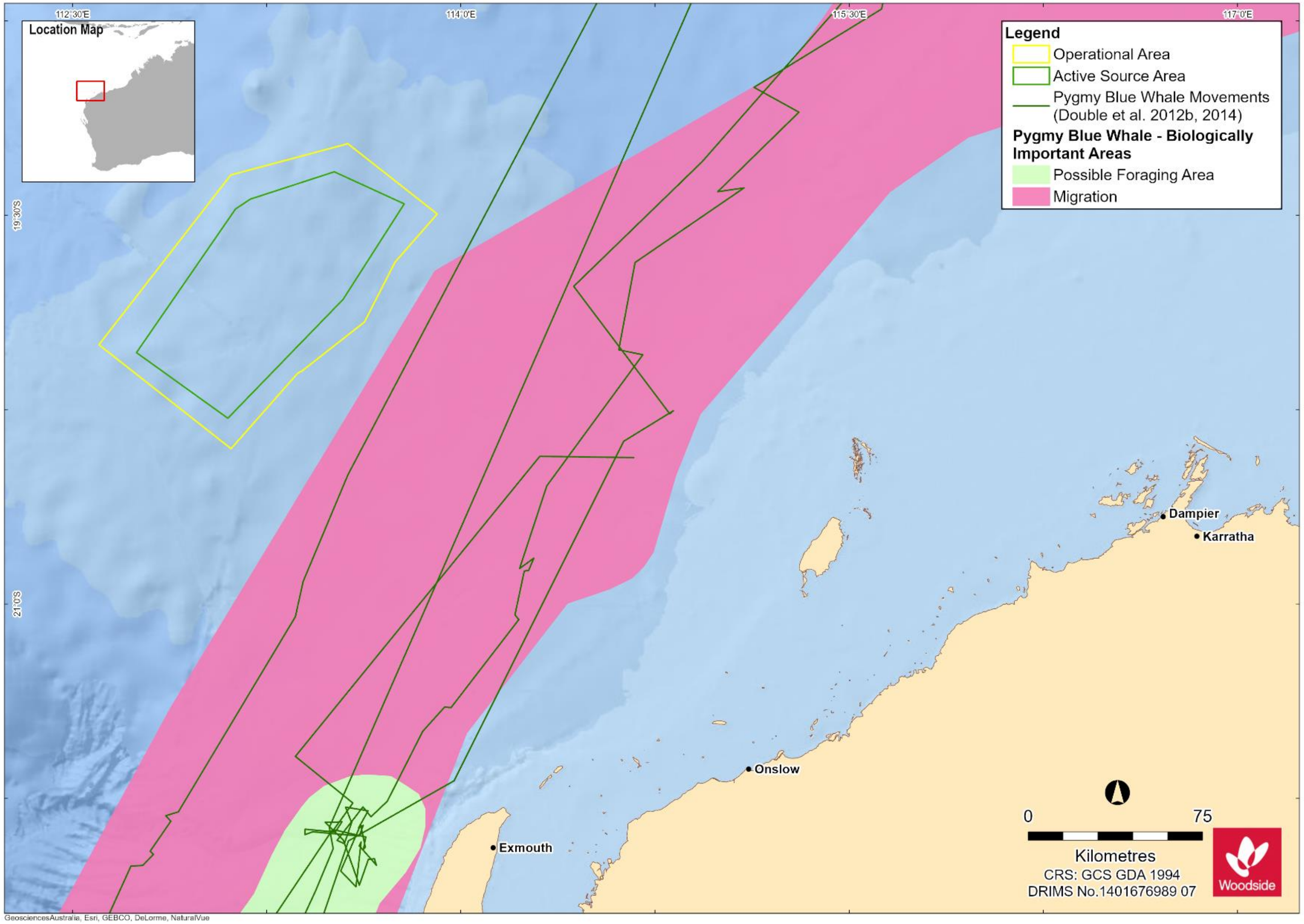


Figure 4-7: Pygmy blue whale BIAs and satellite tracks of whales tagged between 2009 and 2012 (Double et al., 2012b, 2014)

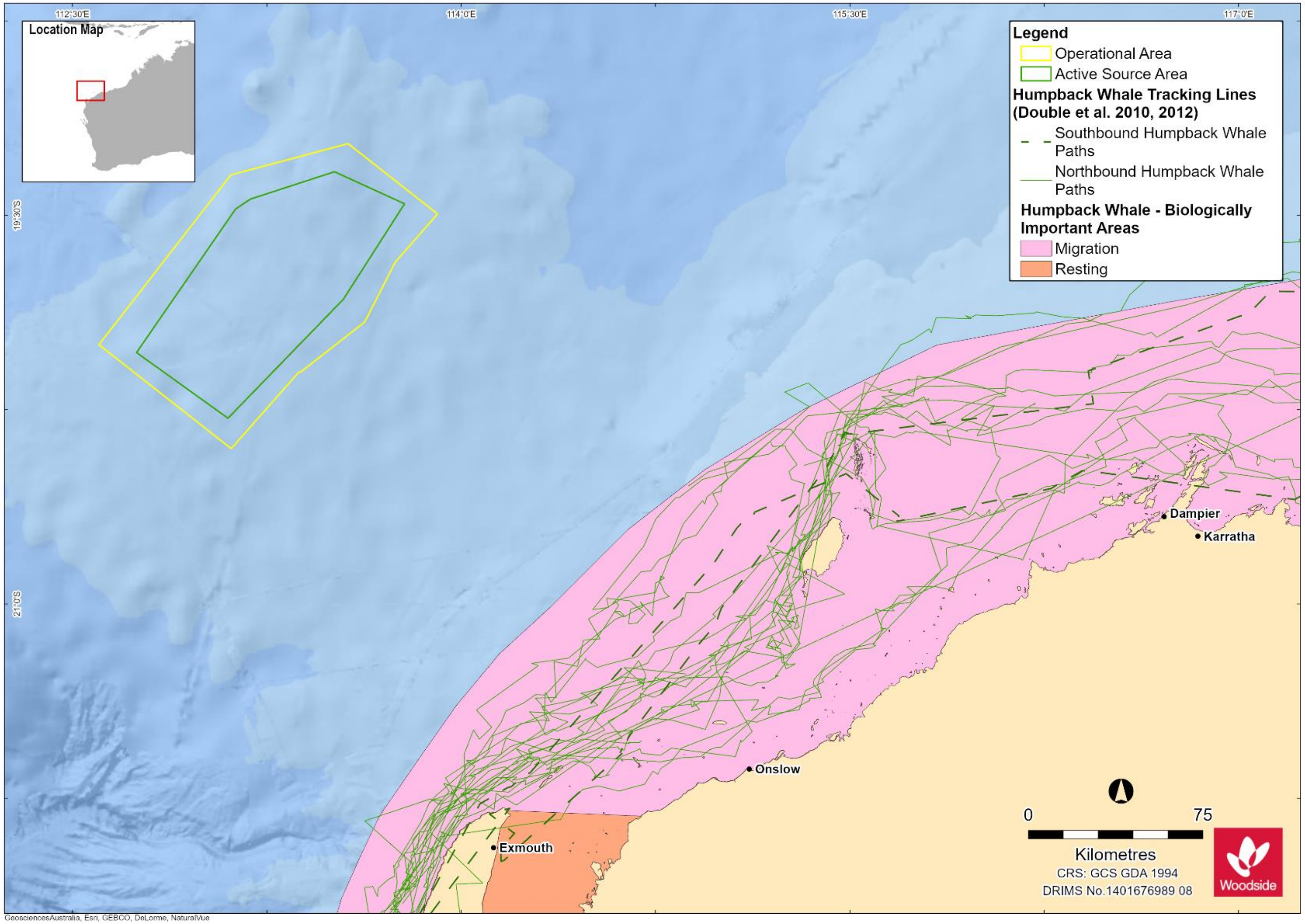


Figure 4-8: Humpback whale BIAs and satellite tracks of whales tagged between 2010 and 2012 (Double et al., 2010, 2012a)

4.6.4 Seabirds and Migratory Shorebirds

Table 4-12: Threatened and Migratory seabird and shorebird species predicted to occur within the Operational Area and EMBA

Species name	Common name	Threatened status	Migratory status	Potential for interaction	
				Operational Area	***EMBA***
Anous stolidus	Common noddy	N/A	Migratory	Species or species habitat may occur w	Species or species habitat may occur
Ardenna carneipes	Flesh-footed shearwater	N/A	Migratory	N/A	Foraging, feeding or related behaviour likely to occur
Calidris canutus	Red knot	Endangered	Migratory	Species or species habitat may occur	Species or species habitat may occur
Calidris ferruginea	Curlew sandpiper	Critically Endangered	N/A	N/A	Species or species habitat may occur
Calonectris leucomelas	Streaked shearwater	N/A	Migratory	N/A	Species or species habitat likely to occur
Fregata ariel	Lesser frigatebird	N/A	Migratory	Species or species habitat may occur	Species or species habitat likely to occur
Fregata minor	Greater frigatebird	N/A	Migratory	N/A	Species or species habitat may occur
Macronectes giganteus	Southern giant petrel	Endangered	Migratory	Species or species habitat may occur	Species or species habitat may occur
Numenius madagascariensis	Eastern curlew	Critically Endangered	Migratory	N/A	Species or species habitat may occur
Papasula abbotti	Abbott's booby	Endangered	N/A	N/A	Species or species habitat may occur
Pterodroma mollis	Soft-plumaged petrel	Vulnerable	N/A	N/A	Foraging, feeding or related behaviour likely to occur
Sterna dougallii	Roseate tern	N/A	Migratory	N/A	Foraging, feeding or related behaviour likely to occur

Species name	Common name	Threatened status	Migratory status	Potential for interaction	
				Operational Area	***EMBA***
Sternula nereis nereis	Australian fairy tern	Vulnerable	N/A	N/A	Foraging, feeding or related behaviour likely to occur
Thalassarche carteri	Indian yellow-nosed albatross	Vulnerable	Migratory	N/A	Foraging, feeding or related behaviour may occur

N.B. The wedge-tailed shearwater was not identified in the PMST as potentially occurring within the EMBA; however, given a BIA for wedge-tailed shearwater breeding partially overlaps the EMBA, it is considered possible that the species may be encountered within the EMBA.

Table 4-13: Seabird and shorebird BIAs within the EMBA

Species	BIA type	Approximate Distance and Direction from Operational Area (km)
Wedge-tailed shearwater	Breeding and foraging (Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef)	85 km south-east
Roseate tern	Breeding and foraging (Kimberley, Pilbara and Gascoyne coasts and islands including Ashmore Reef)	205 km south-east

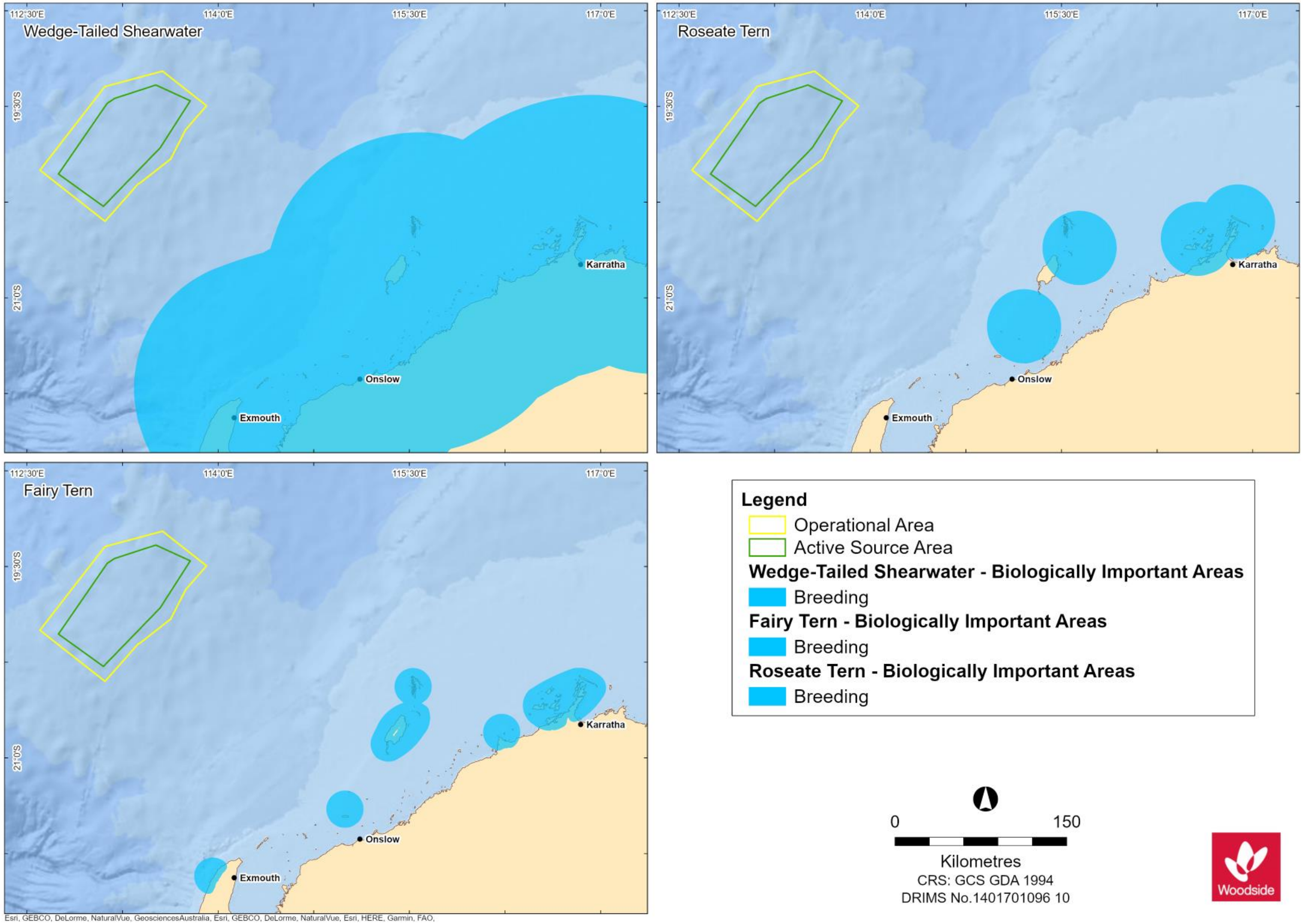


Figure 4-9: Seabird and migratory shorebird BIAs

4.6.5 Seasonal Sensitivities for Protected Species

Seasonal sensitivities for protected migratory species identified as potentially occurring within the Operational Area are identified in **Table 4-14**. Movement patterns of all protected species identified in **Section 4.6** are described in **Appendix H**.

Table 4-14: Key seasonal sensitivities for protected migratory species identified potentially as occurring within the Operational Area.

Species	January	February	March	April	May	June	July	August	September	October	November	December
Fish, sharks and rays												
Whale shark – foraging (northward from Ningaloo)[1]												
Mammals												
Pygmy blue whale – northern migration (Exmouth, Montebello, Scott Reef)[2]												
Pygmy blue whale – southern migration (Exmouth, Montebello, Scott Reef)[3]												
Humpback whale – northern migration (Jurien Bay to Montebello)[4]												
Humpback whale – southern migration (Jurien Bay to Montebello)[5]												
Marine reptiles												
Green turtle (G-NWS)– various nesting areas[6]												
Flatback turtle (F-Pil)– various nesting areas[6]												
Hawksbill turtle (H-WA)– various nesting areas[6]												
Loggerhead turtle (L-WA)– various nesting areas[6]												
Seabirds												
Wedge-tailed shearwater – various breeding sites[7]												
Roseate tern – various breeding sites[7]												

(light yellow)	Species may be present in the Operational Area
(orange)	Peak period. Presence of animals is reliable and predictable each year

References for species seasonal sensitivities:

[1] TSSC, 2015; Wilson et al., 2006

[2] DSEWPaC, 2012; McCauley and Jenner, 2010; Double et al., 2012b, 2014

[3] DSEWPaC, 2012; McCauley and Jenner, 2010, Double et al., 2012b, 2014

[4] *DEH, 2005; Jenner et al., 2001; McCauley and Jenner, 2001; Double et al., 2012a*

[5] *McCauley and Jenner, 2001, Jenner et al., 2001, Double et al., 2010*

[6] *DoEE, 2017a; Chevron, 2015*

[7] *Johnstone and Storr (1998)*

4.7 Key Ecological Features (KEFs)

KEFs within the Operational Area and EMBA are identified in **Table 4-15** and described in **Appendix H. Figure 4-10** shows the spatial overlap with KEFs and the Operational Area and EMBA.

Table 4-15: KEFs within the Operational Area and EMBA.

Key Ecological Feature	Distance and direction from Operational Area to KEF
Exmouth Plateau	Overlaps
Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	103 km south-east
Continental slope demersal fish communities	145 km south-east
Ancient coastline at 125 m depth contour	90 km south-east
Wallaby Saddle	530 km south
Western demersal slope and associated fish communities	690 km south

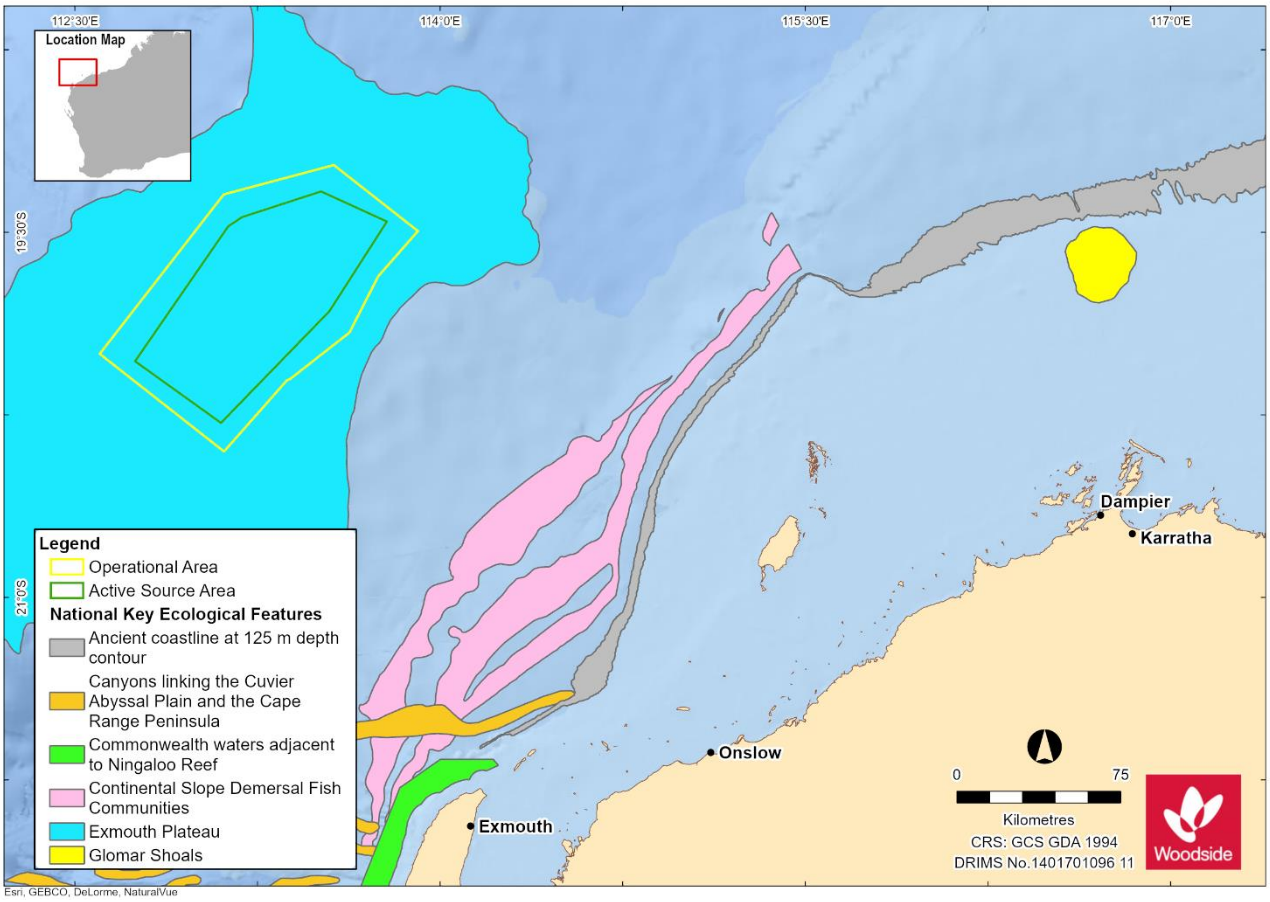


Figure 4-10: KEFs with reference to the Operational Area

4.8 Protected Places

No protected places overlap the Operational Area. Protected places within the EMBA are identified in **Table 4-16** and presented in **Figure 4-11**. **Appendix H** outlines the values and sensitivities of protected places and other sensitive areas in the EMBA.

Table 4-16: Established protected places and other sensitive areas overlapping the EMBA

	Distance and direction from Operational Area to protected place or sensitive area	IUCN category* or relevant park zone overlapping the EMBA
AMPs		
NWMR		
Gascoyne AMP	33 km south	Multiple Use Zone (IUCN VI)
	174 km south	National Park Zone (IUCN II)
	133 km south	Habitat Protection Zone (IUCN IV)
Montebello AMP	170 km east	Multiple Use Zone (IUCN VI)
Carnarvon Canyon AMP	370 km south	Habitat Protection Zone (IUCN IV)
SWMR		
Abrolhos AMP	515 km south	Habitat Protection Zone (IUCN IV)

	Distance and direction from Operational Area to protected place or sensitive area	IUCN category* or relevant park zone overlapping the EMBA
State Marine Parks and Nature Reserves		
Marine Parks		
None identified	N/A	N/A
Marine Management Areas		
None identified	N/A	N/A
Fish Habitat Protection Areas		
None identified	N/A	N/A
Nature Reserves		
None identified	N/A	N/A
Other sensitive areas		
None identified	N/A	N/A

**Conservation objectives for IUCN categories include:*

Ia: Strict Nature Reserve

Ib: Wilderness Area

II: national Park

III: Natural Monument or Feature

IV: Habitat/Species Management Area

V: Protected Landscape

VI: Protected area with sustainable use of natural resources – allow human use but prohibits large scale development.

IUCN categories for the marine park are provided and, in brackets, the IUCN categories for specific zones within each Marine Park as assigned under the North-west Marine Parks Network Management Plan 2018 (DNP, 2018a) and South-west Marine Parks Network Management Plan 2018 (DNP, 2018b).

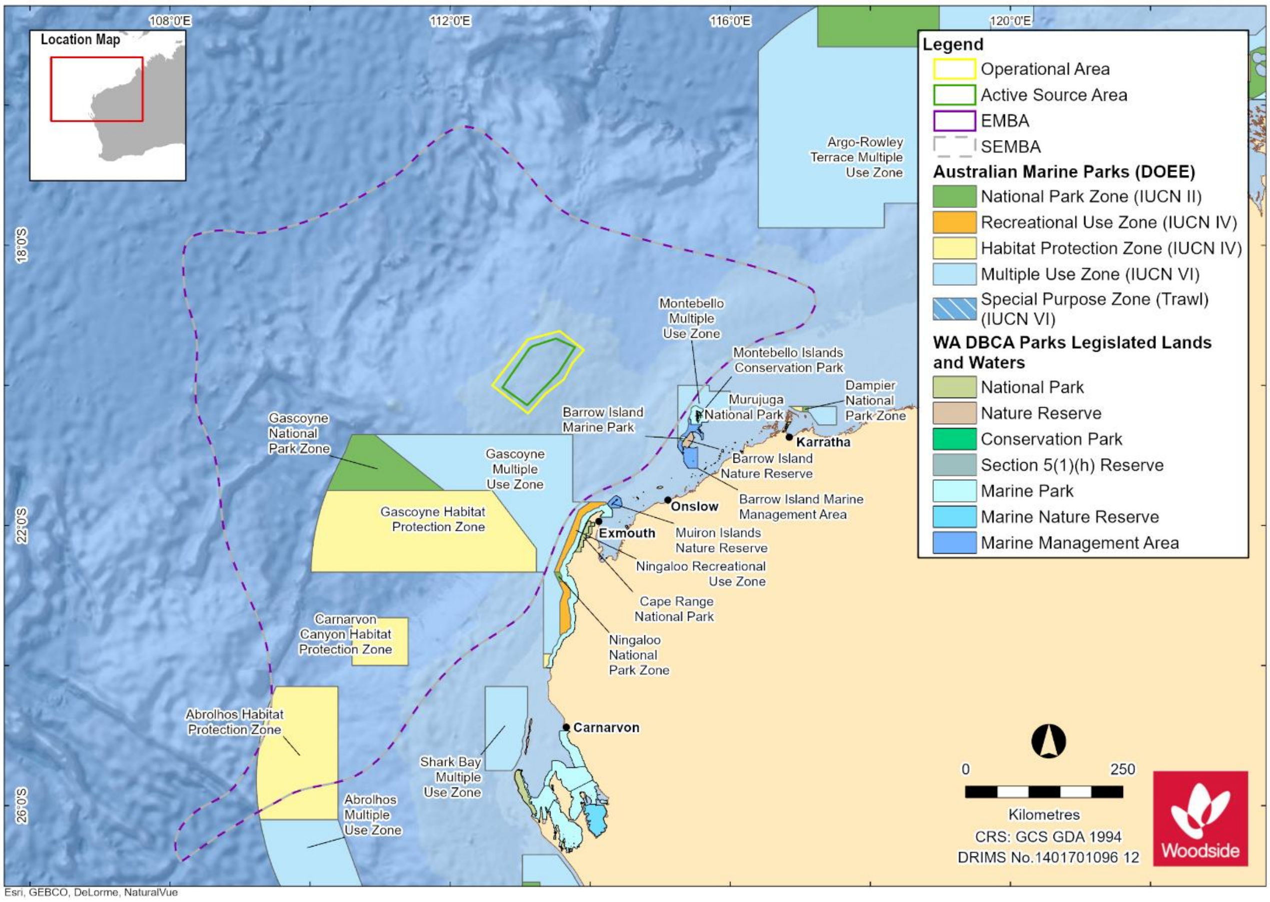


Figure 4-11: Protected Areas with reference to the Operational Area and EMBA

4.9 Socio-Economic Environment

4.9.1 Cultural Heritage

4.9.1.1 Indigenous Sites of Significance

Indigenous Australian people have a strong continuing connection with the area that extends back some 65,000 years. Woodside acknowledges this unique connection between Aboriginal peoples and the land and sea in which the company operates. Woodside also understands that while marine resources used by Indigenous people are generally limited to coastal waters for activities such as fishing, hunting and maintenance of culture and heritage, many Aboriginal groups have a direct cultural interest in decisions affecting the management of deeper offshore waters, particularly through intangible heritage values or culturally significant migratory fauna.

The longstanding relationship between Aboriginal people and the land and sea is prevalent in Indigenous culture today and Indigenous heritage places including archaeological sites protected under the Aboriginal and Torres Strait Islander Heritage Protection Act 1984, Underwater Cultural Heritage Act 2018, Aboriginal Heritage Act 1972 (WA) or EPBC Act. Australia's only known sub-sea Indigenous archaeological site is located within the Dampier Archipelago (Benjamin et al 2020). No Indigenous archaeology is known to exist anywhere within Commonwealth waters.

4.9.1.2 European Sites of Significance

There are no known sites of European cultural heritage significance within the Operational Area. **Appendix H** describes cultural heritage sites within the EMBA.

4.9.1.3 Underwater Heritage

A search of the Australian National Shipwreck Database, which records all known Maritime Cultural Heritage (shipwrecks, aircraft, relics and other underwater cultural heritage) in Australian waters indicated that there are no sites within the Operational Area, and nine sites within the EMBA. The closest Underwater Cultural Heritage site is the wreck of the *Wild Wave*, a Chinese sailing vessel sunk off the Montebello Islands, approximately 150 km east of the Operational Area.

4.9.1.4 World, National and Commonwealth Heritage Listed Places

No listed World, National and Commonwealth heritage places overlap the Operational Area or EMBA.

4.9.2 Commercial Fisheries

A number of Commonwealth and State fishery management areas are located within the Operational Area and EMBA. The Annual Fishery Status Reports published by the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) were used to identify if Commonwealth managed fisheries that have fished within the Operational Area in the last 10 years. FishCube data were also requested from the WA Department of Primary Industries and Regional Development (DPIRD) for the most recently available 10-year period of fishery catch and effort data (2010 – 2019) to analyse the potential for interaction with State managed fisheries within the Operational Area (DPIRD, 2021). This information was used to determine relevant fisheries for consultation who may be impacted by proposed petroleum activities. **Table 4-17** provides an assessment of the potential interaction and provides further detail on the fisheries that have been identified through desk-based assessment and consultation (**Section 5**).

Table 4-17: Commonwealth and State Managed Commercial Fisheries Management Areas overlapping the Operational Area and EMBA

Fishery Name	Overlap with Operational Area	Overlap with EMBA	Potential for interaction within Operational Area	
Commonwealth Managed Fisheries				
Southern Bluefin Tuna Fishery	✓	✓	×	No fishing effort has occurred within or nearby to the Operational Area in at least the last 10 years (Patterson et al., 2015, 2016, 2017, 2018, 2019, 2020). Fishing effort is concentrated mainly in the eastern part of the Great Australian Bight and off the New South Wales coastline (Patterson et al. 2020).
Western Skipjack Tuna Fishery	✓	✓	×	The Western Skipjack Tuna Fishery is not currently active and no fishing has occurred since 2009 (Patterson et al., 2020). Fishing was previously undertaken in the Great Australian Bight off South Australia (Patterson et al., 2020). Therefore, no fishing effort occurs within the Operational Area.
Western Tuna and Billfish Fishery	✓	✓	×	No fishing effort has occurred within or nearby to the Operational Area in at least the last 10 years. The nearest fishing effort occurs over 350 km south of the

Fishery Name	Overlap with Operational Area	Overlap with EMBA	Potential for interaction within Operational Area	
				Operational Area (Patterson et al., 2015, 2016, 2017, 2018, 2019, 2020).
Western Deepwater Trawl Fishery	✓	✓	×	Based on review of the annual fishery status reports published by ABARES, fishing by the Western Deepwater Trawl Fishery on the Exmouth Plateau in an area overlapped by the Operational Area last occurred sometime between 2003 and 2008. Since then, the nearest fishing effort occurred in 2017 over 75 km south of the Operational Area (Woodhams and Bath 2017; Patterson et al., 2015, 2016, 2017, 2018, 2019, 2020).
North West Slope Trawl Fishery	×	✓	×	The Operational Area is located less than 10 km west of the North West Slope Trawl Fishery fishing management boundary. No fishing effort occurs within the Operational Area, with the nearest fishing effort occurring at the boundary of the management area (Patterson et al., 2015, 2016, 2017, 2018, 2019, 2020).
State Managed Fisheries				
Mackerel Managed Fishery	✓	✓	×	The Operational Area is located within the Mackerel Managed Fishery Management Area 3 and less than 10 km west of Area 2. However, no fishing occurs due to the water depths and distance from shore. Current catch and effort data (2010 – 2019) confirms that the Mackerel Managed Fishery does not fish within the Operational Area, with the nearest fishing effort occurring over 125 km south-east (10 nm CAES block 203144) of the Operational Area (DPIRD, 2021).
Pilbara Line Managed Fishery	×	✓	×	The Pilbara Line Managed Fishery operates up to a depth of 600 m. No fishing occurs in the Operational Area due to the water depths and distance from shore. Current catch and effort data (2010 – 2019) confirms that the Pilbara Line Managed Fishery does not fish within the Operational Area (DPIRD, 2021).
Pilbara Trap Managed Fishery	×	✓	×	The Operational Area is located over 130 km north west of the fishing management boundary. Current catch and effort data (2010 – 2019) confirms no catch or effort within the Operational Area (DPIRD, 2021).
Pilbara Fish Trawl (Interim) Managed Fishery	×	✓	×	The Operational Area is located over 130 km north west of the fishing management boundary, and about 220 km west of a zone where trawl fishing is permitted. Current catch and effort data (2010 – 2019) confirms no catch or effort within the Operational Area, with the nearest fishing effort occurring over 230 km east (10 nm CAES block 200160) of the Operational Area (DPIRD, 2021).
South West Coast Salmon Managed Fishery	✓	✓	×	No fishing effort occurs north of the Perth metropolitan area (as advised by WAFIC), and therefore no fishing effort occurs within or nearby to the Operational Area.
Marine Aquarium Managed Fishery	✓	✓	×	This fishery generally collects fish for display in water depths of less than 30 m. Current catch and effort data (2010 – 2019) confirms no catch or effort within the Operational Area, with nearest fishing effort occurring

Fishery Name	Overlap with Operational Area	Overlap with EMBA	Potential for interaction within Operational Area	
				over 170 km south-east (10 nm CAES block 214140) of the Operational Area (DPIRD, 2021).
West Coast Deep Sea Crustacean Managed Fishery	✓	✓	✗	The West Coast Deep Sea Crustacean Managed Fishery can fish in water depths greater than the 150 m isobath, with fishing targeting crystal crabs, which are caught primarily in depths of 500 – 800m. Fishing effort is primarily concentrated between Fremantle and Carnarvon. A single 10 nm CAES block (202125) was reportedly fished on the Exmouth Plateau at the southern boundary of the Operational Area sometime between 2003 and 2010 (How et al., 2015, 2017). However, fishing effort has not been reported here since and more recent catch and effort data (2010 – 2019) confirms no catch or effort within the Operational Area; the closest blocks fished during this period were located about 300 km south (10 nm CAES block 230130) of the Operational Area (DPIRD, 2021). Therefore, fishing effort is unlikely to occur in or near the Operational Area.
Specimen Shell Managed Fishery	✗	✓	✗	The Operational Area is located over 110 km north-west of the fishery management boundary. This fishery primarily uses hand collection methods to collect shells in water depths of less than 30 m. A single licence exemption permits the use of a remote-controlled underwater vehicle at depths of up to 300 m, although this is no longer active. Current catch and effort data (2010 – 2019) confirms no catch or effort within the Operational Area, with nearest fishing effort occurring over 150 km south-west (10 nm CAES block 213140) of the Operational Area (DPIRD, 2021).
Western Australian Abalone Managed Fishery	✗	✓	✗	The Operational Area is located over 110 km north-west of the fishery management boundary. This fishery uses hand collection methods to collect abalone in water depths of less than 40 m. No fishing effort for the West Australian Abalone Fishery has occurred north of Moore River since 2011-2012 (Strain et al., 2019).
Beche-de-Mer Fishery (Sea Cucumber Fishery)	✓	✓	✗	The target species typically inhabit nearshore waters. Species are collected by hand by divers and waders throughout the Kimberley region (Gaughan and Santoro, 2020). While there is an overlap with the fishery management area and the Operational Area, due to water depth, distance offshore, and distance from popular fishing spots, fishers do not collect sea cucumber within the Operational Area.
Pearl Oyster Managed Fishery	✗	✓	✗	This fishery uses hand collection methods to collect pearl oysters in water depths of mainly 10-15 m, up to 35 m. The Operational Area is located approximately 35 km west of the Pearl Oyster Managed Fishery fishing management area Zone 1. Due to the water depth, fishing method limitations and distance offshore there is no fishing effort within the Operational Area. Current catch and effort data (2010 – 2019) confirms no catch or effort within the Operational Area, with the nearest fishing effort occurring over 500 km east

Fishery Name	Overlap with Operational Area	Overlap with EMBA	Potential for interaction within Operational Area	
				(10 nm CAES block 200184) of the Operational Area (DPIRD, 2021).
Onslow Prawn Managed Fishery	✗	✓	✗	The Operational Area is located over 130 km from the Onslow Prawn Managed Fishery fishing management boundary. Current catch and effort data (2010 – 2019) confirms no catch or effort within the Operational Area, with the nearest fishing effort occurring over 230 km south-east (10 nm CAES block 212151) of the Operational Area (DPIRD, 2021).
Pilbara Crab Managed Fishery	✓	✓	✗	The Operational Area overlaps with a closed area of the fishery (as per Schedule 2 of the draft Management Plan [DPIRD, 2018]) and therefore, fishing activity within the Operational Area is currently not permitted. Targeted crab species do not occur in the Operational Area.

4.9.3 Traditional Fisheries

There are no traditional, or customary, fisheries within the Operational Area, as these are typically restricted to shallow coastal waters and/or areas with structures such as reefs. However, it is recognised that Barrow Island, Montebello Islands, Exmouth, Ningaloo Reef and the adjacent foreshores have a known history of fishing when areas were occupied (as from historical records). Areas that are covered by registered native title claims are likely to practice Aboriginal fishing techniques at various sections of the WA coastline.

4.9.4 Tourism and Recreation

Current FishCube data (2010 – 2019) indicates that no tour operators use the waters within or surrounding the Operational Area (DPIRD, 2021). The Operational Area is considered too far offshore for recreational fishing or tourism activities to occur. Additionally, the wider EMBA does not overlap with any recognised tourism or recreational areas, however, it is adjacent to the Montebello Islands (200 km east of the Operational Area), where fishing, surfing, snorkelling and diving activities occur year round.

It is acknowledged that there are growing tourism and recreational sectors in WA. These sectors have expanded in area over the last couple of decades. Potential for growth and further expansion in tourism and recreational activities in the Pilbara and Gascoyne regions is recognised, particularly with the development of regional centres and a workforce associated with the resources sector (Gascoyne Development Commission, 2012).

4.9.5 Oil and Gas

The Operational Area is situated within a region of established oil and gas operations, with additional infrastructure in the broader North West Shelf region.

There are no oil and gas facilities owned or operated by other petroleum titleholders located within 50 km of the Operational Area (**Figure 4-12)**. **Appendix H** describes current oil and gas development within the EMBA.

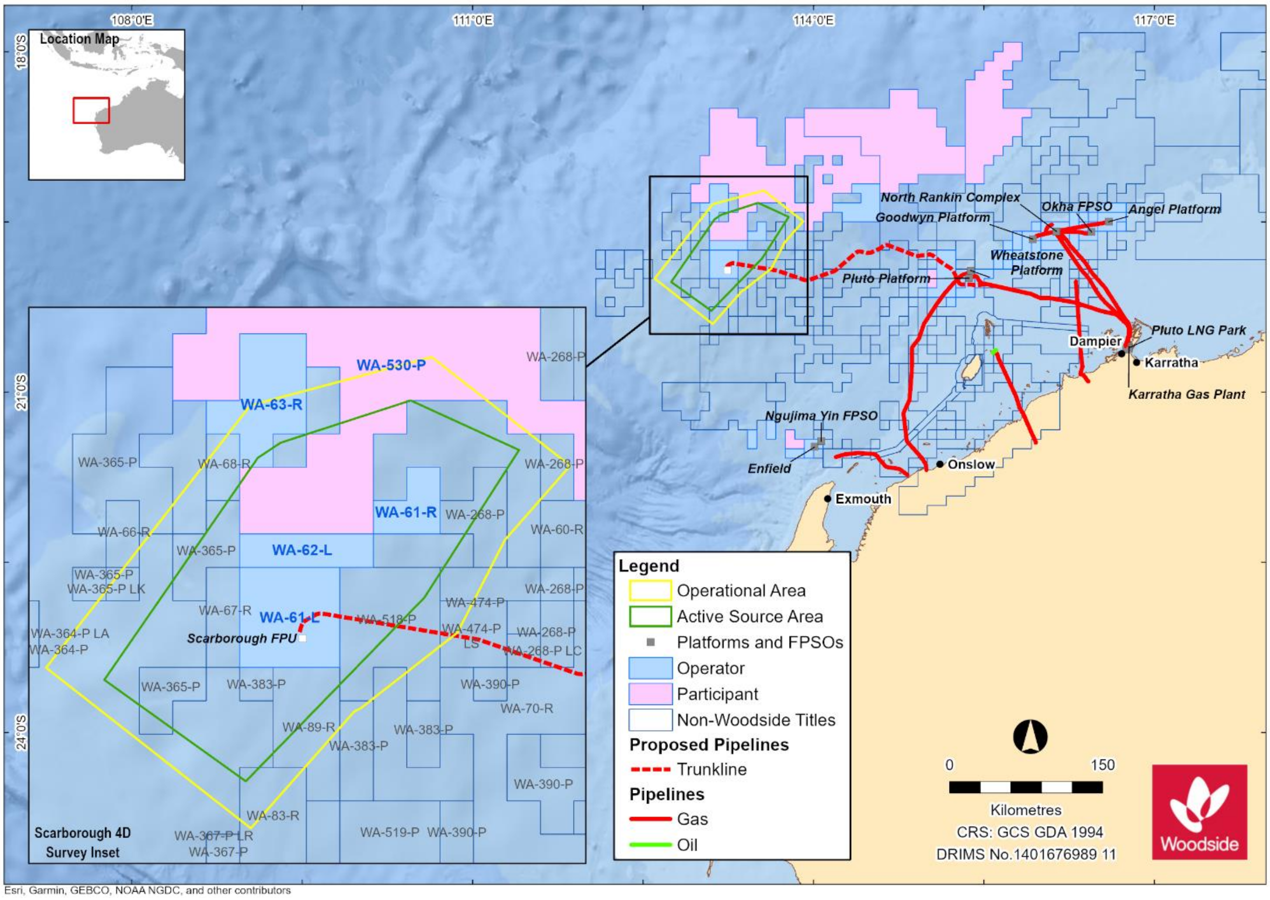


Figure 4-12: Oil and gas Infrastructure in relation to the Operational Area

4.9.6 Commercial Shipping

The Australian Maritime Safety Authority (AMSA) has introduced a network of shipping fairways across the NWMR off WA to reduce the risk of vessel collisions with offshore infrastructure. It is noted that none of these fairways intersect with the Active Source Area; the nearest fairway intersects the north-east corner of the Operational Area (**Figure 4-13**). Vessel tracking data suggest shipping traffic is concentrated within or close to the fairway in the north-east of the Operational Area and is mostly associated with international vessel movements between Australia and Asia.

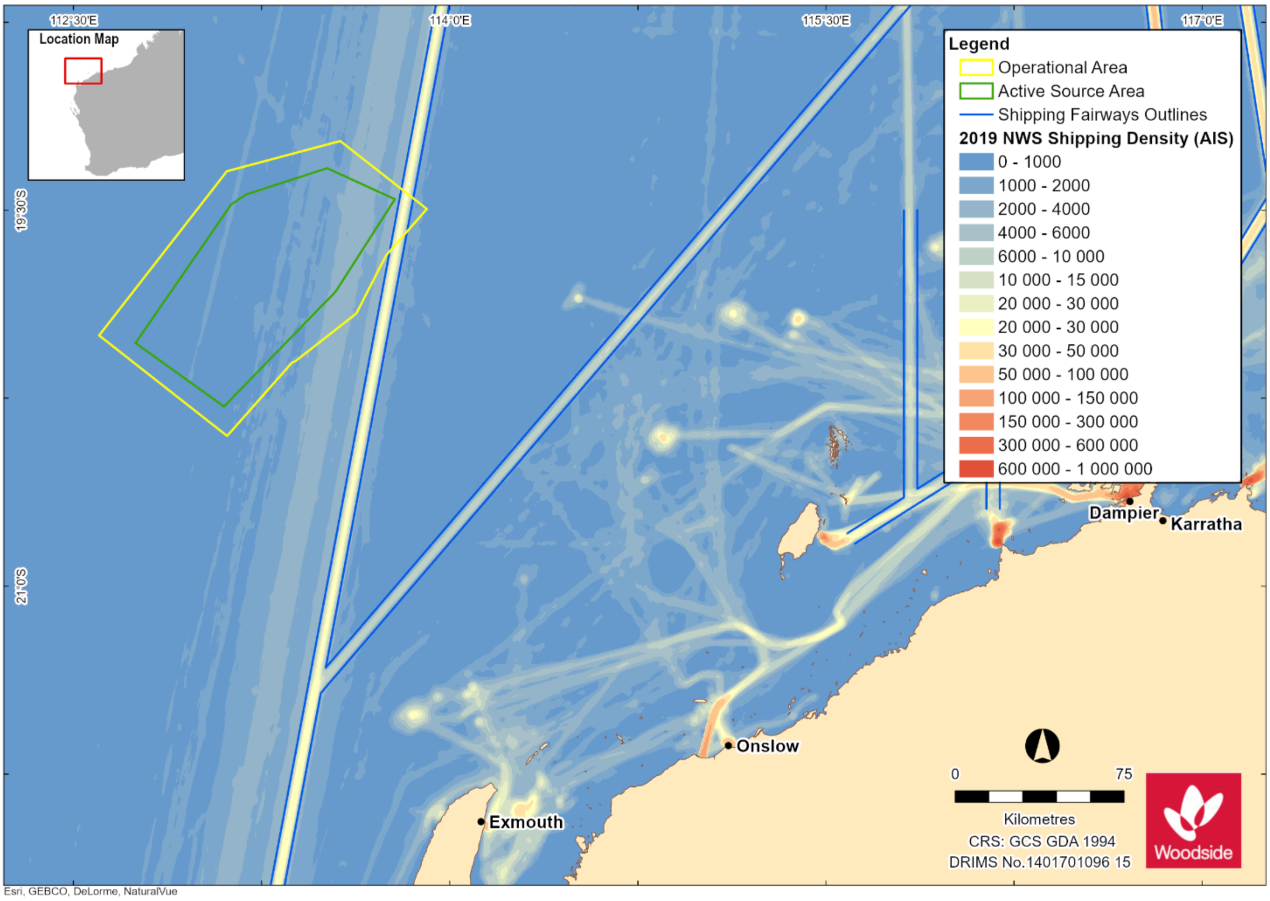


Figure 4-13: Vessel density map for the Operational Area, derived from AMSA satellite tracking system data (vessels include cargo, LNG tanker, passenger vessels, support vessels, and others/unnamed vessels)

4.9.7 Defence

There are designated defence practice and training areas in the offshore marine waters off Ningaloo and the North-west Cape in the EMBA. The Operational Area lies within the northern tip of one of these defence training areas, the North West Exercise Area (NWXA) accessed by Royal Australian Air Force (RAAF) Base Learmonth (**Figure 4-14**). The Learmonth Air Weapons Range (AWR) practice area is located approximately 20 km south of the Operational Area. The closest site where unexploded ordnance is known to occur is 20 km north-west of Bessieres Island, located approximately 190 km from the Operational Area, and outside of the EMBA. Defence areas overlapping the Operational Area are presented in **Figure 4-14**.

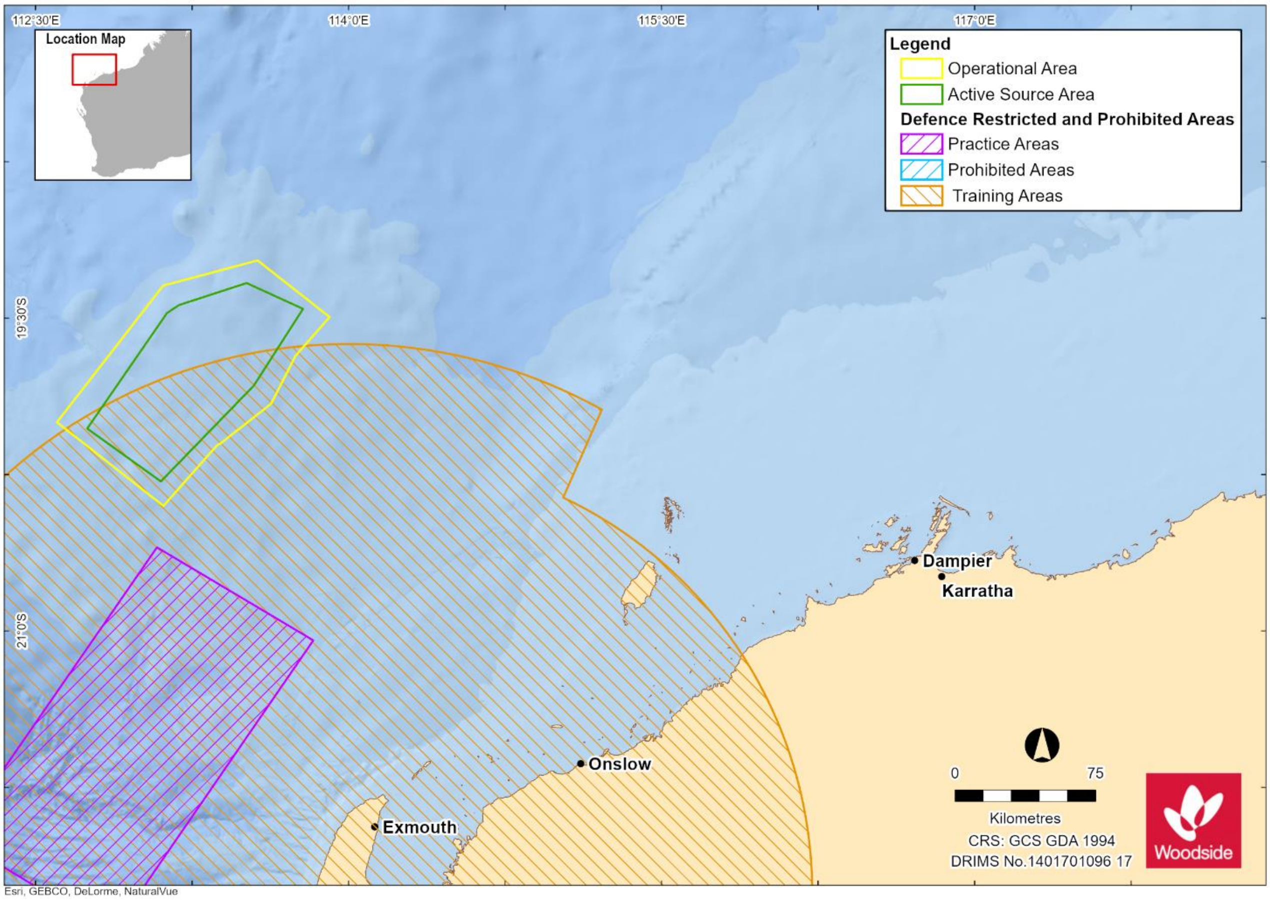


Figure 4-14: Defence areas overlapping and adjacent to the Operational Area

5. STAKEHOLDER CONSULTATION

Woodside is committed to consulting relevant stakeholders to ensure stakeholder feedback informs its decision making and planning for proposed petroleum activities and builds upon Woodside's extensive and ongoing stakeholder consultation for its offshore petroleum activities in the region.

5.1 Stakeholder Consultation Guidance

Woodside has followed the requirements of subregulation 11A (1) of the Environment Regulations to identify relevant stakeholders, these being:

- Each Department or agency of the Commonwealth Government to which the activities to be carried out under the Environment Plan, or the revision of the Plan, may be relevant.
- Each Department or agency of a State or the Northern Territory Government to which the activities to be carried out under the Environment Plan, or the revision of the Plan, may be relevant.
- The Department of the responsible State Minister, or the responsible Northern Territory Minister.
- A person or organisation whose functions, interests or activities may be affected by the activities to be carried out under the Environment Plan, or the revision of the Plan.
- Any other person or organisation that the Titleholder considers relevant.

Woodside's assessment of stakeholder relevance is outlined in Table **5**-**1.**

5.2 Stakeholder Consultation Objectives

In support of this EP, Woodside has sought to:

- Ensure all relevant stakeholders are identified and engaged in a timely and effective manner.
- Develop and make available communications material to stakeholders that is relevant to their interests and information needs.
- Incorporate stakeholder feedback into the management of the proposed activity where practicable.
- Provide feedback to stakeholders on Woodside's assessment of their feedback and keep a record of all engagements.
- Make available opportunities to provide feedback during the life of this EP.

5.3 Stakeholder Expectations for Consultation

Stakeholder consultation for this activity has also been guided by stakeholder organisation expectations for consultation on planned activities. This guidance includes:

NOPSEMA:

- *GL1721 - Environment plan decision making - June 2021*
- *GN1847 - Responding to public comment on environment plans - September 2020*
- *GN1344 - Environment plan content requirements - September 2020*
- *GN1488 - Oil pollution risk management - February 2021*
- *GN1785 – Petroleum activities and Australian Marine Parks – June 2020*
- *GL1887 – Consultation with Commonwealth agencies with responsibilities in the marine area – July 2020*

- *NOPSEMA Bulletin #2 – Clarifying statutory requirements and good practice consultation – November 2019*

Australian Fisheries Management Authority:

- *Petroleum industry consultation with the commercial fishing industry*

Commonwealth Department of Agriculture and Water Resources:

- *Fisheries and the Environment – Offshore Petroleum and Greenhouse Gas Act 2006*
- *Offshore Installations Biosecurity Guide* WA Department of Primary Industries and Regional Development:
- *Guidance statement for oil and gas industry consultation with the Department of Fisheries*

WA Department of Transport:

- *Offshore Petroleum Industry Guidance Note*

Woodside acknowledges that additional relevant stakeholders may be identified prior to or during the proposed activity. These stakeholders will be contacted, provided with information relevant to their interests, and invited to provide feedback about the proposed activity. Woodside will assess their feedback, respond to the stakeholder, and incorporate feedback into the management of the proposed activity where practicable.

Woodside consultation arrangements typically provide stakeholders up to 30 days (unless otherwise agreed) to review and respond to proposed activities where stakeholders are potentially affected. Woodside considers this consultation period an adequate timeframe in which stakeholders can assess potential impacts of the proposed activity and provide feedback.

Table 5-1: Assessment of relevant stakeholders for the proposed activity

Stakeholder	Relevant to activity	Reasoning
Commonwealth Government department or agency		
Australian Border Force (ABF)	Yes	Responsible for coordinating maritime security.
Australian Fisheries Management Authority (AFMA)	Yes	Responsible for managing Commonwealth fisheries.
Australian Hydrographic Office (AHO)	Yes	Response for maritime safety and Notices to Mariners.
Australian Maritime Safety Authority (AMSA) – Shipping	Yes	Statutory agency for vessel safety and navigation and legislated responsibility for oil pollution response in Commonwealth waters. Proposed activity has a hydrocarbon spill risk, which may require AMSA assistance for pollution response.
Australian Maritime Safety Authority (AMSA) – Oil Spill	Yes	Legislated responsibility for oil pollution response in Commonwealth waters. Proposed activity has a hydrocarbon spill risk, which may require AMSA response in Commonwealth waters.
Department of Agriculture, Water and the Environment (DAWE)	Yes	Responsible for implementing Commonwealth policies and programs to support agriculture, water resources, the environment and our heritage. The proposed activity has the potential impact to DAWE's interests in the prevention of introduced marine species.
Department of Defence (DoD)	Yes	Responsible for defending Australia and its national interests. The Operational Area lies within a defence training area.
Department of Industry, Science, Energy and Resources (DISER)	Yes	Department of relevant Commonwealth Minister and is required to be consulted under the Regulations.
Director of National Parks (DNP)	Yes	Responsible for the management of Commonwealth parks and conservation zones. Planned activities will not impact DNP's functions, interests or activities.
WA Government department or agency		
Department of Biodiversity, Conservation and Attractions (DBCA)	Yes	Responsible for managing WA's parks, forests and reserves. Planned activities do not impact DBCA's functions, interests or activities.
Department of Mines, Industry Regulation and Safety (DMIRS)	Yes	Department of relevant State Minister and is required to be consulted under the Regulations.
Department of Primary Industries and Regional Development (DPIRD)	Yes	Responsible for managing State fisheries. Although the Operational Area overlaps a number of State fisheries, none have been active in the Operational Area within the last five years.
Department of Transport (DoT)	Yes	Legislated responsibility for oil pollution response in State waters. Proposed activity has a hydrocarbon spill risk, which may require DoT response in State waters.
Commonwealth fisheries*		
Southern Bluefin Tuna Fishery	No	Although the fishery overlaps the Operational Area, it has not been active in the Operational Area within the last five years. Fishing will not occur in the Operational Area.

Stakeholder	Relevant to activity	Reasoning
Western Tuna and Billfish Fishery	No	Although the fishery overlaps the Operational Area, it has not been active in the Operational Area within the last five years. Fishing will not occur in the Operational Area.
Western Skipjack Fishery	No	Although the fishery overlaps the Operational Area, it has not been active in the Operational Area within the last five years. Fishing will not occur in the Operational Area.
Western Deepwater Trawl	Yes	Although the fishery overlaps the Operational Area, it has not been active in the Operational Area within the last five years. Woodside has chosen to consult Western Deepwater Trawl Fishery should there be future fishing in the area and based on fishing methods and water depth. It is highly unlikely the proposed activity will cause significant impacts to fish spawning and recruitment in any key commercial fish species due to underwater noise. Acquisition of the survey will not overlap the peak spawning season for key target species in the region, such as ruby snapper (December to April). Impacts to fish eggs and larvae are not likely due to the short duration of the survey, and lack of overlap with the peak spawning season.
North West Slope Trawl Fishery	No	The Fishery does not overlap the Operational Area.
		State fisheries*
Mackerel Managed Fishery – Pilbara (Area 3)	No	Although the fishery overlaps the Operational Area, it has not been active in the Operational Area within the last five years. Fishers are not active at water depths greater than 70 m (based on WAFIC advice). Fishing will not occur in the Operational Area.
South West Coast Salmon Managed Fishery	No	Although the fishery overlaps the Operational Area, it has not been active in the Operational Area within the last five years. Fishers are active south of Perth and from the beach (based on WAFIC advice). Fishing will not occur in the Operational Area.
West Coast Deep Sea Crustacean Managed Fishery	No	Although the fishery overlaps the Operational Area, it has not been active in the Operational Area within the last five years. In recent years fishing has only been undertaken along the continental shelf edge and in waters south of Exmouth (West Coast Deep Sea Crustacean Managed Fishery; DPIRD, 2005). Fishing will not occur in the Operational Area.
Pilbara Crab Managed Fishery	No	Although the fishery overlaps the Operational Area, it has not been active in the Operational Area within the last five years, and target species (blue swimmer crab) are only found in waters up to 50 m deep. Fishing will not occur in the Operational Area.
Marine Aquarium Fishery	No	Although the fishery overlaps the Operational Area, it has not been active in the Operational Area within the last five years. This is a dive and wade fishery with activities generally restricted to waters less than 30 m deep (based on previous WAFIC advice). Fishing will not occur in the Operational Area.
Specimen Shell Fishery	No	The fishery does not overlap the Operational Area.
Abalone Managed Fishery	No	The fishery does not overlap the Operational Area.
Onslow Prawn	No	The fishery does not overlap the Operational Area.
Pearl Oyster managed Fishery	No	The fishery does not overlap the Operational Area.
Pilbara Demersal Scalefish Fishery - Pilbara Line Fishery	No	The fishery does not overlap the Operational Area.

Stakeholder	Relevant to activity	Reasoning
Pilbara Demersal Scalefish Fishery - Pilbara Trawl Fishery	No	The fishery does not overlap the Operational Area.
Pilbara Demersal Scalefish Fishery - Pilbara Trap Fishery	No	The fishery does not overlap the Operational Area.
Industry		
Chevron Australia	Yes	Adjacent Titleholder.
Western Gas	Yes	Adjacent Titleholder.
Exxon Mobil Australia	Yes	Adjacent Titleholder.
Shell Australia	Yes	Adjacent Titleholder.
Industry representative organisations		
Australian Petroleum Production and Exploration Association (APPEA)	Yes	Represents the interests of oil and gas explorers and producers in Australia.
Commonwealth Fisheries Association (CFA)	Yes	Represents the interests of commercial fishers with licences in Commonwealth waters.
Pearl Producers Association (PPA)	No	Represents the interests of pearl producers in WA. Activities do not have the potential to impact fishers in WA.
Recfishwest	No	Represents the interests of recreational fishers in WA. Activities do not have the potential to impact recreational fishers.
Marine Tourism WA	No	Represents the interests of recreational fishers in WA. Activities do not have the potential to impact recreational fishers.
WA Game Fishing Association	No	Represents the interests of charter owners and operators in WA. Activities do not have the potential to impact game fishers.
Western Australian Fishing Industry Council (WAFIC)	Yes	Represents the interests of commercial fishers with licences in State Waters.
Other stakeholders		
Conservation Council of Western Australia (CCWA)	No	CCWA have identified themselves as interested in activities relating to the Scarborough Development.

** Fisheries have been identified as being relevant on the basis of fishing licence overlap with the proposed Operational Area, as well as consideration of fishing effort data, fishing methods, water depth, and likelihood of fishing in the future. Table 4-17 provides a detailed assessment of Commonwealth and State fisheries within or adjacent to the Operational Area.*

5.4 Stakeholder Consultation

Consultation activities conducted for the proposed activity are outlined in **Appendix F.**

The Consultation Information Sheet (**Appendix F**, reference 1.1) is published on the Woodside website and includes a toll-free 1800 phone number.

Table 5-2: Stakeholder consultation activities

Stakeholder	Information provided	Stakeholder response	Woodside response	Woodside assessment and outcome
Australian Government department or agency				
ABF	On 13 May 2021, Woodside emailed ABF advising of the proposed activity (Appendix F, reference 1.3) and provided a Consultation Information Sheet.	No feedback received.	No response required.	Woodside has addressed maritime security-related issues in **Section 6** of this EP based on previous offshore activities. Woodside considers this adequately addresses stakeholder interests and no further consultation is required.
AFMA	On 13 May 2021, Woodside emailed AFMA advising of the proposed activity (Appendix F, reference 1.2) and provided a Consultation Information Sheet, a fisheries map (Appendix F, reference 1.19) and a list of previous seismic surveys (Appendix F, reference 1.21).	On 4 June 2021, AFMA responded, advising it was unable to provide comment on specific proposals, and directed Woodside to continue consulting with all fishers who have entitlements to fish within the proposed area via the relevant fishing industry associations or directly with fishers who hold entitlements in the area.	No response required.	Woodside has consulted CFA, DAWE and WAFIC. Woodside has assessed the relevancy of Commonwealth fisheries issues in **Section 4.5.3** of this EP. Woodside has provided specific fishery consultation information the Western Deepwater Trawl Licence Holders Woodside will provide further information prior to the commencement and at the end of the activity. Woodside considers this adequately addresses stakeholder interests and no further consultation is required.
AHO	On 13 May 2021, Woodside emailed the AHO advising of the proposed activity (Appendix F, reference 1.8) and provided a Consultation Information Sheet, and shipping lanes map (Appendix F, reference 1.8).	No feedback received.	No response required.	Woodside will notify the AHO no less than four working weeks before operations commence, as referenced as a **Control 1.1** in this EP. Woodside considers this adequately addresses stakeholder interests and no further consultation is required.

Stakeholder	Information provided	Stakeholder response	Woodside response	Woodside assessment and outcome
AMSA (marine safety)	On 13 May 2021, Woodside emailed AMSA advising of the proposed activity (Appendix F, reference 1.13) and provided a Consultation Information Sheet, and shipping lanes map (Appendix F, reference 1.9).	On 18 May 2021, AMSA emailed Woodside requesting: • The AHO be contacted no less than four working weeks before operations commence for the promulgation of related notices to mariners. • AMSA's Joint Rescue Coordination Centre (JRCC) be notified at least 24–48 hours before operations commence • Provide updates to the AHO and JRCC should there be changes to the activity. • Vessels exhibit appropriate lights and shapes to reflect the nature of operations and comply with the International Rules of Preventing Collisions at Sea. AMSA provided advice on obtaining vessel traffic plots, including digital datasets and maps.	No response required.	Woodside has addressed AMSA's requests: Woodside will notify AMSA's JRCC at least 24–48 hours before operations commence, as referenced as **Control 1.2** in this EP. Woodside will notify AHO no less than four working weeks before operations commence, as referenced as a **Control 3.1** in this EP. Woodside considers this adequately addresses stakeholder interests and no further consultation is required.
AMSA (marine pollution)	On 13 May 2021, Woodside emailed AMSA advising of the proposed activity (Appendix F, reference 1.14) and provided a Consultation Information Sheet, and shipping lanes map (Appendix F, reference 1.9).	No feedback received.	No response required.	Woodside has addressed oil pollution planning and response in **Appendix D**. Woodside considers this adequately addresses stakeholder interests and no further consultation is required.
	On 6 July 2021, Woodside emailed AMSA and provided the First Strike Plan (Appendix F, reference 1.26).	No feedback received.	No response required.	

Stakeholder	Information provided	Stakeholder response	Woodside response	Woodside assessment and outcome
DAWE	On 13 May 2021, Woodside emailed DAWE advising of the proposed activity considering biosecurity matters (Appendix F, reference 1.18) and provided a Consultation Information Sheet, and fisheries map (Appendix F, reference 1.19).	On 25 May 2021, DAWE responded noting the information required and requested Woodside communicate future developments with the AFMA and the relevant fishing industry representation organisations.	No response required.	Woodside has consulted CFA, AFMA and WAFIC. Woodside has assessed the relevancy of Commonwealth fisheries issues in **Section 4.9.2** of this EP. Woodside has provided specific fishery consultation information to the Western Deepwater Trawl Licence Holders. Woodside will provide further information prior to the commencement and at the end of the activity. Woodside has addressed maritime biosecurity issues in **Section 6.6** of this EP based on previous offshore activities. Woodside considers this adequately addresses stakeholder interests and no further consultation is required.
DoD	On 13 May 2021, Woodside emailed DoD advising of the proposed activity (Appendix F, reference 1.15) and provided a Consultation Information Sheet, and defence map (Appendix F, reference 1.16).	On 15 May 2021, DoD responded noting: • a proportion of the survey area is within the North West Exercise Area (NWXA) and restricted airspace. • unexploded ordinance (UXO) may be present on and in the sea floor within the NWXA. DoD additionally advised that: • All activities in the area are conducted at Woodside's own risk. • The Commonwealth of Australia, represented by the Department of Defence, takes no responsibility for: • Reporting the location and type of UXO that may be in the areas. • Identifying or removing any UXO from these areas.	On 4 August 2021, Woodside responded requesting shape files or further specific detail in relation to the mentioned UXO so that Woodside can map it against the proposed activity. Woodside also noted the notifications outlined by DoD.	Woodside reviewed the proposed activity and the location of the NXWA and UXOs to understand the potential for UXOs to be within the Operational Area. The Learmonth Air Weapons Range (AWR) practice area is approximately 20 km south of the operational area and the location of any UXOs (known to occur) are near Bessieres Island which is located 190 km from the Operational Area. Based on the locations of the proposed activity and potential UXOs it was determined that there is no credible risk from UXOs for the proposed activity. Woodside acknowledges the potential presence of UXOs and has

Stakeholder	Information provided	Stakeholder response	Woodside response	Woodside assessment and outcome
		• Any loss or damage suffered or incurred by Woodside Energy or any third party arising out of, or directly related to, UXO in the area. DoD also required the following notifications: • DoD five weeks prior to the commencement of activities. • Airservices Australia if Notice to Airmen notification is required for activities in Restricted Airspace. • AHO three weeks prior to the commencement of activities.		considered this in its risk assessment planning. Woodside has addressed DoDs expectations on notifications – Defence, restricted air space and AHO (**PS 1.1** and **PS1.5**). AHO have been engaged for the activity and are included in Woodside's activity notification protocols. AHO will be notified four weeks prior to the start of activities. Woodside considers this adequately addresses stakeholder interests and no further consultation is required.
		On 4 August 2021, DoD responded and provided a link to its mapping system which identifies UXO locations within the NXWA.	No response required.	
DISER	On 13 May 2021, Woodside emailed DISER advising of the proposed activity (Appendix F, reference 1.2) and provided a consultation Information Sheet.	No feedback received.	No response required.	Woodside has provided sufficient information and opportunity to respond. Woodside considers this adequately addresses stakeholder interests and no further consultation is required.

Stakeholder	Information provided	Stakeholder response	Woodside response	Woodside assessment and outcome
DNP	On 13 May 2021, Woodside emailed DNP advising of the proposed activity considering potential risks to Australian marine Parks (Appendix F, reference 1.17), and provided a Consultation Information Sheet.	On 5 July 2021, DNP responded, noting it has no claims or objections.	No response required.	This EP demonstrates how Woodside will identify and managed all impacts and risks on Australian marine park values (including ecosystem values) to an ALARP and acceptable level and that the activity is not inconsistent with the management plan (**Section 6.7**). Woodside will ensure DNP is made aware of any incidences within a marine park for the activity, as per the commitment in the Oil Pollution First Strike Plan. Woodside considers this adequately addresses stakeholder interests and no further consultation is required.
Western Australian Government department or agency or advisory body				
DBCA	On 13 May 2021, Woodside emailed DBCA advising of the proposed activity (Appendix F, reference 1.6) and provided a Consultation Information Sheet.	On 24 May 2021, DBCA responded advising that it has no comments.	No response required.	Woodside notes DBCA has no comments to provide based on its responsibilities. Woodside considers this adequately addresses stakeholder interests and no further consultation is required.
DMIRS	On 13 May 2021, Woodside emailed DMIRS advising of the proposed activity (Appendix F, reference 1.4) and provided a Consultation Information Sheet.	No feedback received.	No response required.	Woodside will provide notifications to DMIRS prior to the commencement and at the end of the activity. Woodside considers this adequately addresses stakeholder interests and no further consultation is required

Stakeholder	Information provided	Stakeholder response	Woodside response	Woodside assessment and outcome
DPIRD	On 14 May 2021, Woodside emailed DPIRD advising of the proposed activity (Appendix F, reference 1.25) and provided a Consultation Information Sheet, fisheries map (Appendix F, 1.19) and list of previous seismic surveys (Appendix F, reference 1.21).	No feedback received.	No response required.	Woodside has consulted DPIRD and WAFIC. Woodside has assessed the relevancy of State fisheries in **Section 4.9.2** of this EP. Woodside has provided specific fishery consultation information to the Western Deepwater Trawl Licence Holders Woodside will provide further information prior to the commencement and at the end of the activity. Woodside considers this adequately addresses stakeholder interests and no further consultation is required.
DoT	On 13 May 2021, Woodside emailed DoT advising of the proposed activity (Appendix F, reference 1.5) and provided a Consultation Information Sheet.	On 18 May 2021, DoT responded and requested that if there is a risk of a spill impacting State waters from the proposed activities, to ensure that DoT is consulted as outlined in the Department of Transport Offshore Petroleum Industry Guidance Note – Marine Oil Pollution: Response and Consultation Arrangements (July 2020).	On 18 August 2021, Woodside responded, confirming it will consult DoT if there is a risk of a spill impacting State waters from the activities.	Woodside has addressed oil pollution planning and response at **Appendix D**. Woodside will send DoT a copy of the First Strike Plan once approved. Woodside considers this adequately addresses stakeholder interests and no further consultation is required.
	On 8 July 2021, Woodside emailed DoT and provided a copy of the First Strike Plan (Appendix F, reference 1.27).	On 9 July 2021, DoT responded and advised it will review. On 11 August 2021, DoT responded with comments for review, which sought clarification on priorities, estimates of waste quantities and marine response options.	On 12 August 2021, Woodside responded to DoT's comments.	
		On 19 August 2021, DoT responded and advised it didn't have any further comments. DoT requested a copy of the	On 19 August 2021, Woodside responded and confirmed that it will send DoT a copy of the First Strike Plan once approved.	

Stakeholder	Information provided	Stakeholder response	Woodside response	Woodside assessment and outcome
		final version of the First Strike Plan once accepted.		
Industry				
Chevron Australia	On 13 May 2021, Woodside emailed title holder advising of the proposed activity (Appendix F, reference 1.10) and provided a Consultation Information Sheet, and Titleholder map (Appendix F, reference 1.11).	No feedback received.	No response required.	Woodside has provided sufficient information and opportunity to respond. Woodside considers this adequately addresses stakeholder interests and no further consultation is required.
Exxon Mobil Australia	On 13 May 2021, Woodside emailed title holder advising of the proposed activity (Appendix F, reference 1.10) and provided a Consultation Information Sheet, and Titleholder map (Appendix F, reference 1.11).	No feedback received.	No response required.	Woodside has provided sufficient information and opportunity to respond. Woodside considers this adequately addresses stakeholder interests and no further consultation is required.
Western Gas	On 13 May 2021, Woodside emailed title holder advising of the proposed activity (Appendix F, reference 1.10) and provided a Consultation Information Sheet, and Titleholder map (Appendix F, reference 1.11).	No feedback received.	No response required.	Woodside has provided sufficient information and opportunity to respond. Woodside considers this adequately addresses stakeholder interests and no further consultation is required.
Shell Australia	On 13 May 2021, Woodside emailed title holder advising of the proposed activity (Appendix F, reference 1.12) and provided a Consultation Information Sheet, and Titleholder map (Appendix F, reference 1.11).	No feedback received.	No response required.	Woodside has provided sufficient information and opportunity to respond. Woodside considers this adequately addresses stakeholder interests and no further consultation is required

Stakeholder	Information provided	Stakeholder response	Woodside response	Woodside assessment and outcome
Industry representative organisations				
APPEA	On 13 May 2021 Woodside emailed APPEA advising of the proposed activity (Appendix F, reference 1.7) and provided a Consultation Information Sheet.	No feedback received.	No response required.	Woodside has provided sufficient information and opportunity to respond. Woodside considers this adequately addresses stakeholder interests and no further consultation is required.
CFA	On 13 May 2021, Woodside emailed the CFA advising of the proposed activity (Appendix F, reference 1.22) and provided a Consultation Information Sheet, fisheries map (Appendix F, reference 1.19) and list of previous seismic surveys (Appendix F, reference 1.21).	No feedback received.	No response required.	Woodside has consulted relevant Commonwealth fishery stakeholders including AFMA, DAWE and WAFIC. Woodside has assessed the relevance of Commonwealth fisheries issues in **Section 4.9.2** of this EP. Woodside has provided specific fishery consultation information to the Western Deepwater Trawl Licence Holders. Woodside will provide further information prior to the commencement and at the end of the activity. Woodside considers this adequately addresses stakeholder interests and no further consultation is required.
WAFIC	On 13 May 2021, Woodside emailed WAFIC advising of the proposed activity (Appendix F, reference 1.23) and provided a Consultation Information Sheet, fisheries map (Appendix F, reference 1.19) and list of previous seismic surveys (Appendix F, reference 1.21).	On 16 June 2021, WAFIC thanked Woodside for the information and noted the following risks: • Mobile invertebrates – Moderate • Immobile invertebrates – Low • Finfish demersal – Moderate • Pelagic – Negligible – Commercial fishers have advised WAFIC that they are encountering a significant change in catchability of mackerel species following seismic survey activity, so fish behaviour and distribution are	On 23 August 2021, Woodside responded, thanking WAFIC for the feedback and confirmed that the receptors outlined and impact of seismic surveys will be considered in the EP, and control measures implemented where relevant.	Woodside provided consultation materials to WAFIC which has informed the assessment of fishing potential (**Section 4.9.2** of this EP). The operational area has not identified any relevant State Fisheries. Woodside has addressed WAFIC's queries in relation to risk mitigation and control measures for seismic survey equipment in **Section 6.5.3**.

Stakeholder	Information provided	Stakeholder response	Woodside response	Woodside assessment and outcome
		changing which is having a direct impact on the economic viability of commercial fishers and potential fish stocks for those species. There is an opportunity for further research into this indirect impact to fully understand the effect. WAFIC also noted notwithstanding the above, risk mitigation and control measures should be implemented to ensure all impacts are managed and detailed evidence based analysis has considered the timing of the survey to minimise impacts to commercial fishing operations and the ecological impacts to fish species.		Woodside considers this adequately addresses stakeholder interests and no further consultation is required.
Other stakeholders				
CCWA	On 20 August 2021, Woodside emailed CCWA advising of the proposed activity (Appendix F, reference 1.28) and provided a Consultation Information Sheet.	On 14 September 2021, CCWA emailed requesting: 1) An additional 2 weeks timeframe for comment to be received 2) Provision of draft the EP for comment noting “the consultation documents attached and linked on your website are highly summarized and not really adequate to assess the EP’s and provide meaningful comment. We request copies of the draft EP’s and other application documents including studies that will be submitted to the regulator in support of the EP’s. This will enable a reasonable comment to be made.”	On 17 September 2021, Woodside responded to CCWA with the following. 1) Please provide your consultation responses by 20 September 2021 as this period is consistent with other stakeholder response times, and general Environment Plan drafting timeframes and no additional time will be allocated. The factsheet has been available on our website for public comment since 13 May 2021 (Scarborough Seismic). An additional 30 day comment period has already been granted to CCWA, following its request, which allows a reasonable opportunity for consultation. 2) During Woodside’s consultation period, stakeholders are provided with a factsheet containing	Woodside has provided sufficient information and opportunity to respond. Woodside considers this adequately addresses stakeholder interests and no further consultation is required.

Stakeholder	Information provided	Stakeholder response	Woodside response	Woodside assessment and outcome
			information relevant to the Environment Plan, for the purposes of the consultation. Consistent with the process in the legislation, consultation occurs while the draft Environment Plan is being developed. Given the EPs are in development, copies of those drafts are not provided to stakeholders during the consultation phase.	

5.5 Ongoing Stakeholder Consultation

Woodside is committed to the engagements listed in **Table 5-3**, based on stakeholder feedback.

Table 5-3: Ongoing stakeholder consultation

Stakeholder	Activity
AHO	Woodside will notify the AHO no less than four weeks before operations commence and provide updates to AHO on any changes to planned activities.
AMSA	Woodside will notify AMSA's JRCC at least 24-48 hours before operations commence.
DAWE	Woodside will inform DAWE of future developments relating to the project.
DMIRS	Woodside will send DMIRS commencement and cessation notifications.
DNP	Woodside will contact if any incidences occur in a marine park.
DoD	Woodside will notify Defence at least five weeks prior to the start of activities.
DoT	Woodside will consult DoT if there is a spill impacting State water from the proposed activity. Woodside will provide DoT with a copy of the First Strike Plan once approved.
Western Deepwater Trawl licence holders	Woodside will send licence holders commencement and cessation notifications.

6. ENVIRONMENTAL IMPACT AND RISK ASSESSMENT, PERFORMANCE OUTCOMES, STANDARDS AND MEASUREMENT CRITERIA

6.1 Overview

This section presents the impact and risk analysis and evaluation, EPOs, EPSs and MC for the Petroleum Activities Program, using the methodology described in **Section 2.**

6.2 Analysis and Evaluation

The analysis and evaluation demonstrate that the identified risks and impacts associated with the Petroleum Activities Program are reduced to ALARP, are of an acceptable level and consider all operations of the activity, including potential emergency conditions.

The risks identified during the ENVID (including decision type, current risk level, acceptability of risk and tools used to demonstrate acceptability and ALARP) have been divided into two broad categories:

- planned (routine and non-routine) activities
- unplanned events (accidents, incidents or emergency situations).

Within these categories, impact assessment groupings are based on stressor type, e.g. emissions, physical presence, etc. In all cases, the worst credible consequence was assumed.

The ENVID conducted on 12 April 2021 identified seven impacts and seven risks associated with the Petroleum Activities Program. Planned activities and unplanned events are summarised in **Table 6-1**.

The analysis and evaluation for the Petroleum Activities Program indicate that all the current environmental risks and impacts associated with the activity are reduced to ALARP and are of an acceptable level, as discussed further in **Sections 6.5** and **6.6.**

6.3 Cumulative Impacts

Woodside has assessed the cumulative impacts of the Petroleum Activities Program in relation to other petroleum activities which could realistically result in overlapping temporal and spatial extents. The potential cumulative impact of concurrent seismic activities is assessed in **Section 6.5.1** (Physical Presence) and **Section 6.5.3** (Routine Acoustic Emissions: Seismic Survey Equipment).

6.4 Environment Risks/Impacts not Deemed Credible or Outside the Scope of this EP

The ENVID identified one source of environmental risk/impact, the generation of noise from helicopters, that was assessed as not being applicable (not credible) within or outside the Operational Area and therefore was determined to not form part of this EP (refer **Section 2.6**).

Due to the distance from the coast crew change is most likely by vessel and helicopter will only be used in the event of an emergency. Consequently, risks associated with helicopter activities such as generation of noise were assessed as not credible.

Table 6-1: Environmental impact analysis summary of planned and unplanned activities

Aspect	EP section	Risk rating				Acceptability of impact/risk
		Impact/consequence	Potential impact/consequence level	Likelihood	Current risk rating	
Planned activities (routine and non-routine)						
Physical presence: Interference with marine users	**6.5.1**	E	Social and Cultural – Slight, short-term impact (less than one year) to a community or areas/items of cultural significance	-	-	Broadly acceptable
Physical presence: Disturbance to benthic habitat from the placement of AUV and commercial nodes	**6.5.2**	E	Environment – Slight, short-term impact (less than one year) to a community or areas/items of	-	-	Broadly acceptable
Routine acoustic emissions: Seismic survey equipment	**6.5.3**	D	Environment – Minor, short-term impact (one to two years) on species, habitat (but not affecting ecosystems function), physical or biological attributes	-	-	Acceptable
Routine acoustic emissions: Vessels, AUV nodes and mechanical equipment operation	**6.5.4**	F	Environment – No lasting effect (less than one month); localised impact not significant to environmental receptors.	-	-	Broadly acceptable
Routine atmospheric emissions: Fuel combustion	**6.5.5**	F	Environment – No lasting effect (less than one month); localised impact not significant to environmental receptors (e.g. air quality).	-	-	Broadly acceptable
Routine discharges: Bilge water, grey water, sewage, putrescible wastes and deck drainage water	**6.5.6**	F	Environment – No lasting effect (less than one month); localised impact not significant to environmental receptors.	-	-	Broadly acceptable
Routine light emissions: External lighting on project vessels	**6.5.7**	F	Environment – No lasting effect (less than one month); localised impact not significant to environmental receptors.	-	-	Broadly acceptable
Unplanned activities (accidents, incidents, emergency situations)						
Accidental hydrocarbon release: Vessel collision	**6.6.2**	D	Environment – Minor, short-term impact (one to two years) on species, habitat (but not affecting ecosystems function), physical or biological attributes	1	M	Acceptable
Accidental hydrocarbon release: Bunkering	**6.6.3**	E	Environment – Slight, short-term impact (less than one year) on species, habitat (but not affecting ecosystems function), physical or biological attributes.	1	L	Broadly acceptable
Unplanned discharge: Deck spills	**6.6.4**	F	Environment – No lasting effect (less than one month); localised impact not significant to environmental receptors (e.g. water quality).	2	L	Broadly acceptable
Unplanned discharge: Loss of solid hazardous and non-hazardous wastes (including dropped objects)	**6.6.5**	F	Environment – No lasting effect (less than one month); localised impact not significant to environmental receptors (e.g. water quality).	1	L	Broadly acceptable
Physical presence: Vessel collision/entanglement with marine fauna	**6.6.6**	E	Environment – Slight, short term local impact (less than one year) on species, habitat (but not affecting ecosystems function), physical or biological attributes.	1	L	Broadly acceptable
Physical presence: Loss of equipment	**6.6.7**	F	Environment – No lasting effect (less than one month); localised impact not significant to environmental receptors.	2	L	Broadly acceptable
Physical presence: Introduction and establishment of invasive marine species	**6.6.8**	D	Environment – Minor, short-term impact (one to two years) on species, habitat (but not affecting ecosystems function), physical or biological attributes.	0	L	Broadly acceptable

6.5 Planned Activities (Routine and Non-routine)

6.5.1 Physical Presence: Interactions with Other Marine Users

Context		
Activity Components – **Section 3.6**	Socio-Economic Environment – **Section 4.9**	Stakeholder Consultation – **Section 5**

Impact Evaluation Summary

Source of Impact	*Environmental Value Potentially Impacted*							*Evaluation*						
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl Odour)	Ecosystems/ Habitat	Species	Socio-Economic	Decision Type	Consequence/Impact	Likelihood	Risk Rating	ALARP Tools	Acceptability	Outcomes
Displacement of other marine users – proximity of project vessels (and submersible equipment) interfering with or displacing third party vessels (commercial fishing, recreational fishing/tourism, research/monitoring programs and commercial shipping)							X	A	E	-	-	GP	Broadly Acceptable	EPO 1 EPO 2
Potential interactions with proposed oil and gas activities							X							

Description of Source of Impact

Project Vessels (including the towed seismic equipment)

The Petroleum Activities Program will be conducted using a single seismic vessel. A temporary 3 nm SNA will be maintained around the seismic vessel and towed array (comprising the airgun array and streamer array, which includes header buoys, starboard and port deflectors or baravanes, streamers and tail buoys) during seismic operations. Marine users are requested to avoid this area during the survey to ensure the safety of the seismic vessel and third-party vessels.

The support/chase vessel, capable of AUV/commercial seismic node deployment/retrieval (further details below), will accompany the seismic vessel to re-supply it with fuel and other logistical and operational supplies (including taking the seismic vessel under tow, if required). An additional chase vessel may be used to manage interactions with shipping and fishing activities, if required.

AUV and Commercial Nodes

The Petroleum Activities Program will involve the deployment and use of up to 50 seismic nodes (combined AUV and commercial nodes) in the Active Source Area. The proposed AUV nodes are cylindrical in shape with short wings on the sides for stabilisation and steering, at approximately 1000 mm long and 300 mm in diameter (weights approximately 30 kg in air and 10 kg in sea water). The AUV nodes are based on current autonomous technology as developed with gliders (e.g. Slocum) that move through the water column by changing buoyancy. The AUV nodes, however, are adapted to and settle for periods of time on the seabed to record the seismic signal.

During the survey, the AUV nodes will relocate autonomously up to five times, each time landing near a commercial node. When deployed the nodes will be laid out in a grid of approximately 500 m x 500 m in a 10 km² area of seabed within the Active Source Area.

Commercial nodes will be used to 'ground truth' the AUV nodes. The proposed commercial nodes weigh approximately 21 kg (9.5 kg in sea water) and measure approximately 350 mm (L), by 300 mm (W) and 150 mm (H). Commercial nodes are weighted to the seafloor by a concrete pad, approximately 450 mm (L), by 500 mm (W) and 50 mm (H) (weights approximately 25 kg in air and 16 kg in seawater), which degrades over time.

The AUV and commercial nodes will be deployed/retrieved from a support/chase vessel. The commercial nodes are deployed to the seabed via gravity and recovered via positive buoyancy. An SRD is included within the AUV nodes to raise them to the surface if unable to do so with its normal functioning.

Impact Assessment

Potential Impacts to Environmental Values

Commercial Fishing

Potential for interaction with commercial fisheries is a common consideration for marine seismic surveys. Should any commercial fishing activities occur within the Operational Area, commercial fishers may be asked to deviate from fishing grounds periodically to accommodate seismic survey operations, any potential interactions with commercial fisheries would be short term due to the transient nature of the seismic vessel and the small area occupied by the seismic vessel (and SNA) at any one time, and AUV/commercial nodes, and limited to operational inconvenience (navigational hazard) and temporary displacement from fishing grounds within the Operational Area.

There are a number of Commonwealth and State managed fisheries with management areas that overlap with the Operational Area, however, none of these fisheries have conducted any fishing activities within the Operational Area in at least the last 10 years. There is only one Commonwealth managed fishery (Western Deepwater Trawl Fishery) and one State managed fishery (West Coast Deep Sea Crustacean Managed Fishery) that have historically had catch/effort within the Operational Area prior to 2010. There has been no recent fishing catch/effort within the Operational Area from 2008-2019 (Woodhams and Bath 2017; Patterson et al., 2020) and 2010-2019 (DPIRD, 2021), respectively (refer to **Section 4.9.2**). The Operational Area is located in water depths ranging from about 800-1150 m, located outside of the depth range where significant fisheries effort normally occurs.

Given the lack of fishing catch/effort in the Operational Area in recent years, it is expected that there will be no impact to commercial fisheries as a result of the presence of the proposed Scarborough 4D B1 MSS.

Recreational Fishing and Tourism Operations

The presence of project vessels and submersible equipment has the potential to impact third party vessels within or adjacent to the Operational Area. Interactions could result in short-term displacement of vessels as they make course alterations to avoid the project vessels (and associated towed seismic equipment in the SNA) and AUV/commercial nodes.

However, the Operational Area is considered too far offshore for recreational fishing or tourism activities to occur. Therefore, it is expected that there will be no impact to recreational fishing or tourism activities as a result of the presence of the proposed Scarborough 4D B1 MSS.

Commercial Shipping

The presence of project vessels and submersible equipment may cause temporary disruptions to commercial shipping. Moderate density shipping traffic may be encountered in the northeast corner of the Operational Area.

The potential impacts to commercial shipping vessels are expected to include short-term displacement of vessels as they make slight course alterations to avoid the project vessels (and associated towed seismic equipment in the SNA).

Oil and Gas Activities

No oil and gas production wells or facilities are located within the Operational Area (refer to **Figure 4-12**). Therefore, no impacts to oil and gas activities are expected.

Defence

The DoD did not identify any activities within the NWXA however the potential for UXOs was raised. Based on the locations of the proposed activity and potential UXOs it was determined that there is no credible risk from UXOs for the proposed activity.

Cumulative Assessment

<u>Commercial Fishing</u>

As above, there has been no recent fishing catch/effort within the Operational Area for the Commonwealth Western Deepwater Trawl Fishery (2008-2019) and WA West Coast Deep Sea Crustacean Managed Fishery (2010-2019), and therefore no impacts to commercial fisheries are expected. There are no other known seismic surveys planned to occur in these fisheries and, therefore, no cumulative impacts are expected.

<u>Commercial Shipping</u>

The Operational Area overlaps with a shipping fairway and north-south international shipping traffic. There are no other known seismic surveys planned to occur on the west coast of WA that may interact with the same international vessels within the fairway and, therefore, no cumulative impacts to shipping are expected.
Summary of Potential Impacts to Environmental Values(s)
Given the adopted controls, it is considered that physical presence of project vessels (including towed seismic equipment) and AUV/commercial nodes will not result in a potential impact greater than slight, short-term temporary displacement of commercial shipping. Commercial vessels may be required to make small alterations to their course to avoid the project vessels (and associated towed seismic equipment in the SNA) but these interactions can be managed in accordance with standard maritime practices.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[1]***	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
None identified.				
Good Practice				
Notify AHO of activities and movements no less than four weeks before the scheduled activity commencement date.	F: Yes CS: Minimal cost. Standard practice.	Notification to AHO will enable them to generate navigation warnings (Maritime Safety Information Notifications (MSIN)) and NTM [including AUSCOAST warnings where relevant)]).	Benefits outweigh cost/sacrifice. Control is also standard practice.	Yes **C 1.1**
Notify AMSA Joint Rescue Coordination Centre (JRCC) of activities and movements 24-48 hours before the scheduled activity commencement date.	F: Yes CS: Minimal cost. Standard practice.	Communication of the Petroleum Activities Program to other marine users ensures they are informed and aware, thereby reducing the likelihood of interference with other marine users.	Benefits outweigh cost/sacrifice. Control is also standard practice.	Yes **C 1.2**
Notify AFMA, DPIRD and WAFIC of activities and movements no less than four weeks before the scheduled activity commencement date.	F: Yes CS: Minimal cost. Standard practice.	Communication of the Petroleum Activities Program to other marine users ensures they are informed and aware, thereby reducing the likelihood of interference with other marine users. Although no fishing activities occur in or near the Operational Area and there are no relevant fishery licence holders, notification can be provided to WA DPIRD, WAFIC and AFMA, who have an interest in the broader	Benefits outweigh cost/sacrifice. Control is also standard practice.	Yes **C 1.3**

[1] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[1]***	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
		fishery management areas.		
Engage with proponents identified as having potential concurrent activities within the Operational Area prior to commencing the Petroleum Activities Program and develop an operations plan including the following aspects: • communications • work programming • hazard management • emergency response.	F: Yes CS: Minimal cost. Standard practice.	Communication of the Petroleum Activities Program to other marine users ensures they are informed and aware, thereby reducing the likelihood of interference with other marine users.	Benefits outweigh cost/sacrifice. Control is also standard practice.	Yes **C 1.4**
Notify Defence of activities and movements no less than five weeks before the scheduled activity commencement date	F: Yes CS: Minimal cost. Standard practice.	Communication of the Petroleum Activities Program to other marine users ensures they are informed and aware, thereby reducing the likelihood of interference with other marine users.	Benefits outweigh cost/sacrifice. Control is also standard practice.	Yes **C 1.5**
Establish and maintain a 3 nm radius SNA around the seismic vessel and towed array.	F: Yes CS: Minimal cost. Standard practice.	Presence of the SNA will reduce the likelihood of interfering with other marine users.	Benefits outweigh cost/sacrifice. Control is also standard practice.	Yes **C 2.1**
At least one dedicated support/chase vessel will be employed to assist the seismic vessel.	F: Yes CS: Minimal cost. Standard practice.	Use of a support/chase vessels to assist the seismic vessel will reduce the likelihood of an interaction with a third party vessel.	Benefits outweigh cost/sacrifice. Control is also standard practice.	Yes **C 2.2**
Project vessels to operate AIS, and tail buoys will be fitted with lights, Global Navigation Satellite System (GNSS) and virtual AIS.	F: Yes CS: Minimal cost. Standard practice.	Use of AIS on project vessels, and lights, virtual AIS and GNSS on tail buoys will reduce the likelihood of an interaction with a third party vessel.	Benefits outweigh cost/sacrifice. Control is also standard practice.	Yes **C 2.3**
Woodside will consider evidence based claims from commercial fishing licence holders where: • There is genuine displacement from undertaking normal fishing activities that results in demonstratable economic loss. • Deployed fishing equipment has been accidentally lost or damaged by any activities under Woodside's control.	F: Yes However, due to the absence of commercial fishing in the Operational Area, displacement of fishers are not expected. CS: Time, stakeholder fatigue and potential confusion associated with communicating	Given limited fishing activity has ever taken place in or near the Operational Area and no fishing effort has been reported in over 10 years, the Operational Area does not represent an area that is significant to fisheries and displacement is not expected.	Cost is grossly disproportionate to the limited benefit gained.	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[1]***	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
• There is a loss of catch due to the seismic activity that can be demonstrated	[Document Title] and engaging with fishers unnecessarily.	Therefore, providing a process for compensation claims provides no benefit.		
Professional Judgement – Eliminate				
Limit activities to avoid peak shipping and commercial fishing activities.	F: No. Shipping occurs year-round and cannot be avoided. Concurrent operations (CONOPS) with fishing seasons cannot be eliminated as fishing activities occur consistency throughout the year, and exact timings and locations of fishing activities are not known. CS: Not considered – control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No
Eliminate use of vessels.	F: No. The use of vessels is required to conduct the Petroleum Activities Program. CS: Not considered – control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No
Eliminate use of AUV/commercial nodes.	F: Yes. Woodside will be able to continue to acquire the seismic survey without the use of AUV/commercial nodes, given the seismic vessel will be towing streamer(s) that can listen to/record the seismic signal. However, the use of AUV/commercial nodes has the potential to improve both seismic data quality and efficiently, and reduce the frequency and duration of future seismic surveys. CS: No additional costs. Inability to confirm the functionality and performance of the novel technology on a commercial-scale seismic survey.	Eliminates the potential for the AUV/commercial nodes to interfere with third party vessels.	Although the control would eliminate the potential for interaction with third party vessels, it would result in the inability for Woodside to confirm the functionality and performance of the novel technology on a commercial-scale seismic survey. Therefore, delaying Woodside's ability to advance technological advancements in acquiring seismic data.	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[1]	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Professional Judgement – Substitute				
None identified.				
Professional Judgement – Engineered Solution				
None identified.				
ALARP Statement On the basis of the environmental impact assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to manage the impacts and risks of the physical presence of the project vessels and AUV/commercial nodes on other marine users, which is expected to be limited to commercial shipping movements. As no reasonable additional/alternative controls were identified that would further reduce the impacts and risks without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that, given the adopted controls, physical presence of the project vessels (and associated towed seismic equipment in the SNA) and AUV/commercial nodes is unlikely to result in potential impact greater than slight, short-term impact to other marine users, such as commercial shipping. Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice and meet expectations of AMSA and AHO provided during consultation with stakeholders. The potential impacts and risks are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks of the physical presence of the project vessels (and associated towed seismic equipment in the SNA) and AUV/commercial nodes to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 1 Marine users are aware of the Petroleum Activities Program.	**C 1.1** Notify AHO of activities and movements no less than four weeks before the scheduled activity commencement date.	**PS 1.1** Notification to AHO four weeks prior to scheduled commencement to allow for the generation of navigation warnings (MSIN and NTM [including AUSCOAST warnings where relevant]).	**MC 1.1** Consultation records demonstrate that AHO has been notified prior to commencement of the Petroleum Activities Program within the required timeframes.
	C 1.2 Notify AMSA Joint Rescue Coordination Centre (JRCC) of activities and movements 24-48 hours before the scheduled activity commencement date.	**PS 1.2** Notification to AMSA JRCC 24-48 hours prior to the scheduled commencement date.	**MC 1.2.1** Consultation records demonstrate that AMSA JRCC has been notified prior to commencement of the Petroleum Activities Program within the required timeframes.
	C 1.3 Notify AFMA, DPIRD and WAFIC of activities and movements no less than four weeks before the scheduled activity commencement date.	**PS 1.3** Notification to WA DPIRD, WAFIC and AFMA four weeks prior to the scheduled commencement date.	**MC 1.3.1** Consultation records demonstrate that WA DPIRD, WAFIC and AFMA have been notified prior to commencement of the Petroleum Activities Program

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
			within the required timeframes.
	C 1.4 Engage with proponents identified as having potential concurrent activities within the Operational Area prior to commencing the Petroleum Activities Program and develop an operations plan including the following aspects: • communications • work programming • hazard management • emergency response	**PS 1.4** A concurrent operations plan developed for any concurrent MSS activities identified within the Operational Area.	**MC 1.4.1** Records demonstrate Woodside re-engage with identified proponent before commencing the Petroleum Activities program and developed a concurrent operations plan (if required).
	C 1.5 Notify Defence of activities and movements no less than five weeks before the scheduled activity commencement date.	**PS 1.5** Notification to Defence five weeks prior to the scheduled commencement date.	**MC 1.5.1** Records demonstrate that Defence has been notified prior to commencement of the Petroleum Activities Program within the required timeframes.
EPO 2 Prevent adverse interactions between vessels and other marine users during the Petroleum Activities Program	**C 2.1** Establish and maintain a 3 nm radius SNA around the seismic vessel and towed array.	**PS 2.1** SNA established, communicated and maintained around the seismic vessel and towed array during the Petroleum Activities Program.	**MC 2.1.1** Records demonstrate that the SNA has been established and details have been communicated to approaching third-party vessels.
	C 2.2 Employ at least one support/chase vessel will be employed to assist the seismic vessel.	**PS 2.2** At least, one vessel employed to assist the seismic vessel mitigate interactions with third-party vessels.	**MC 2.2.1** Records demonstrate that a second vessel is employed for the Petroleum Activities Program.
	C 2.3 Project vessels to operate AIS, and tail buoys will be fitted with lights, GNSS and virtual AIS.	**PS 2.3** Project vessels operating AIS and tail boys fitted with lights, GNSS and virtual AIS.	**MC 2.3.1** Records demonstrate that project vessels operating AIS, and tail boys are fitted with lights, GNSS and virtual AIS.

6.5.2 Physical Presence: Disturbance to Benthic Habitat from Placement of AUV and Commercial Nodes

Context		
AUV Nodes – **Section 3.6**	Physical Environment – **Section 4.4** Biological Environment – **Section 4.5**	Stakeholder Consultation – **Section 5**

Impact Evaluation Summary														
Source of Impact	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl Odour)	Ecosystems/ Habitat	Species	Socio-Economic	Decision Type	Consequence/Impact	Likelihood	Risk Rating	ALARP Tools	Acceptability	Outcomes
Disturbance to seabed from placement of AUV nodes		X	X		X			A	E	-	-	GP	Broadly Acceptable	EPO 3

Description of Source of Impact

Placement of AUV/Commercial Nodes

The placement of AUV/commercial nodes on the seabed within the Active Source Area may result in temporary seabed disturbance and suspension of sediments, causing a localised increase in turbidity.

Up to 50 seismic nodes (combined AUV and commercial nodes) may be deployed in the Active Source Area. When deployed, the nodes will be laid out in a grid of approximately 500 m x 500 m in a 10 km² area of seabed within the Active Source Area. The AUV nodes will relocate autonomously up to five times, each time landing near a commercial node. The AUV nodes will be moved in a staged approach during the Petroleum Activities Program (i.e. the nodes will not all be moving all at the same time, except for during deployment and retrieval). The AUV and commercial nodes may be deployed for the duration of the Petroleum Activities Program.

The proposed AUV nodes are cylindrical in shape with short wings on the side for flight stabilisation and steering, at approximately 1000 mm long and 300 mm in diameter (weights approximately 30 kg in air and 10 kg in sea water). The AUV nodes are based on current autonomous technology as developed with gliders (e.g. Slocum) that move through the water column by changing buoyancy. The AUV nodes, however, are adapted to and settle for periods of time on the seabed to record the seismic signal. As a control, the AUV nodes will be fitted with thrusters to be periodically used for propulsion, navigation assistance, managing low impact landings and to assist with take-offs as required.

The AUV nodes are able to position accurately on the seabed. If the AUV node is unable to position due to unsuitable substrate, the AUV node will automatically relocate to more suitable substrate for landing. Recovery devices are included within each AUV node, which will deploy inflatable air bags to raise the node to the surface if the node is unable to do so with its normal functioning. The commercial nodes are deployed to the seabed via gravity and recovered via positive buoyancy.

Commercial nodes will be used to ‘ground truth’ the AUV nodes. The proposed commercial nodes weigh approximately 68.2 kg (10.2 kg in sea water) and measure approximately 450 mm (H), by 350 mm (L) and 300 mm (W). Commercial nodes are weighted to the seafloor by a biodegradable concrete pad, approximately 450 mm (L), by 500 mm (W) and 50 mm (H) (weights approximately 25 kg in air and 16 kg in seawater). The concrete is made of a mixture of aggregate (rock fragments and sand) and Portland cement. When water is added, the cement minerals harden by hydration and adhere to the aggregate to bind the mix together. The binder of concrete based on Portland cement is amorphous calcium silicate hydrate (CSH-gel). If enough calcium carbonate is added to the concrete (e.g. as limestone filler), the concrete is prone to degradation by sulphur attack. The reaction takes place uniformly throughout the concrete and even crumbling occurs, leaving a pile of naturally occurring material (gravel and sand) on the seafloor. The following concrete mix has been shown to dissolve in seawater in four months; Portland cement (9%), crushed limestone (4%), anhydrite (5%), sand (37%), crushed stone (gravel) 8-16 mm (37%) and free water (8%).This concrete contains no

materials that are harmful to the marine environment, and all ingredients are natural, gravel, limestone and/or seawater.

Impact Assessment
Potential Impacts to Environmental Values
Benthic Habitats The placement of AUV/commercial nodes on the seafloor is expected to result in localised disturbance to soft sediment habitats, and localised elevated turbidity. Physical modifications to the seabed are not expected to occur, as nodes will be deployed at one location for a short period of time before self-recovering. As mentioned above, the AUV nodes are able to be positioned accurately on the seabed. If the AUV node is unable to position due to unsuitable substrate (such as hard substrate), the AUV node will automatically relocate to more suitable substrate for landing. As described in **Section 4.5**, the Operational Area is expected to consist primarily of fine grain, soft sediments. The seabed is likely to be inhabited by a low abundance of filter feeders (primarily echinoderms) and other epifauna and infauna. The Operational Area lies within the Exmouth Plateau KEF. This KEF 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 1000 m (DoEE, n.d.). Additionally, the Operational Area overlaps entirely with the Northwest Province, which typically supports a low abundance, richness and diversity of benthic communities (Heyward et al., 2001). The placement of the AUV/commercial nodes on the seafloor may result in highly localised effects to biota, as a result of physical disturbance and elevated turbidity. Very high elevations in turbidity may cause the clogging of respiratory and feeding parts of filter-feeing organisms. However, elevated turbidity from placement of the AUV/commercial nodes (including concrete pads) is expected to be very localised, short-term and temporary, and is therefore not expected to have a significant impact to environmental receptors. These impacts are expected to be highly localised around the footprint of the AUV/commercial nodes. The biodegradable concrete pads used for the commercial nodes do not contain materials that are harmful to the marine environment. When on the seafloor, the concrete is expected to degrade to naturally occurring material (gravel and sand) in a number of months. Following degradation, localised patches of sand and gravel may remain on the surface of the seabed. Some gradual reworking of these sediments may occur over time due to the influence of ocean currents and bioturbation. The highly localised patches of relatively coarse sediment are not expected to result in detrimental impacts to the broader soft sediment benthic habitats and communities that are widespread across the Exmouth Plateau. If any changes occur, the patches of coarse sediment may attract some epifauna from surrounding sediments or provides points of attachment for small filter feeding organisms. Based on the above assessment, seabed disturbance is unlikely to impact on the ecological values of the Active Source Area and surrounding environment, including the Exmouth Plateau KEF.
Summary of Potential Impacts to Environmental Values(s)
Given the adopted controls, seabed disturbance from the Petroleum Activities Program will result in no greater than localised, impacts to benthic habitat and communities. Highly localised changes may occur as a result of the placement of nodes and the degradation of the concrete pads (over a number of months), but these changes will not affect the ecosystems function, physical or biological attributes of the benthic habitats of the Exmouth Plateau.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[2]***	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Sea Dumping Permit for leaving the commercial node concrete pads in-situ	Determined a permit under the Environment Protection (Sea Dumping) Act 1981 is not required, given the infrastructure is considered to fall under the scope of article 1.4.2.3 of the London Protocol, which states that sea dumping does not include the 'abandonment in the sea of matter (such as cables, pipelines and marine research devices) placed for a purpose other than the mere disposal thereof'.			No
Good Practice				
Environmental monitoring of the seabed prior to and following the Petroleum Activities	F: Yes CS: Significant. Monitoring of the seabed would have	The AUV/commercial nodes will be predominately deployed in deep water, soft	Control grossly disproportionate. Monitoring will not reduce the	No

[2] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[2]***	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Program to assess any impacts to seabed.	significant additional costs to obtain and analyse data with the spatial resolution to accurately assess changes to the seabed.	sediment habitat that is widely represented within the broader region and reductions of consequence are therefore not expected.	consequence of any impacts to the seabed, and the costs associated with the level of monitoring required to accurately assess any impacts greatly outweighs the benefits gains.	
Professional Judgement – Eliminate				
Eliminate use of AUV/commercial nodes.	F: Yes. Woodside will be able to continue to acquire the seismic survey without the use of AUV/commercial nodes, given the seismic vessel will be towing streamer(s) that can listen to/record the seismic signal. However, the use of AUV/commercial nodes has the potential to improve both seismic data quality and reduce the duration of future seismic surveys. CS: No additional costs. Inability to confirm the functionality and performance of the novel technology on a commercial-scale seismic survey.	Adoption of this control would result in no seabed disturbance during planned activities.	Although the control would reduce the consequence of any impacts to the seabed, it would result in the inability for Woodside to confirm the functionality and performance of the novel technology on a commercial-scale seismic survey. Therefore, delaying Woodside's ability to advance technological advancements in acquiring seismic data.	No
Professional Judgement – Substitute				
None identified.				
Professional Judgement – Engineered Solution				

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[2]***	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Nodes designed with appropriate tracking and monitoring systems including: • AUV nodes will be pre-programmed with the planned movements prior to deployment • sub-surface positioning can be tracked via USBL while AUV is moving • surface live positioning of AUV / commercial nodes is tracked via two GNSS systems. • nodes can be monitored from vessel via health check system; if significant issues are identified buoyancy air-bag will be deployed to bring node to the surface and tracking systems will allow for retrieval.	F: Yes. CS: Minimal cost. Nodes are designed and built with tracking and monitoring systems.	Implementation of these controls will reduce the likelihood of nodes being lost and unable to be recovered, therefore preventing structures from remaining on the seabed in an otherwise fine grained soft sediment environment.	Benefits outweigh the cost/sacrifice.	Yes **C 3.1**

ALARP Statement

On the basis of the environmental impact assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to management the impacts of seabed disturbance from the placement of AUV/commercial nodes. As no reasonable additional/alternative controls were identified that would further reduce the impacts without grossly disproportionate sacrifice, the impacts are considered ALARP.

Demonstration of Acceptability

Acceptability Statement

The impact assessment has determined that, given the adopted controls, disturbance to the seabed from placement of AUV/commercial nodes may result in highly localised impacts to benthic habitats and communities (but not affecting ecosystem function).

The adopted controls are considered consistent legislative requirements (with industry good practice and professional judgement. On the basis of the environmental impact assessment outcomes and Woodside's criteria for acceptability outlined in **Section 2.7.2**, this is considered an acceptable level of impact.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 3 No disturbance to benthic communities from the placement of AUV / commercial nodes with a consequence level greater than E[3] for the duration of the Petroleum Activities Program.	**C 3.1** AUV/commercial nodes designed with appropriate tracking and monitoring systems, including: • AUV nodes will be pre-programmed with the planned movements prior to deployment • sub-surface positioning of AUV can be tracked via USBL while AUV is moving • surface live positioning is tracked via two GNSS systems. • AUVs can be monitored from vessel via health check system; if significant issues are identified buoyancy air-bag will be deployed to bring AUV to the surface and tracking systems will allow for retrieval.	**PS 3.1** Location and status of AUV/commercial nodes can be tracked/monitored from vessels	**MC 3.1.1** Records demonstrate that systems are in place to track/monitor the location and status of AUV/commercial nodes from vessels when deployed
		PS 3.2 AUV/commercial nodes will be designed with buoyancy self-recovery devices that include air-bags deployed to facilitate surfacing where necessary	**MC 3.2.1** Records demonstrate that AUV/commercial nodes are designed with buoyancy air-bag devices

[3] Defined as 'Slight, short-term impact (less than one year) on species, habitat (but not affecting ecosystems function), physical or biological attributes.'

6.5.3 Routine Acoustic Emissions: Seismic Survey Equipment

Context		
Activity Components – **Section 3.6**	Physical Environment – **Section 4.4** Biological Environment – **Section 4.5** Socio-Economic Environment – **Section 4.9**	Stakeholder Consultation – **Section 5**

Impact Evaluation Summary														
Source of Impact	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl Odour)	Ecosystems/ Habitat	Species	Socioeconomic	Decision Type	Consequence/Impact	Likelihood	Risk Rating	ALARP Tools	Acceptability	Outcomes
Generation of underwater noise from seismic survey equipment					X	X	X	B	D	-	-	LG S GP	Acceptable	EPO 4, 5, 6, 7

Description of Source of Impact
The Petroleum Activities Program will use a seismic source, consisting of an airgun array with a maximum capacity of up to 3150 in³, towed at a water depth of 6–8 m (±1 m). The source will be used to generate acoustic pulses by periodically discharging compressed air into the water column, at intervals of about five to six seconds as the vessel transits along planned survey lines within the Active Source Area. The 3150 in³ seismic source is expected to produces far-field source levels up to a maximum of 254.4 dB re 1 μPa m (PK) and per-pulse SEL of 227.4 – 230.2 dB re 1 μPa²m²s (at 10-2000 Hz) in the vertical plane directly beneath the array. In the horizontal (broadside) plane, the seismic source is expected to produce far-field source levels up to a maximum of 248.1 dB re 1 μPa m (PK) and per-pulse SEL of 224.1 dB re 1 μPa²m²s (at 10-2000 Hz).

Impact Assessment

Elevated underwater noise can affect marine fauna, including marine mammals (cetaceans), turtles and fishes in three main ways (Richardson et al.,1995; Simmonds et al., 2004):

1. By causing direct physical effects, including injury or hearing impairment. Hearing impairment may be temporary (temporary threshold shift – TTS), or permanent (PTS), with PTS generally considered to represent a form of injury.
2. Through disturbance leading to behavioural changes or displacement from important areas. The occurrence and intensity of disturbance is highly variable and depends on a range of factors relating to the animal and situation.
3. By masking or interfering with other biologically important sounds (including vocal communication, echolocation, signals and sounds produced by predators or prey).

The area over which seismic sound may adversely impact marine species depends upon multiple factors including the extent of sound propagation relative to the location of receptors, and the sensitivity and range of spectral hearing of different species (Slabbekoorn et al., 2010; Popper and Hawkins, 2012).

Without adequate control measures in place, noise emitted from the seismic source used during the Petroleum Activities Program has the potential to impact a range of receptor groups, being:

- plankton
- benthic invertebrates
- fish, sharks and rays
- cetaceans
- marine turtles

- seabirds and migratory shorebirds
- commercial fisheries
- marine protected areas.

Sound metric terminology

Sound levels and the decibel scale

The decibel (dB) scale is used to measure the amplitude or 'loudness' of a sound wave. For underwater sounds, the dB scale is denoted relative to the reference pressure of 1 micropascal (μPa) e.g. dB re 1 μPa, whereas the reference pressure level used in air is 20 μPa, which was selected to match human hearing sensitivity. Because of these differences in reference standards, dB sound levels in air are not comparable to underwater sound levels i.e. dB sound levels underwater are much quieter than the same dB sound levels in air (Carroll et al., 2017).

Sound metrics

Marine seismic surveys emit pulses of underwater sound. These sounds are termed 'impulsive' sounds as they are brief and intermittent with rapid rise times and decay back to ambient levels (within a few seconds).

There are four main metrics used to measure and describe underwater sound pressure and energy that are applied to the assessment of these types of sound, all of which use the decibel scale (adapted from ISO/DIS 18405.2:2017):

- **Zero-to-peak sound pressure (PK)**, the greatest magnitude of the sound pressure during a specified time interval (**Figure 6-1**); unit: dB re 1 μPa; PK levels are relevant to the assessment of potential physical injury and impairment impacts to marine fauna and biota resulting from a single seismic pulse.
- **Peak-to-peak sound pressure (PK-PK),** sum of the peak compressional pressure and the peak rarefactional pressure during a specified time interval (approximately double the zero-to-peak pressure) (**Figure 6-1**); unit: dB re 1 μPa; PK-PK levels, like PK levels, are relevant to the assessment of potential physical injury and impairment impacts to marine fauna and biota resulting from a single seismic pulse.
- **Root-mean-square sound pressure level (SPL),** the time-mean-square sound pressure, in a stated frequency band, to the square of the reference sound pressure over the duration of an acoustic event (i.e. the duration of a single seismic pulse) (**Figure 6-1**); unit: dB re 1 μPa; because the SPL represents the effective sound pressure over the full duration of the acoustic event rather than the maximum instantaneous peak pressure, it is regularly used to represent the effective loudness of a sound and to assess the potential for a behavioural response from marine fauna.
- **Sound exposure level (SEL),** a measure related to the sound energy (instead of the sound pressure) in one or more pulses, or the ratio of the time-integrated squared sound pressure to the specified reference value; unit: dB re 1 $\mu Pa^2 \cdot s$; SEL is specified in terms of either a per-pulse SEL or an accumulated SEL (SEL_{cum}) from multiple pulses over a given period. SEL recognises that the effects of sound can be a function of exposure duration as well as maximum instantaneous peak pressure. SEL can therefore be considered a dose-type measurement with SEL_{cum} being used to assess dose-type impacts such as the potential for the gradual onset of temporary threshold shift (TTS) in marine fauna hearing because of prolonged exposure to high sound levels. It is standard practice for SEL_{cum} to be assessed over a summation period of 24-hours (SEL_{24h}).

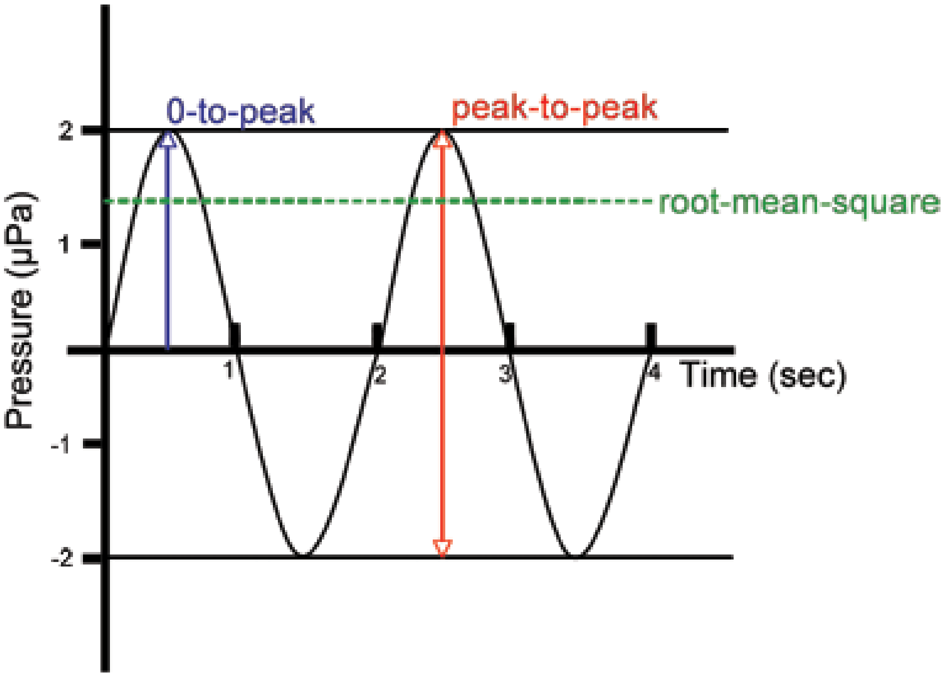


Figure 6-1: Simplified sound wave and sound pressure metrics (University of Rhode Island and Inner Space Center, 2017)

Particle motion

The particle motion component of sound is also relevant to the assessment of potential impacts to marine fauna. Acoustic particle motion refers to the physical motion caused by a sound wave within the water, seabed or other medium. Unlike pressure, particle motion is directional in nature, although the actual to-and-fro particle displacements that constitute sound are extremely small, in the order of nanometres (Popper and Hawkins, 2018). Particle motion can be described in terms of particle displacement (m), velocity (m/s), or acceleration (m/s^2) (Popper et al., 2014; Carroll et al., 2017). Alternatively, it is sometimes expressed in dB with respect to a reference value of displacement (dB re 1 pm), velocity (dB re 1 nm/s) or acceleration (dB re 1 µm/s^2) (Nedelec et al., 2016).

Particle motion is important because marine invertebrates and most fishes are primarily sensitive to particle motion rather than sound pressure and, therefore, particle motion is the most relevant metric for perceiving underwater sound by invertebrates and most fish species (Popper and Hawkins, 2019). However, there is currently limited information available to quantify the particle motion sensitivity of fishes and invertebrates. It is complex and challenging to directly measure particle motion compared to sound pressure, hence most research is presented in the context of sound pressure or exposure levels instead of particle motion (Carroll et al., 2017; Popper and Hawkins, 2018). Therefore, while the assessment of underwater noise impacts in this EP considers the role of particle motion and its effect on fishes and invertebrates, the acoustic modelling and impact threshold criteria are based upon sound pressure and sound exposure metrics.

It should be noted that particle motion is most relevant close to the source where it is the dominant component of a sound wave, while pressure will dominate a sound wave propagating over distance (Radford et al., 2012; Morley et al., 2014; Nedelec et al,. 2016; Popper and Hawkins, 2018). Sound pressure levels received at increasing distance from a source do not, therefore, provide a reliable representation of particle motion. Organisms that are sensitive only to particle motion have typically been found to be sensitive only at close range where these particle motions are greatest (Popper et al., 2014; Edmonds et al., 2016; Popper and Hawkins, 2018).

Sound frequency and hearing sensitivity

Different animals are sensitive to different sound frequencies, which are measured in Hertz (Hz) and kilohertz (kHz). Therefore, if an animal is sensitive to a particular frequency range, a sound in that frequency range will seem louder to that animal than to a different animal which is less sensitive to those frequencies. For example, some large baleen whales are sensitive to very low frequency sounds (7 Hz to 35 kHz), while other toothed whales and dolphin species are considered more sensitive to mid-high frequency sounds (150 Hz to 160 kHz) with their peak hearing frequency somewhere between these frequency ranges (National Marine Fisheries Service, 2018). Therefore, how loud a sound will be perceived will differ between species.

In some cases, a sound level is specified relative to a given frequency range or is weighted according to the auditory sensitivity of an animal (e.g. low-frequency, medium-frequency and high-frequency groups of cetaceans). This has the advantage of placing the sound into a more biologically relevant context for that animal. If a frequency range or weighting is not specified, the frequency of the sound is generally referred to as "broadband" sound i.e. the sound level accounts for sound across all frequencies, noting again that a particular animal may not be able to detect all of the sound frequencies and associated energy that are emitted.

Therefore, the frequency of a sound and how sensitive different animals are to sound can make a considerable difference to how loud the sound is perceived to be and any resultant impact.

Acoustic modelling

To assess the potential magnitude and extent of impacts from underwater noise produced during the Petroleum Activities Program, Woodside commissioned JASCO Applied Sciences (JASCO) to model sound propagation at several locations that were representative of the different water depths, bathymetry and seabed properties within the Active Source Area (Koessler et al., 2021; **Appendix G**).

The objective of this acoustic modelling study was to evaluate the potential effects of sound (potential injury and behavioural disruption) to marine fauna including cetaceans, marine reptiles, fishes, elasmobranchs, and zooplankton. The modelling also provides information to support the evaluation of potential effects of sound on socio-economic receptors such as commercial fisheries and marine protected areas.

Two standalone single-impulse sites were modelled and used to model one scenario for survey operations over 24 hours to assess accumulated SEL. The modelled sites and acquisition lines are shown in **Figure 6-2** along with the survey boundaries and other areas of interest. The accumulated SEL scenario assumed that a survey vessel sailed along survey lines at ~4.5 knots, with an impulse interval of 12.5 m. The locations of the single impulse sites were selected to cover a range of water depths along the survey lines that will be acquired during the Scarborough 4D B1 MSS, and the potential sound propagation characteristics that may arise during acquisition.

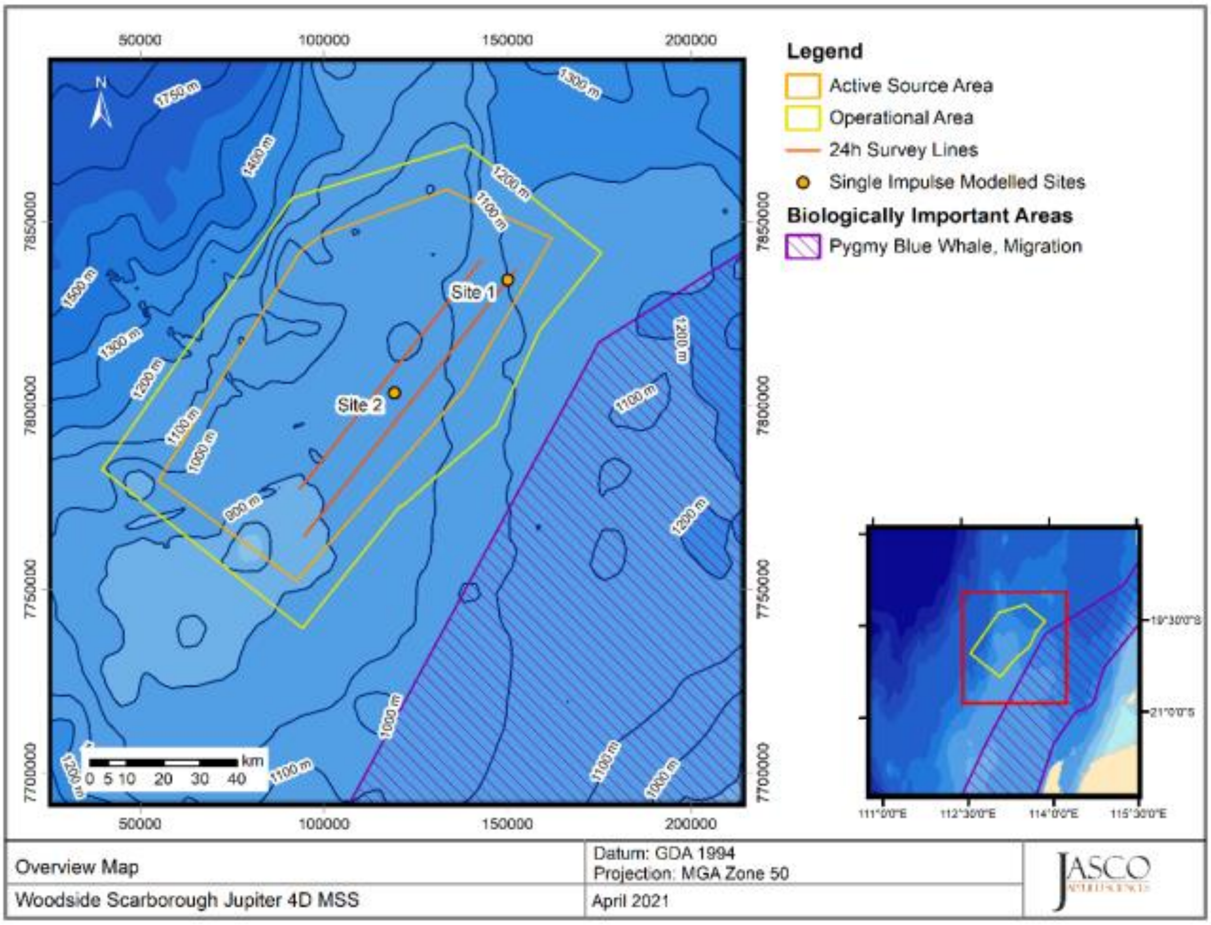


Figure 6-2: Overview of the modelled sites, acquisition lines, and features for the Scarborough 4D B1 MSS (Koessler et al., 2021)

Contours of the modelled underwater sound fields were computed, sampled either as the maximum value over all modelled depths (maximum-over-depth: MOD) or at the seafloor for the two single pulse locations, and one cumulative

SEL_{24h} scenario. The modelled distances to each of the sound exposure thresholds for marine fauna were computed from these contours. Two distances relative to the source are reported for each sound level:

- R_{max} - the maximum range to the given sound level over all azimuths; and
- $R_{95\%}$ - the range to the given sound level after the 5% farthest points were excluded.

The difference between R_{max} and $R_{95\%}$ depends on the source directivity and the non-uniformity of the acoustic environment. In some environments a sound level contour might have small anomalous isolated fringes in which case the use of R_{max} can misrepresent the area of the region exposed to such effects. In these instances $R_{95\%}$ is considered more representative. In environments that have bathymetric features that affect sound propagation then the $R_{95\%}$ may neglect to account for these and therefore R_{max} might better represent the region of effect in specific directions. For this impact assessment the R_{max} values have been considered. In many of the impact assessments, the maximum R_{max} values resulting from the various modelling sites have been referenced (unless specified) which provides a further level of conservatism to the assessment.

The results of the acoustic modelling are presented in relation to the sound exposure thresholds relevant to each receptor group assessed below. The detailed results are provided in the acoustic modelling report (Koessler et al., 2021; **Appendix G**).

Animal movement and exposure modelling (ANIMAT modelling)

In addition to the propagation modelling outlined above, Woodside commissioned JASCO to perform an acoustic exposure analysis study for pygmy blue whales (*Balaenoptera musculus brevicauda*) within the migration BIA to investigate any potential effects on pygmy blue whale migration from the Scarborough 4D B1 MSS (Koessler et al., 2021; **Appendix G**). Detailed information on pygmy blue whales was derived from a range of sources that used multi-sensor tags to record fine-scale dive and movement behaviour (Owen et al., 2016; Möller et al., 2020). Where information was unavailable for pygmy blue whales, parameters were derived from blue whale (*B. musculus*) tagging data (Goldbogen et al., 2011).

Sound exposure distribution estimates were determined by moving large numbers of simulated animals (animats) through a modelled time-evolving sound field, computed using the existing sound source and sound propagation model (Koessler et al., 2021). This approach provides the most realistic prediction of the maximum expected root-mean-square sound pressure level (SPL) and peak pressure level (PK), and the temporal accumulation of sound exposure level (SEL) that are now considered the most relevant sound metrics for impact assessment.

The acoustic exposure analysis and animal movement (animat) scenario was modelled for a seven day period, with the spatial distribution of animats restricted to the migration BIA, and the same vessel speed and impulse interval as the accumulated SEL scenario discussed above. On each day, a 24-hour segment of the planned seismic track lines was run. **Figure 6-3** shows the geographic features associated with the modelled animat scenario. The results of the ANIMAT modelling are discussed below, and detailed results are provided in the acoustic modelling report (Koessler et al., 2021; **Appendix G**).

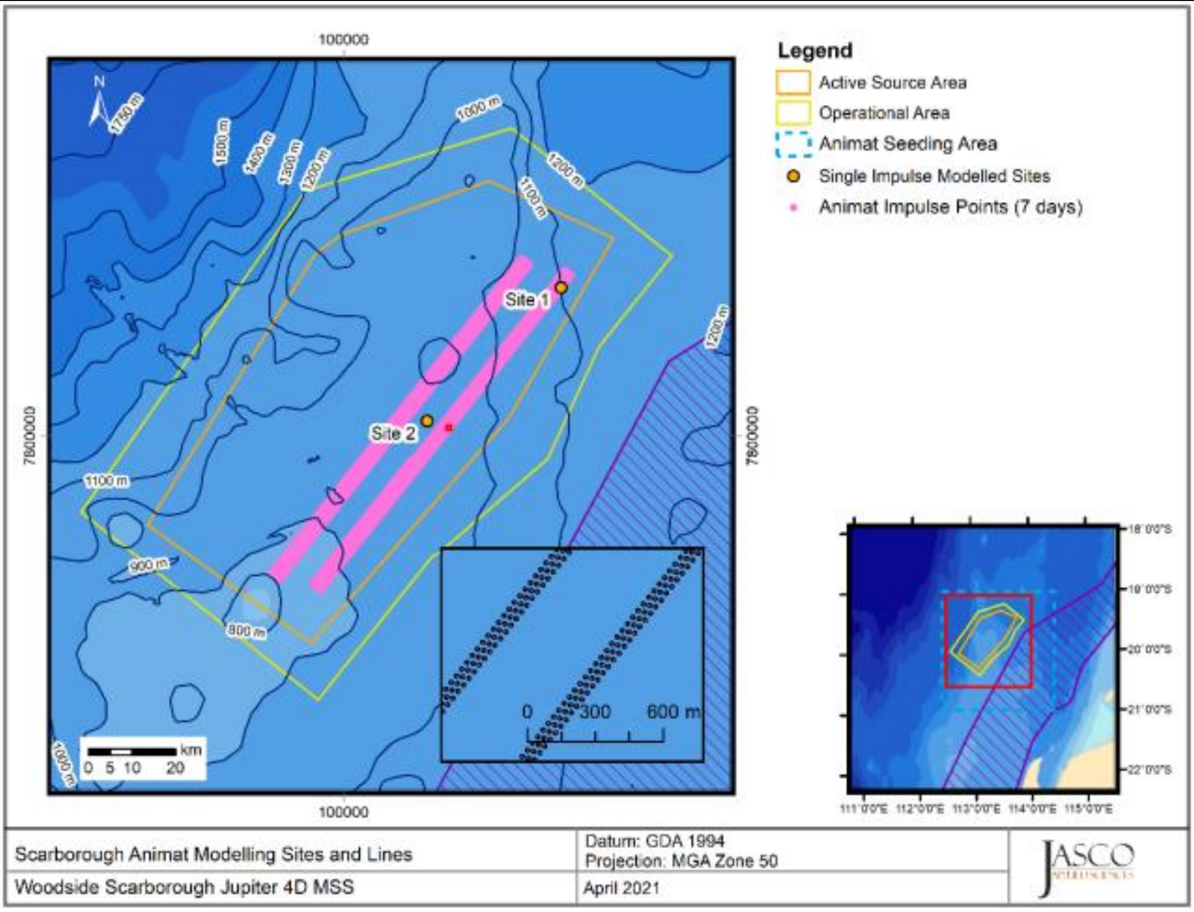


Figure 6-3: Overview of the features for the pygmy blue whale exposure modelling for the Scarborough 4D B1 MSS (Koessler et al., 2021)

Zooplankton

Species sensitivity and sound exposure thresholds

Plankton is a collective term for all marine organisms that are unable to swim against a current. This group is diverse and includes phytoplankton (plants) and zooplankton (animals), as well as fish and invertebrate eggs and larvae. There is no scientific information on the potential for noise-induced effect in phytoplankton and no functional cause-effect relationship has been established. Noise-induced effects on zooplankton, such as copepods, cladocerans, chaetognaths and euphausiids, have been investigated in a number of sound exposure experiments.

Zooplankton includes fish eggs and larvae that are transported by currents and winds and hence cannot take evasive behaviour to avoid seismic sources. Larval fish species studied appear to have hearing frequency ranges similar to those of adults and similar acoustic startle thresholds (Popper et al., 2014). Swim bladders may develop during the larval stage and may render larvae susceptible to pressure-related injuries such as barotrauma. Effects of sound upon eggs, and larvae containing gas bubbles, is focused on barotrauma rather than hearing (Popper et al., 2014). Larval stages are often considered more sensitive to stressors than adult stages, but exposure to seismic sound reveals no differences in larval mortality or abundance for fish, crabs or scallops (Carroll et al., 2017).

Parry et al. (2002) studied the abundance of plankton after exposure to airgun sounds but found no evidence of mortality or changes in catch-rate at a population-level. Other studies have also noted limited negative impacts on zooplankton, fish eggs, larvae or fry, and most have reported that impacts occur within a few metres or tens of metres from the source (Kostyuchenko, 1973; Dalen and Knutsen, 1987; Holliday et al., 1987; Kosheleva, 1992; Pearson et al., 1994; Turnpenny and Nedwell, 1994; Booman et al., 1996; Payne, 2004; Payne et al., 2009). These studies included exposures to sound pressures up to approximately 242 dB re 1 µPa, comparable to those predicted in close range to the Scarborough 4D B1 MSS seismic source.

McCauley et al. (2017) found that after exposure to airgun sounds generated with a single airgun (150 cui) zooplankton abundance decreased and mortality in adult and larval zooplankton increased two-to three fold when compared with controls. In this large-scale field experiment on the impact of seismic activity on zooplankton, a sonar and net tows were used to measure the effects on plankton, and a maximum effect-range of horizontal 1.2 km was determined. The findings contradicted the conventional idea of limited and very localised impact of intense sound in general, and seismic airgun signals in particular, on zooplankton, with the results indicating that there may be noise-induced effects on these taxa and that these effects may even be negatively affecting ocean ecosystem function and productivity.

The study measured zooplankton abundance and the proportion of the population that was dead at three distances from a single 150 cui airgun; 0 m, 200 m and 800 m. The experiment estimated the proportion of the zooplankton that was found to be dead, both before and after exposure to airgun noise, using net samples to measure zooplankton abundance, and bioacoustics to identify the distribution of zooplankton. In this study, copepods dominated the mesozooplankton (0.2-20 mm), and impacts were not assessed on microzooplankton (0.02-0.2 mm) or macrozooplankton (>20 mm).

McCauley et al. (2017) provide three findings from the experiment to show that zooplankton were affected by the seismic source:

1. the proportion of the mesozooplankton community that was dead increased two- to three-fold;
2. the abundance of zooplankton estimated by net samples declined by 64%; and
3. the opening of a “hole” in the zooplankton backscatter observed via acoustics.

They found that exposure to airgun noise significantly decreased zooplankton abundance, and increased the mortality rate from a natural level of 19% per day to 45% per day (on the day of exposure, and that these impacts were observed out to the maximum range assessed (1.2 km) (McCauley et al., 2017).

Scientists from CSIRO’s Oceans and Atmosphere Business Units were contracted by APPEA to undertake a desktop study that: a) critically reviewed the methodologies and findings of the McCauley et al. (2017) experiment; and b) simulated the large scale impact of a seismic survey on zooplankton in the North West Shelf region, based on the mortality rate associated with airgun noise exposure reported by McCauley et al. (2017).

The CSIRO review of the McCauley et al. (2017) study found that there were three primary questions raised by the results of the experiment, all of which warrant further investigation (Richardson et al., 2017):

1. Why was there no attenuation of the impact with distance? There is no consistent decline in the proportion of zooplankton that are dead with increasing distance away from the airgun. The energy of the sound waves at a distance of 1.2 km is substantially lower than at the source.
2. Why was there an immediate decline in abundance? It is unclear why there would be a near immediate drop in zooplankton abundance as measured by net samples and acoustic data. If zooplankton were killed, they would not immediately sink from the surface layers, or be rapidly eaten. A drop in abundance would be more likely once the dead zooplankton either sunk to the bottom or were removed by predation.
3. Was there sufficient replication to be confident in the study findings?

The conclusions made by McCauley et al. (2017) were based on a relatively small number of zooplankton samples. A total of 24 samples were collected – 2 tows each sampling time x 3 distances from the gun (0 m, 200 m, 800 m) x 2 levels (Control, Exposed) x 2 replicate experiments (Day 1, Day 2). Therefore, there were only 12 samples collected under conditions exposed to the airgun, six on each day of the two experiments. The major confounding explanation for this study is that a different water mass entered the area on each day of the experiment and had lower abundance and higher quantities of dead zooplankton. Richardson et al. (2017) concluded that: “although this is relatively unlikely it cannot be discounted because of the relatively few samples collected and only two replicate experiments conducted.”

Independently of the APPEA/CSIRO study, the International Association of Geophysical Contractors (IAGC) conducted its own review of the McCauley et al. (2017) paper. This review came to the following conclusion: “While we found the study interesting, we are also troubled by the small sample sizes, the large day-to-day variability in both the baseline and experimental data, and the large number of speculative conclusions that appear inconsistent with the data collected over a two-day period. Both statistically and methodologically, this project falls short of what would be needed to provide a convincing case for adverse effects from geophysical survey operations.” (IAGC, 2017).

The second component of the CSIRO study (Richardson et al., 2017) was to estimate the spatial and temporal impact of seismic activity on zooplankton on the North West Shelf from a large-scale seismic survey, considering mortality estimates of McCauley et al. (2017), and accounting for typical growth rates, natural mortality rates, and the ocean circulation in the region. The approach modelled a hypothetical 3D survey (2,900 km^2 in size, over a 35-day period, in water depths of 300-800 m) on the edge of the North West Shelf during summer. To simulate the movement of zooplankton by currents, the researchers used a hydrodynamic model that seeded 0.5 million particles into CSIRO’s Ocean Forecast Australia Model. Zooplankton particles could be hit multiple times by airgun pulses if they were carried by currents into the future survey path. The greatest limitation in this approach was accurate knowledge of the natural growth and mortality rates of zooplankton, and to address this the CSIRO researchers tested the sensitivity of the model to different recovery (growth-mortality) rates, and also the sensitivity of the results to ocean circulation by undertaking simulations with and without water motion (Richardson et al., 2017).

The results of the simulations, that included ocean circulation, showed that the impact of the seismic survey on zooplankton biomass was greatest in the Survey Region (defined as the survey Acquisition Area with a 2.5 km impact zone around it) (22% of the zooplankton biomass was removed) and declines as one moves beyond it to the Survey Region + 15 km (14% of biomass removed), and the Survey Region + 150 km (2% of biomass removed). The time to recovery (to 95% of the original level) for the Survey Region and Survey Region + 15 km recovery was 39 days (38-42 days) after the start of the survey and 3 days (2-6 days) after the end of the survey (Richardson et al., 2017).

The major findings of the CSIRO study were that there was substantial impact of seismic activity on zooplankton populations on a local scale within or close to the survey area, however, on a regional scale the impacts were minimal and were not discernible over the entire North West Shelf bioregion. Additionally, the study found that the time for the zooplankton biomass to recover to pre-seismic levels inside the survey area, and within 15 km of the area, was only three days following the completion of the survey. This relatively quick recovery was due to the fast growth rates of zooplankton, and the dispersal and mixing of zooplankton from both inside and outside of the impacted region (Richardson et al., 2017).

A more recent study by Fields et al. (2019) exposed zooplankton (copepods) to seismic pulses at various distances up to 25 m from a seismic source. The source levels produced were estimated to be 221 dB re $\mu Pa^2 \cdot s$. The study observed an increase in immediate mortality rates of up to 30% of copepods in samples compared to controls at distances of 5 m or less from the airguns. Mortality one week after exposure was significantly higher by 9% relative to controls in the copepods placed 10 m from the airguns. Fields et al. (2019) also reported no sub-lethal effects of seismic exposure to the copepods. These findings of the study are consistent with numerous other field studies referenced above, indicating that the potential effects of seismic pulses to zooplankton are limited to within approximately 10 m from the seismic source. Fields et al. (2019) note that the findings of the McCauley et al. (2017) study are difficult to reconcile with the body of other available research. The findings of the McCauley et al. (2017) study may, therefore, provide an overly conservative estimate of the potential effects of seismic pulses to zooplankton.

Impact Assessment

For this impact assessment the sound exposure thresholds for mortality/potential mortal injury (PMI) to fish eggs and larvae from Popper et al. (2014) were applied and consider both PK and SEL_{24h} metrics (refer to **Table 6-2**: Maximum predicted distance (Rmax) to mortality/PMI thresholds in the water column for fish eggs and larvae, and zooplankton). The thresholds were based on limited data, and were selected on the basis that Popper et al. (2014) note that they are likely to be conservative. While research generally suggests limited impacts to plankton beyond approximately 10 m distance from seismic sources, the precautionary Popper et al. (2014) thresholds for larval mortality / PMI have been selected to indicate the magnitude and extent of potential impacts from the survey.

Table 6-2: Maximum predicted distance (R_{max}) to mortality/PMI thresholds in the water column for fish eggs and larvae, and zooplankton

Sound Exposure Threshold	R_{max} distance (km)
207 dB re 1 µPa (PK)	0.11
210 dB re 1 μPa^2.s (SEL_{24h})	0.05

As shown in **Table 6-2**, the maximum distance (R_{max}) to mortality/PMI thresholds for fish eggs and larvae, and zooplankton, applying the single pulse (PK) 207 dB re 1 µPa threshold from Popper et al. (2014) is 110 m.

Any potential mortality/PMI impacts to zooplankton communities have to be assessed in the context of natural mortality in these populations. Any mortality or mortal injury effects to zooplankton (including fish eggs and larvae) resulting from seismic noise emissions are likely to be inconsequential compared to natural mortality rates, which are very high—exceeding 50% per day in some species and commonly exceeding 10% per day (Tang et al., 2014). For example, in a review of mortality estimates (Houde and Zastrow, 1993), the mean mortality rate for marine fish larvae was M = 0.24, a rate equivalent to a loss of 21.3% per day. In the experiment undertaken by McCauley et al. (2017) zooplankton mortality rate background levels were 19%. Sætre and Ona (1996) calculated that under the ‘worst-case’ scenario, the number of larvae killed during a typical seismic survey was 0.45% of the total population, and they concluded that mortality rates caused by exposure to airgun sounds are so low compared to natural mortality that the impact from seismic surveys must be regarded as insignificant.

The magnitude of such localised impacts (≤110 m from the seismic source) is negligible and is not expected to be discernible at the regional scale when considering the large natural spatial and temporal variability and scale of plankton and spawning biomass in the NWMR. In particular, phytoplankton and zooplankton biomass in the oceans can vary significantly at spatial scales ranging from hundreds of metres to hundreds of kilometres and temporal scales of hours, days, seasons and inter-annually, due to tidal and large scale currents, bathymetry, temperature, salinity, water chemistry parameters and other environmental factors (Gibbons and Hutchings, 1996; Holliday et al., 2011; McKinnon et al., 2008; Pearce et al., 2000; Sutton and Beckley, 2017). Therefore, changes in zooplankton abundance are likely to be replenished and indistinguishable from natural levels and distributions within hours of a seismic survey vessel passing.

Zooplankton – Impact Assessment Conclusion

The potential impacts of noise emissions from the seismic source on zooplankton during the seismic acquisition are considered to be slight and short-term, and the activity is not likely to result in any ecologically significant impacts at a population level for any zooplankton, fish eggs or larvae that may be present in the water column within or adjacent to the Operational Area. The Exmouth Plateau KEF is recognised as an area of upwelling of deeper, nutrient rich waters to the surface. These upwelling events experience high natural variability and therefore it is expected any impacts to zooplankton will be minimal at a regional scale.

Benthic Invertebrates

Species Sensitivity and Sound Exposure Thresholds

Research is ongoing into the relationship between sound and its effects on benthic invertebrates, including the relevant metrics for both effect and impact. Marine invertebrates lack a gas-filled bladder and are unable to detect the pressure component of sound waves (Parry and Gason, 2006; Carroll et al., 2017) or "hear" sound in the way that mammals and fish are able to. Instead, invertebrates detect sound by sensing the particle motion component of sound in water and seabed sediments through physiological structures such as sensory hairs, statocysts and muscles, and therefore detect sound at close range (McCauley, 1994; Parry and Gason, 2006; André et al., 2016; Roberts et al., 2016; Edmonds et al, 2016; Carroll et al., 2017; Popper and Hawkins, 2018).

Statocysts, found in a wide range of invertebrates, are utilised by animals to maintain their orientation, direct their movements through the water and may play a key role in controlling the behaviour responses of invertebrates to a wide range of stimuli. Although directly sensitive to particle motion and not to sound pressure, most available research on seismic impacts to invertebrates characterises received sound levels in terms of the sound pressure. Therefore, available literature suggests particle motion, rather than sound pressure, is a more important factor for benthic invertebrates such as crustacean and molluscs. Water depth and seismic source size are related to the particle motion levels at the seafloor, with larger arrays and shallower water being related to higher particle motion levels, thus more relevant to effects on crustaceans and bivalves (Koessler et al., 2021; **Appendix G**).

A range of physiological responses have been identified in some studies; however, the received sound levels are typically at levels that would be received within tens or a few hundred metres from the sound source or have been from repeated exposure at the same sound levels, which is not typical of an actual seismic survey (Carroll et al., 2017; Edmonds et al., 2016; Salgado Kent et al., 2016; Webster et al., 2018).

Studies by Christian et al. (2003), DFO (2004) and Payne et al. (2007, 2008) have exposed crustaceans to seismic sound levels of approximately 197–237 dB re 1 µPa PK-PK. No acute or chronic lethal or sub-lethal effects were observed in the weeks to months following exposure, with the exception of Payne et al. (2007, 2008) who noted a decrease in serum enzymes and an increase in food consumption in the weeks to months post exposure, which may indicate stress effects or potential osmo-regulatory disturbance.

Research undertaken by Day et al. (2016a, 2016b) in Australian waters exposed captive southern rock lobster (*Jasus edwardsii*) to multiple passes of a seismic source element in 10-12 m water depths. Maximum received sound exposures were 209-212 dB re 1µPa PK-PK, 186 to 190 dB re 1 $\mu Pa^2 \cdot s$ per-pulse SEL, and SEL_{cum} of 192 to 199 dB re $\mu Pa^2 \cdot s$. Exposed lobsters and control lobsters were sampled up to a year post-exposure. The findings of the study are as follows:

- Exposure to seismic sound did not result in any mortalities to adult lobsters.
- Some potential sub-lethal changes in adult lobsters were observed, including some long-term impairment to lobsters' statocysts, which was also linked to a short delay in the lobsters' ability to right themselves when upturned.
- Haemocyte count (indicative of immune response function) also showed some evidence of decline over time.
- The condition or development of eggs carried by female lobsters at the time of exposure, even at close proximity directly beneath the seismic source, were not affected.

The significance of the seismic exposures and whether the sub-lethal effects may have wider ecological implications (e.g. ability to feed, avoid predators and resist disease) warrants further consideration. Day et al. (2016a, 2016b) reported that some of the control lobsters used in the experiments were collected from a marine reserve and were found to have a high level of pre-existing impairment to statocysts similar to that induced by the seismic exposure experiments, which was considered to be the result of long-term exposure to shipping noise. Some experiments showed no significant differences in righting times between control and exposed lobsters, while in some instances the control lobsters demonstrated slower righting times than exposed lobsters. Lobsters with pre-existing statocyst impairment demonstrated the fastest righting times of all experiments, which Day et al. (2016a, 2016b) suggested may indicate that lobsters are able to adapt or compensate for long-term statocyst impairment. Therefore, the level of statocyst impairment resulting from seismic exposure is not clear. Monitoring of the lobster population at the same reserve where the lobsters with pre-existing statocyst impairment were taken from showed that the rock lobster population within the reserve was thriving and at carrying capacity (Green and Gardner, 2009; Kordjazi et al., 2015). Therefore, the levels of statocyst impairment reported in the Day et al. (2016a, 2016b) study does not appear to be impacting on the survival of the lobster population, and any population-level survivability effects from statocyst impairment are not significant and wider ecological implications are likely to be negligible.

More recently Day et al. (2019) concluded that airgun exposure did cause damage to the righting reflect and statocysts in rock lobsters (*Jasus edwardsii*). Following exposure equivalent to a full-scale commercial array (3100 cui) passing within 100–500 m, lobsters showed impaired righting and significant damage to the sensory hairs of the statocyst. Reflex impairment and statocyst damage persisted up to 365 days post-exposure and did not improve following moulting. For this study, maximum measured received noise levels were 209-213 dB re 1 µPa (PK-PK).

Day et al. (2021) examined the potential impacts of seismic surveys on the larval stages of southern rock lobster (*Jasus edwardsii*) to determine whether early development and recruitment may be affected. Lobster puerulus (post-larval stage) and juveniles were held in baskets and exposed to multiple passes of a seismic source element in 10-12 m water depths. Maximum received sound exposures were 203-219 dB re 1µPa PK-PK, 181 to 190 dB re 1 µPa²·s per-pulse SEL, and SEL_{cum} of 201 to 205 dB re µPa²·s, comparable to Day et al. (2016a, 2016b) (Day et al., 2021). Lobster puerulus were randomly assigned to control (not exposed to airgun signals) or E0 (exposed to airgun signals at a nominal range of 0 m from the sail line), and juveniles were assigned to control, E0 and E500 (exposed to airgun signals at a nominal range of 500 m from the vessel sail line). The findings of the study are as follows:

- Exposure did not result in any elevated mortality for puerulus or juveniles.
- Righting was significantly impaired for all exposure treatments immediately after exposure, indicating that the range of impact extended to at least 500 m from the source (maximum range tested in the study).
- Puerelus and juvenile E0 treatment lobsters did not show the capacity for recovery, while juvenile E500 lobsters recovered from impairment after the first moult, providing evidence of a range threshold for recovery.
- Intermoult period was significantly increased in E0 juvenile lobsters, and appeared to be increased in puerulus, while juvenile E500 treatment lobsters show a moderate, non-significant increase in moult duration.
- Increased intermoult duration suggested impacted development and potentially slowed growth, and physiological stress.

Kosheleva (1992) identified no detectable effects to marine bivalves and gastropods (mussels and periwinkles) after exposure to a single seismic source element of source level 233 dB re 1µPa at a distance of 0.5 m or greater from the source. Conversely, Matishov (1992) reported a single scallop shell splitting in a sample of three scallops, but this was located 2 m beneath a seismic source element and therefore exposed to maximum sources levels (which is not representative of a typical commercial seismic survey).

Recent Australian studies (Przeslawski et al., 2016, 2018; Day et al., 2016b, 2017) have focused on commercial scallops (*Pecten fumatus*). Przeslawski et al. (2016, 2018) examined the short-term impacts on scallops and other marine invertebrates from a 2,530 in³ seismic array and found no evidence of mortality or change in condition following exposure to a seismic survey. Analysis of images and samples revealed some site-specific differences in scallop abundance, size, condition and assemblages, but these were not related to seismic operations. Day et al. (2016b, 2017) exposed scallops to maximum received sound exposures of up to 213 dB re 1µPa PK-PK, 181 to 188 dB re 1 µPa².s per-pulse SEL, and SEL_{cum} of 188 to 198 dB re 1µPa².s. The study also predicted ground acceleration of up to 37.57 m/s². Day et al. (2016b, 2017) concluded that exposures did not result in any immediate mass mortalities, however, repeated exposures resulted in a chronic increase in mortality over timeframes of approximately four months post-exposure, though not beyond naturally occurring rates of mortality. Separate experiments undertaken in 2013 and 2014 yielded mortalities of 3.6-3.8% in control scallops (no seismic exposure), 9.4-11.3% mortality in scallops exposed to a single pass of the seismic source, 11.3-16.1% mortality in scallops exposed to two passes of the seismic source, and 14.8-17.5% mortality in scallops exposed to four passes of the seismic source. The mortality rates were at the low end of the range of naturally occurring mortality rates documented in the wild, which range from 11-51% with a six year mean of 38% (Day et al., 2017). A third experiment in 2015 resulted in 100% mortality to both control scallops and exposed scallops, and accordingly was attributed to other causes and not to seismic exposure (Day et al., 2016b, 2017).

Sub-lethal effects to exposed scallops were also observed by Day et al. (2016b, 2017) indicating a compromised capacity for homeostasis and potential immunodeficiency over acute (hours to days) and chronic (months) timescales post exposure. Exposures did not elicit energetically expensive behaviours (i.e. extensive swimming or long periods of valve closure), but scallops showed significant changes in some behavioural patterns during exposure (e.g. "flinch" response) and an increase in recessing into sediment following exposure (Day et al., 2017).

Published sound exposure criteria do not currently exist for acoustic impacts to invertebrates but the available literature above provides an indication of the sound levels and distances within which some impacts may occur. A range of sound levels, from 202 dB re 1 µPa PK-PK to 212 dB re 1 µPa PK-PK, based on the findings of the Payne et al. (2008) and Day et al. (2016a, 2016b) studies, were applied in the assessment. The Payne et al. (2008) 202 dB re 1 µPa PK-PK is considered to be associated with no impacts to benthic crustaceans (such as prawns, scampi and lobsters), whereas the 209-212 re 1 µPa PK-PK thresholds could be associated with some level of sub-lethal effects in these animals (Koessler et al., 2021). A 213 dB re 1 µPa PK-PK level is considered as representative of levels that may result in sub-lethal effects and chronic mortality in molluscs and some other invertebrates based on Day et al. (2016b, 2017). A PK sound level of 226 dB re 1 µPa PK was applied for sponges, based on a study where corals and sponges received maximum sound pressure levels of 226-232 dB re 1µPa PK-PK, but no mortality, damage to soft tissue or skeletal integrity, visible signs of stress, change in abundance or community structure was detected immediately after, and up to four months following exposure (Heyward et al., 2018).

Impact Assessment

The benthic habitats and communities present in the Operational Area are likely to be related to the water depth. As described in **Section 4.5**, the Operational Area is located entirely on the Exmouth Plateau KEF. The benthic communities associated with the water depths of the Operational Area (>800 m) include mostly echinoderms (e.g. sea cucumbers and sea stars), with benthic filter feeders and other epifauna likely present, although diversity and abundance is expected to be low. The substrate in these water depths is comprised of fine grain soft sediments, with a lack of hard substrate.

The seismic source will not be operated in shallow water areas where benthic communities are likely to be more diverse than in deeper waters. Seafloor sound levels and ranges were not specifically assessed in the noise modelling report; however, Koessler et al. (2021) note that the distribution of the sound within the water column indicates the ranges at the seafloor would not exceed the reported maximum-over-depth distances. Given the water depths of the Active Source Area (>800 m), it is likely that the ranges at the seafloor are less than the maximum-over-depth distances. Adjusting the PK levels reported in Koessler et al. (2021) by 6 dB (double the sound pressure) to convert to PK-PK levels, the Payne et al. (2008) 202 dB re 1 µPa PK-PK level associated with no impacts to benthic crustaceans is equivalent to 196 dB re 1 µPa PK, which has reported maximum-over-depth distance of 390 m. Similarly, converting the higher PK-PK levels that may result in sub-lethal effects to crustaceans and sub-lethal effects and chronic mortality in molluscs, suggests a maximum-over-depth distance in Koessler et al. (2021) of up to a few tens of metres. The effects ranges on the seafloor are likely to be less and may not be exceeded. The 226 dB re 1 µPa PK level is not expected to be exceeded at the seafloor and so deep water sponges or other similar filter-feeders that may be present in low abundance in the Operational Area will not be impacted.

Given the low diversity benthic communities present in the Operational Area, and the likely received sound levels on the seafloor in the >800 m water depths, impacts to benthic invertebrate communities on the seafloor are expected to be highly localised and temporary. Any impacts are likely to occur in parallel with the continuous natural cycle of death, recovery and recruitment of invertebrates, and therefore it is questionable whether any impacts from seismic exposure would be detectable from natural fluctuations in relative abundance, benthic community composition and structure (Day et al., 2017; Payne et al., 2007, 2008).

It is acknowledged that crystal crabs (also commonly known in Australia as snow crab), a commercial crab species targeted by the West Coast Deep Sea Crustacean Fishery, have been recorded off the west coast of WA in water depths of 300 – 1200 m (How et al., 2015) and so are considered in this assessment due to having the potential to occur within the Operational Area. However, the species core depth range is 500 – 800 m and the Ningaloo/North-west Cape region is understood to represent the species' most northerly extent (How et al., 2015). Egg-bearing females also tend to be found in greater abundance in water depths of less than 700 m (How et al., 2015). While some fishing effort was reported on the Exmouth Plateau between 2003 and 2010 (How et al., 2015), reported effort was low (potentially an isolated event) and based on 2010 – 2019 FishCube data, no fishing effort has been reported here since. Based on this information, it is unlikely that the Operational Area supports any significant numbers of crystal crab.

A study specifically into the effects of seismic on snow crabs (Christian et al., 2003, 2004) exposed captive adult male crabs and egg-bearing female crabs to approximately 197–237 dB re 1 µPa PK. The crabs were exposed to 200 pulses over a 33-minute period. No acute or chronic (12-weeks post-exposure) mortality impacts were observed in the adult crabs. Stress indicators in the snow crabs also showed no evidence of significant acute or chronic impacts. The crabs also did not exhibit any overt startle response during the exposure period or avoidance of the area following exposure.

Given the Operational Area is unlikely to support significant numbers of crystal crab and the limited reported effects of seismic to crustaceans, including to egg-bearing female crabs reported in Christian et al., (2003, 2004), no impacts to the commercial crystal crab stock are expected.

Benthic invertebrates – Impact Assessment Conclusion

Impacts to benthic invertebrates from noise emissions from the seismic source during the acquisition of the survey include potential sub-lethal effects and chronic mortality to some organisms within a few tens of metres below the source. However, given the water depths (>800 m), natural cycle of death, recovery and recruitment, impacts are expected to be slight and short-term, and the activity is not likely to result in any ecologically significant impacts at a population level for any benthic invertebrates that may be present on the seafloor within or adjacent to the Active Source Area.

Fish, Sharks and Rays

Species Sensitivity and Sound Exposure Thresholds

Every species of fish studied to date is able to hear. Fish produce sounds in a wide range of context such as feeding, mating or fighting, and as a result anything that inhibits the detection of these sounds can have a negative effect on their fitness and survival (Popper and Hawkins, 2019). The majority of fish species detect sounds from <50 Hz up to 500-1,500 Hz (Popper and Hawkins, 2019). A smaller number of species can detect sounds over 3 kHz, while very few species can detect ultrasound over 100 kHz (Ladich and Fay, 2013). The critical issue for understanding whether an anthropogenic sound will affect the hearing of a fish is whether it is within the hearing frequency range of the fish and loud enough to be detectable above background ambient noise.

The hearing sensitivity of fishes varies depending upon the auditory structures in the inner ear (otoliths surrounded by an epithelium of hair cells) and, if present, the swim bladder (Finneran and Hastings 2000; Nedwell et al., 2004). Otoliths are sensitive only to particle motion, while the swim bladder may provide an indirect route for sound pressure to reach the inner ear. The other main mechano-reception system in fishes is the lateral line system, which runs along the side of the body and is more pronounced in some groups of fish than others. The lateral line system responds to particle motion produced in the near-field of a sound source, as well as to tiny water currents set up by the motions of the fish (Nedwell et al., 2004), therefore all fish are sensitive to the particle motion component of sound at close range from a sound source. Particle motion is the most relevant metric for perceiving underwater sound for most species, but with the exception of a few species (Popper and Fay, 2011; Popper et al., 2014), there is an almost complete lack of relevant data on particle motion sensitivity in fishes (Popper and Hawkins, 2018). Some more specialised fish with a swim bladder that they use for hearing are sensitive to sound pressure and are capable of detecting less intense noise and a wider range of frequencies, compared to less-specialised groups of fish (Popper et al., 2014; Carroll et al., 2017; Hawkins and Popper, 2017). The susceptibility of fishes to injury from noise exposure varies depending on the species and the presence and possible role of a swim bladder in hearing.

In marine fishes, the connection with the swim bladder and ability to detect sound pressure is understood to be present to some varying degree in the families Clupeidae (e.g. herrings, sardines, pilchards and shads), Gadidae (e.g. true cods such as Atlantic cod and whiting), and some nearshore/reef species relevant to tropical Australia, including some species in the families Pomacentridae (e.g. damsel fishes and clown fishes), Holocentridae (soldierfishes and squirrelfishes) and Haemulidae (e.g. grunters and sweetlips) (Nedwell et al., 2004; Braun and Grande, 2008; Popper et al., 2014; Popper and Hawkins, 2018, 2019). However, the vast majority of marine fish species do not have this hearing specialisation.

A great many fish species possess a swim bladder or other gas-filled cavity but do not have a connection with their hearing, for example various demersal snapper, emperor and cod. Fish species that lack a gas-filled cavity altogether include elasmobranchs (e.g. sharks and rays), some flat fishes, some tunas, and mackerels (Casper et al., 2012; Popper et al. 2014).

The sound exposure thresholds applied for fish and elasmobranchs (sharks and rays) in the acoustic modelling study and in this impact assessment are summarised in **Table 6-3** and explained in more detail in the acoustic modelling report (Koessler et al., 2021). The modelling study assessed the ranges for quantitative threshold criteria based on the Popper et al. (2014) guidelines for three types of immediate effects to fish:

- Mortality, including injury leading to death.
- Recoverable injury, including injuries unlikely to result in mortality, such as hair cell damage and minor haematoma.
- TTS.

The modelling study considered single pulse (PK) and multiple pulse (SEL_{24h}) metrics for both the entire water column and seafloor in the following categories reflective of the different hearing mechanisms and sensitivity to sound:

- I - Fish without a swim bladder (also appropriate for sharks in the absence of other information).
- II - Fish with a swim bladder that do not use it for hearing.
- III - Fish that use their swim bladders for hearing.

For this impact assessment, it is assumed that all fish can detect signals below 500 Hz and so can 'hear' the seismic source.

Table 6-3: Thresholds for seismic sound exposure for fish, adopted from Popper et al. (2014)

Type	Mortality and Potential Mortality Injury	Impairment			Behaviour
		Recoverable Injury	TTS	Masking	
I Fish: No swim bladder (particle motion detection)	>219 dB SEL_{24h} or >213 dB PK	>216 dB SEL_{24h} or >213 dB PK	>>186 dB SEL_{24h}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
II Fish: Swim bladder not involved in hearing (particle motion detection)	>210 dB SEL_{24h} or >207 dB PK	203 dB SEL_{24h} or >207 dB PK	>>186 dB SEL_{24h}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
III Fish: Swim bladder involved in hearing (primarily pressure detection)	207 dB SEL_{24h} or >207 dB PK	203 dB SEL_{24h} or >207 dB PK	186 dB SEL_{24h}	(N) Low (I) Low (F) Moderate	(N) High (I) High (F) Moderate

Notes: Peak sound level (PK) dB re 1 µPa; SEL_{24h} dB re 1µPa^2·s. All criteria are presented as sound pressure, even for fish without swim bladders, since no data for particle motion exist. Relative risk (high, moderate, or low) is given for animals at three distances from the source defined in relative terms as near (N – tens of metres), intermediate (I – hundreds of metres), and far (F – thousands of metres).

Mortality/Injury

It is noted that while thresholds for fish mortality have been included for consideration in this assessment based on the Popper et al. (2014) guidelines, no studies to date have demonstrated direct mortality of free-swimming adult fishes in response to airgun emissions, even when fired at close proximity (within 1– 7 m) (DFO, 2004; Boeger et al., 2006; Popper et al., 2016; Carroll et al., 2017). Although some fish deaths have been reported during cage experiments, these were more likely caused by experimental artefacts of handling fish or confinement stress (Hassel et al., 2004). For free-swimming fishes that are able to move away from seismic sources as they approach, the potential for lethal physical damage from airgun emissions is even further nullified. However, reef or bottom-dwelling fish that show greater site attachment may be less inclined to flee from a seismic sound source and experience greater effects as a consequence.

Despite mortality being a possibility for fishes exposed to airgun sounds, Popper et al. (2014) did not reference an actual occurrence of this effect. At the time of developing the guidelines, no quantified data on injury and mortality from seismic sources on fish had been reviewed by the Working Group. Therefore, the Popper et al. (2014) exposure guidelines for mortality/potential mortal injury and recoverable injury for fish exposed to seismic source emissions are based solely on data from pile driving conducted on predominantly temperate, freshwater fish species. Although seismic surveys and pile driving both produce impulsive sound, their sound characteristics are markedly different; pile driving impulses result in a more rapid rise time in sound pressure than seismic pulses and it is this rapid rise time that has the greatest potential for trauma (Caltrans, 2001, 2004; Hastings and Popper, 2005; Popper et al., 2006).

Environmental Resources Management Australia (ERM) undertook a detailed literature review of potential fish mortality and physical injury as a result of exposure to seismic sources (ERM, 2017). Of the 28 studies reviewed, only three observed direct mortality and in each case, mortalities occurred to caged fishes at very close proximity to the seismic source (<2 m), which is not representative of real-life exposures from seismic surveys because fish are free-swimming and are not typically exposed at such close range. The received sound levels that resulted in mortality ranged from 220 to 241 dB re 1 µPa PK, however, other studies reported no mortality or injury at levels as high as 246 dB re 1 µPa PK. Therefore, the sound exposure criteria proposed by Popper et al. (2014) for mortality and injury are considered to be highly conservative and provide a precautionary approach in the assessment of potential injury and mortality effects to fishes from exposure to underwater noise from marine seismic surveys.

Temporary Threshold Shift

Temporary hearing impairment, known as temporary threshold shift (TTS), can occur due to fatigue and temporary changes to the epithelium (hair cells) of the inner ear and/or damage to auditory nerves innervating the ear, which has the potential to occur in some fishes exposed to intense sound pressures for prolonged periods of time (Smith et al., 2006; Popper et al., 2014; Liberman, 2015). While experiencing TTS, fishes may have a decrease in fitness in terms of communication, detecting predators or prey, and/or assessing their environment. The period over which normal hearing ability returns following the termination of a sound that causes TTS is variable, and dependent on many factors including the intensity and duration of sound exposure (e.g. Popper and Clarke, 1976; Scholik and Yan, 2001; Amoser and Ladich, 200;, Smith et al., 2004a, 2004b, 2006, 2011; Popper et al., 2005, 2007).

The impact threshold of 186 dB re 1 $\mu Pa^2 \cdot s$ proposed by Popper et al. (2014) in **Table 6-3** is based on exposure of a freshwater fish species with a connection between the swim bladder and inner ear (more specialised hearing than the demersal and pelagic fish species likely to occur in the Scarborough 4D B1 MSS Operational Area). Fish that showed TTS recovered to normal hearing levels within 18 – 24 hours. Given that reliable auditory frequency weightings have not been defined for the three categories of fishes in the way they have for cetaceans, the 186 dB re 1 $\mu Pa^2 \cdot s$ SEL_{24h} criteria in **Table 6-3** includes a level of conservatism as:

- Many types of fish that are likely to occur in the Operational Area do not possess a direct connection between the swim bladder and the inner ear; they are therefore sensitive primarily to particle motion rather than sound pressure and may be less sensitive than the types of fish upon which the 186 dB re 1 $\mu Pa^2 \cdot s$ threshold is derived;
- Modelled SELs are based on broadband sounds and may therefore account for more sound energy associated with frequencies that are not within the auditory ranges of the fish species likely to occur in the Operational Area; and
- The main contribution of sound energy to the onset of TTS will occur over just a few hours when the source is at the closest point of approach; the 24-hour modelled accumulation period accounts for additional sound energy accumulated while the seismic source is at greater distances and potentially not audible to fishes.

It is also noted that many of the available studies on TTS are based on captive fish, whereas free-swimming fishes in the wild are likely to make some effort to avoid the intense sound pressures that contribute the most to the onset of TTS. If TTS does occur, the effects will be temporary and recoverable.

Behavioural Effects

Behavioural effects of noise on fish will vary depending on the circumstances of the fish, hearing sensitivity, the activities in which it is engaged, its motivation, and the context in which it is exposed to sounds (Hawkins and Popper, 2017). Responses may include avoidance behaviours, startle reactions, increased swimming speed, change in orientation, change in position in the water column, changes to schooling behaviour (e.g. tightening of school structure), and temporary avoidance of an area (Simmonds and MacLennan, 2005; McCauley et al., 2000a; Fewtrell and McCauley, 2012; Popper et al., 2014; Carroll et al., 2017). Changes in movement patterns may also temporarily divert efforts away from feeding, egg production and spawning success (Hawkins and Popper, 2017). The potential extent and duration of behavioural effects based on studies of seismic exposure are summarised below.

A degree of caution should be given when interpreting behavioural studies, given that many are conducted on captive fishes which may not provide an accurate representation of responses in free-swimming fishes in the wild (Popper et al., 2014; Salgado Kent et al., 2016; Carroll et al., 2017). Behavioural studies are also highly subjective. Extrapolation of observed effects on fish should also be undertaken with caution (Carroll et al., 2017). This is particularly the case given that many exposure experiments report received SPL or SEL, even though the most relevant metric for most fish species is particle motion (Popper and Hawkins, 2018, 2019). Many exposure experiments are undertaken using a single airgun and it is not clear how transferrable the behaviours and received SPL/SEL levels are to a full commercial-sized seismic array, particularly if observed behaviours are in response to particle motion close to the sound source rather than to sound pressure.

Pearson et al. (1992) exposed captive demersal rockfish to multiple 10-minute periods of seismic sound from a seismic source towed at distances of less than 215 m, which is not representative of real-life exposures to a seismic survey. Schools of rockfish were observed to exhibit a ‘startle’ response (shudders, flexions of the body followed by rapid swimming) at sound levels above 200-205 dB re 1μPa SPL. An ‘alarm’ response (change in vertical position in the water column to be closer to the seabed, short-term post-exposure behavioural changes) was found to occur above approximately 180 dB re 1μPa SPL, although it was suggested that some individuals may begin to exhibit subtle changes in behaviour and position in the water column at sound levels above 161 dB re 1μPa SPL. Changes in behaviour were found to return to normal before the end of the sound exposure or within just minutes of the sound ceasing, indicating only very short-term, transient effects and potential habituation to the disturbance.

Santulli et al. (1999) exposed caged European sea bass (a demersal species) to a 2,500 in³ seismic source. Limited response was observed at 2.5 km distance, a startle response was observed when the array was at a distance of approximately 800 m, but after passing within 180 m, fish behaviour appeared to return to normal within one hour.

The Scott Reef Study associated with the Woodside Maxima 3D survey reported in McCauley et al. (2008), Miller and Cripps (2013), and summarised in Salgado-Kent et al. (2016), included a component that examined how the behaviour of caged fishes exposed to seismic signals changed. The study examined the effects to fish species in the Holocentridae family, which have adaptations linking the swim bladder to the otolith system of the inner ear, as well as to bluestripe snapper, a demersal species without such a hearing adaptation. Fish were exposed to either one or two passes of the active source at three distance categories (45–74 m, 105–131 m, 475–807 m). Alarm responses (including the startle response and behavioural avoidance) occurred within less than 200 m either side of the pass by, but responses were too infrequent to include in analyses. Less significant agitation levels (defined by changing swim direction) in Holocentridae increased with increasing received sound level above 155–165 dB re 1 uPa².s SEL, but agitation levels did not seem to increase with increasing received sound levels for the less sensitive bluestripe snapper (McCauley et al., 2008). Fish began to feed and behave normally again within 20-minutes after the passage of the seismic source (McCauley et al., 2008; Miller and Cripps, 2013).

McCauley et al. (2000a, 2003) reported that trials involving captive fishes (of various species, including snappers, emperors, groupers, trevally, bream, herring and others) exposed to seismic sound showed a common ‘startle’ response (C-turns), 'alarm' responses (e.g. swimming faster, darting movements and sudden changes in school structure), or less obvious changes such as moving closer to the seabed or huddling closer together. Subtle responses such as moving closer to the seabed or changes in schooling behaviour were suggested to commence when sound levels exceeded approximately 147 - 151 dB re 1 μPa².s SEL. Similar behaviours in pink snapper and trevally were noted by Fewtrell and McCauley (2012) in response to comparable sound levels. These are minimal reactions that are likely to be an indication of awareness and perception of the sound rather than a response that could result in significant ecological impacts. More obvious startle and alarm responses were apparent in trials when received sound levels were in the order of 159-172 dB re 1 μPa².s SEL. In situations where a behavioural response was observed, fish were considered to have resumed normal behaviour within 4 – 31 minutes after cessation of the seismic activity (McCauley et al., 2000, 2003). Startle and alarm responses reduced with time, indicating some habituation to the sound. No statistically clear trends in physiological stress response were observed following exposure (McCauley et al., 2000, 2003).

Behavioural observations of two tropical snapper species and another coral reef fish species, spadefish, in field enclosures before, during and after exposure to seismic sound showed that repeated exposure resulted in increasingly less obvious startle responses (Boeger et al., 2006). This is consistent with the potential habituation suggested by McCauley et al. (2000a) and by Fewtrell and McCauley (2012).

McCauley and Salgado Kent (2007) observed the behaviour of goldband snapper in fish traps in the Timor Sea using cameras placed inside the fish traps. A seismic vessel towed two 3090 in³ seismic sources. Maximum signals reached at the closest trap to each seismic pass-by were 200, 202 and 212 dB re 1 μPa PK-PK (equivalent to approximately 194, 196 and 206 dB re 1 μPa PK). No dramatic behavioural responses of fishes to the passing seismic source were observed. Fishes generally displayed increased activity immediately after entering a trap presumably as they searched for a way out, with this activity reducing with time. Fishes that had been in a trap for some time showed increased activity levels as the operating seismic source approached but were ‘quiet’ when the array passed at the point of closest approach.

Bruce et al. (2018) tagged tiger flathead and two shark species, which were monitored during a seismic survey undertaken in Australian waters. Sharks moved freely in and out of the study area and exposed sharks did not show any indication of differences in behaviour or distribution compared with control areas. Minor behavioural effects were observed in exposed tiger flathead, which increased their swimming speed during the seismic survey and changed daily movement patterns after the survey, but showed no significant displacement. Overall, there was little evidence for consistent behavioural responses (Bruce et al., 2018).

Paxton et al. (2017) observed temperate reef fish, including snapper and grouper species, in 33 m water depths located 7.9 km from a seismic survey line using video recordings. The authors observed fish abundance and habitat use during the evening hours for three days prior to a seismic survey and then during the evening of the day when seismic activity occurred. The authors attempted to measure sound at two other reefs in closer proximity to the survey, but the hydrophones malfunctioned. No video recordings were made at the other reefs where hydrophone measurements were attempted. While no hydrophone measurements were made at the reef were video recordings took place, maximum sound levels were estimated to be in excess of 170 dB re 1 μPa SPL. Despite no clear visual evidence of behavioural responses in fishes during the seismic survey, the authors noted a 78% decline in abundance in the evening following the survey. No further recordings were made to assess when fish abundance returned to pre-exposure levels or how far they may have moved. Therefore, with limited data, it is not clear from this study if reduced abundance is attributed to the seismic sound or other natural factors such as tidal influence or food availability. However, the study may indicate a possible avoidance response and change in local abundance and distribution.

Meekan et al. (2021) studied the effects of seismic surveys on tropical demersal fishes targeted by commercial fisheries on the North West Shelf of WA. The authors found no short-term (days) or long-term (months) effects of seismic exposure on the composition, abundance, size structure, behaviour of movement of these species, suggesting that seismic surveys have little impact on demersal fishes in this environment (Meekan et al., 2021).

Many pelagic Scombroidei species, including some tuna species do not possess a swim bladder or it is poorly developed (Popper et al., 2014; Bray and Schultz, 2019a, 2019b), indicating they are sensitive only to the particle motion component of sound at close range to a sound source. Some other types of tuna, including southern bluefin tuna, yellowfin tuna, bigeye tuna and billfish have swim bladders but have no apparent specialist connection with the inner ear (Bertrand and Josse, 2000; Song et al., 2006). The lateral line system appears to feature in Scombroidei fishes, again indicating fishes are mainly sensitive to particle motion, but some pressure detection is possible. Song et al. (2006) note that unless bluefin tuna are exposed to very high intensity sounds from which they cannot swim away, short- and long-term effects may be minimal or non-existent. And, considering that bluefin tuna are powerful swimmers and divers, it is possible that if they encounter a sound that is very loud to them, they will move away from the sound rapidly enough to result in minimal exposure.

Some other studies looking at the behavioural response of sound pressure-sensitive Gadidae and Clupeidae species, such as whiting, Atlantic cod and herring, have reported changes in vertical position in the water column, potential avoidance responses and short-term changes in distribution. Chapman and Hawkins (1969) observed that the depth distribution of free-ranging whiting changed in response to an intermittently discharging stationary seismic source, which resulted in fish being exposed to an estimated SPL of 178 dB re 1 μPa. The fish school responded to the sound by shifting downward, forming a more compact layer at greater depth although temporary habituation was observed after one hour of continual sound exposure (Chapman and Hawkins, 1969).

Hawkins et al. (2014) exposed free-swimming sprat (a sound pressure-sensitive Clupeidae species with a swim bladder connected to the inner ear) and Atlantic mackerel (a particle motion detecting species without a swim bladder) to playback of impulsive sound. Sprat schools were more likely to disperse laterally in response to received sound levels of approximately 135 dB re 1 μPa²\.s SEL. Mackerel schools were more likely to alter their depth in the water column in response to approximately 142 dB re 1 μPa².s SEL. Hawkins et al. (2014) note how the two different species seemed to respond to the sound playback at similar sound levels despite the differences in sound sensitivity of the two species, but suggested that mackerel were simply more “flighty” than sprat and therefore more likely to react. The tests were also undertaken using low sound level playback in very close proximity to the schools of fish and it is not clear how relevant the sound pressure and sound exposure levels are in relation to mackerel given that their response was likely driven by particle motion. The study location, a very small, enclosed, quiet, coastal sea lough, where fishes were not accustomed to heavy disturbance from shipping and other intense sound sources is also very different from an open ocean location.

Slotte et al. (2004) monitored the effects of a 3,090 in³ seismic array on migrating herring (Clupeidae) and whiting (Gadidae), mapping their distribution and abundance in relation to the seismic survey lines. There was no significant evidence of immediate, near-field scaring reactions on the horizontal scale in response to acquiring survey lines, but there was some evidence that fish changed position in the water column, moving closer to the seabed. Some short-term changes in distribution were observed but weren’t statistically significant; fish consistently remained within the immediate vicinity of the survey area, but in a limited number of measurements there was an indication that fish abundance was lower near to the survey area and increased with distance out to a maximum range of 37 km. However, results were inconsistent and clear trends were not observed in all cases. Slotte et al. (2004) concluded that it was not possible to determine how much abundance and distribution were attributed to the seismic survey or to the natural migration patterns and food availability of the fish, or other natural factors. Herring and whiting were found to be abundant in the survey area again after a pause in seismic acquisition and monitoring of fishes for three to four days, indicating that if any displacement did occur as a result of seismic sound exposure, the displacement was temporary (i.e. less than three to four days) (Slotte et al., 2004).

In similar studies, Engås et al. (1996) and Engås and Løkkeborg (2002) reported on the effects of seismic surveys on Atlantic cod and haddock (Gadidae) and found that the abundance of fishes were lower in the survey area compared with areas outside of the survey area, which the authors hypothesize may be the result of an avoidance response. Some differences in abundance were still detectable within the survey area five days after the survey was completed (Engås et al., 1996; Engås and Løkkeborg, 2002).

Conversely, Peña et al. (2013) described the real-time behaviour of herring schools exposed to a full-scale 3D seismic survey, observed using sonar. No changes were observed in swimming speed, swimming direction, or school size that could be attributed to a transmitting seismic vessel as it approached from a distance of 27 km to 2 km, over a six hour period. The unexpected lack of a response to the seismic survey was interpreted as a combination of a strong motivation for feeding by the fishes, a lack of suddenness of the onset of sound, and an increased level of tolerance to seismic pulses.

Davidsen et al. (2019) investigated the effects of seismic sound exposure on the physiology and behaviour of captive Atlantic cod (*Gadus morhua*) and saithe (*Pollachius virens*) using a combination of biologgers and acoustic tags, as well as video monitoring. Experimental sound exposures were 18–60 dB above ambient). Fish were held in a large sea cage and exposed over a 3-day period. The cod exhibited reduced heart rate in response to the particle motion component of the sound from the airgun, indicative of an initial flight response. No behavioural startle response to the airgun was observed; both cod and saithe changed both swimming depth and horizontal position more frequently during sound exposure. The saithe became more dispersed in response to the elevated sound levels. The fish seemed to habituate both physiologically and behaviourally with repeated exposure. The authors concluded that sound exposures induced over the time frames used in this study appear unlikely to be associated with long-term alterations in physiology or behaviour.

Hubert et al. (2020) exposed captive Atlantic cod to one hour of playback of seismic airgun sound pulses with a 10 second shot point interval. Cod were placed in a net pen positioned 7.8 m from the speaker. The mean peak sound pressure and particle acceleration levels at a distance of 9.7 m from the speaker were 164 dB re 1 µPa and 101 dB re 1 nm/s2 respectively. At a distance of 16.4 m from the speaker, the mean peak sound pressure and particle acceleration levels were 158 dB re 1 µPa and 99 dB re 1 nm/s2 respectively. These levels compare with a mean SPL of the ambient conditions in the pen of 113 dB re 1 µPa and a mean sound particle acceleration of 61 dB re 1 nm/s2. Results indicated no strong overall pattern of change in swimming patterns or immediate, short-term behaviours during the exposure, compared to baseline periods without playback. However, several individuals changed their time spent in several behavioural states during the one hour sound exposure. Several individuals spent more time transiting and less time being locally active or inactive. This may be indicative of changes in energy expenditure, which may be relevant if sound exposure occurs over the long term. However, due to experimental design limitations, it was not possible to test the significance of these behavioural state trends (Hubert et al., 2020).

Van der Knaap (2021) investigated the effect of a 3.5-day, full-scale, seismic survey exposure on the movement behaviour of free-swimming Atlantic cod, using acoustic telemetry. The closest point of approach to the tagging location was 2.25 km. The study found that during the experimental survey, cod did not leave the detection area more than expected from baseline data. However, cod left more quickly than expected, from two days to two weeks after the seismic survey. Furthermore, behavioural analyses indicated that during the exposure cod decreased their activity, with time spent being locally active (moving over small distances, showing high body acceleration) becoming shorter, and time spent being inactive (moving over small distances, having low body acceleration) longer. Additionally, diurnal activity cycles were disrupted with lower locally active peaks at dusk and dawn, periods when cod is known to actively feed.

The following conclusions are made regarding behavioural effects to fish from seismic airguns, based on the literature above:

- Different fishes may exhibit different behavioural responses when exposed to seismic survey noise, depending on their activities, motivation and the context in which they receive sound.
- Fish may initially change position in the water column (i.e. move closer to the seabed) in response to becoming aware of approaching seismic sound, but this varies depending on hearing sensitivity and context (e.g. Pearson et al., 1992; McCauley et al., 2000, 2003; Slotte et al., 2004; Fewtrell and McCauley, 2012; Miller and Cripps, 2013; Davidsen et al., 2019).
- Exposure to higher sound levels at close range to a seismic source may begin to result in more noticeable startle or alarm responses, such as changes in school structure, increased swimming speed and avoidance of the sound source (typically observed within hundreds of metres of the seismic source) depending on hearing sensitivity and context) (e.g. Simmonds and MacLennan, 2005; McCauley et al., 2000, 2003; Fewtrell and McCauley, 2012; Popper et al., 2014; Carroll et al., 2017).
- Many exposure experiments are undertaken using a single airgun and it is not clear how transferrable the behaviours and received SPL/SEL levels are to a full commercial-sized seismic array, particularly if observed behaviours are in response to particle motion close to the sound source rather than to sound pressure.

- There is some evidence that fish may tolerate gradual increases in sound levels and habituate to repeated sound exposures (Chapman and Hawkins, 1969; McCauley et al., 2000; Boeger et al., 2006; Fewtrell and McCauley, 2012; Peña et al., 2013; Davidsen et al., 2019).
- Many studies indicate that fishes resume normal behaviour shortly after cessation of the acoustic disturbance (within minutes / less than an hour), with no evidence of long-term changes (e.g. Wardle et al., 2001; Pearson et al., 1992; Santulli et al., 1999; McCauley et al., 2000, 2003; Fewtrell and McCauley, 2012; Miller and Cripps, 2013).
- There is some evidence that changes in distribution may persist for longer than the initial change in behaviour, i.e. position in the water column, schooling behaviours and swim speeds may return to normal relatively quickly (within minutes or hours), but their distribution may not return to normal for hours or days. Potential changes in distribution of fish has been observed in some studies for approximately five days following sound exposure, although such changes are limited to studies that focused primarily on migrating sound pressure-sensitive types of fish with a swim bladder-ear connection (e.g. Clupeidae, Gadidae). These studies also acknowledge that it is difficult to attribute these changes in distribution directly to the seismic survey or to natural migration patterns, food availability or other natural factors (Slotte et al., 2004; Engås et al., 1996; Engås and Løkkeborg, 2002). However, it is possible that changes to the behaviour and distribution of some sound-sensitive prey species (e.g. herring, sardines) may have some indirect influence on the distribution of larger predatory fishes during the days following exposure and disturbance.
- Changes in behaviour or disruption to diurnal activities may indicate that activities such as feeding and energy expenditure can be affected if exposed long term (Hubert et al., 2020; Van der Knaap, 2020, 2021).

Given the limited convergence in results from the available studies, the subjective nature of many assessments and the context under which fish received sound, the Popper et al. (2014) ANSI-Accredited Standards Committee Sound Exposure Guidelines for Fishes and Turtles determined that it is not possible to define exact sound level thresholds for changes in fish behaviours. Instead, Popper et al. (2014) applies relative risk criteria (**Table 6-3**). The criteria reflect the potential for substantial changes in behaviour for a large proportion of the animals exposed to a sound, which may alter distribution, and movement from preferred sites for feeding and reproduction. The criteria do not include effects on single animals or small changes in behaviour such as a startle response or minor movements. As such, Popper et al. (2014) indicate that fish without a swim bladder or with no connection between the swim bladder and the inner ear may experience substantial changes in behaviour within tens or hundreds of metres of a seismic source. These peer-reviewed and accredited sound exposure criteria are reflected in Woodside's risk assessment. It is acknowledged that some fishes with swim bladders may show varying levels of awareness of sound pressure at greater distances from the seismic source, but it is important to recognise changes in behaviour that may be of ecological significance from those that are not.

Impact Assessment

The Operational Area lies entirely within the Exmouth Plateau KEF. While parts of this KEF are characterised by topographic features including terraces, canyons and pinnacles, in the deep water depths of the Operational Area (~800-1,200 m) sediments are mostly soft and there is a lack of hard substrate, therefore, is expected that abundance and diversity of marine life will be low. However, a range of bony fishes (teleosts) and elasmobranchs (sharks and rays), including benthic, demersal, and pelagic fishes may still be present.

Benthic and demersal fish species recorded on or around the Exmouth Plateau in similar water depths as the Operational Area include grenadiers, slickheads, cusk eels, basketwork eels, and halosaurs, smelts, anglerfish, dogfish sharks and sixgill stingrays (Williams et al., 1996). Pelagic species include small bathy-pelagic and meso-pelagic species, such as lanternfishes (Williams et al., 1996), plus larger pelagic species such as tunas and billfish. Juvenile southern bluefin tuna may occur during their migration south from spawning grounds near Indonesia to more temperate southern waters. Southern bluefin tuna is listed as a conservation dependent species under the EPBC Act (DAWE, 2021). Due to the water depths of the Operational Area being greater than 800 m, it does not support any of commercial indicator species such as the snapper, emperor, cod or mackerel species targeted by Commonwealth or WA fisheries on the continental shelf or upper continental slope. For example, the core water depth range for ruby snapper (*Etelis carbunculus*, *Etelis* spp.), an indicator species for the Commonwealth managed Western Deepwater Trawl Fishery and the WA managed Pilbara Line Fishery, is 150 – 480 m (DPIRD, 2019).

In addition to the elasmobranch species reported in Williams et al. (1996), the EPBC Protected Matters Search **(Appendix C**) identified four shark species and one ray species that may potentially occur within the Operational Area.

Table 6-4 presents the results of the acoustic modelling study for maximum predicted distances to mortality/PMI, recoverable injury and TTS onset in fish. Data is presented for both the entire water column (MOD) and at the seafloor.

Table 6-4: Summary of maximum distances to mortality/PMI, recoverable injury and TTS onset in fish for single pulse and SEL_{24h} modelled scenarios

Relevant hearing group	Potential impact	Sound exposure threshold	Water column (MOD)
			R_{max} (km)
I Fish: No swim bladder	Mortality/PMI	219 dB re 1 µPa²·s (SEL_{24h})	0.05
		213 dB re 1 µPa (PK)	0.06
	Recoverable injury	216 dB re 1 µPa²·s (SEL_{24h})	0.05
		213 dB re 1 µPa (PK)	0.06
	TTS	186 dB re 1 µPa²·s (SEL_{24h})	4.5
II Fish: Swim bladder not involved in hearing	Mortality/PMI	210 dB re 1 µPa²·s (SEL_{24h})	0.05
		207 dB re 1 µPa (PK)	0.11
	Recoverable injury	203 dB re 1 µPa²·s (SEL_{24h})	0.05
		207 dB re 1 µPa (PK)	0.11
	TTS	186 dB re 1 µPa²·s (SEL_{24h})	4.5
III Fish: Swim bladder involved in hearing	Mortality/PMI	207 dB re 1 µPa²·s (SEL_{24h})	0.05
		207 dB re 1 µPa (PK)	0.11
	Recoverable injury	203 dB re 1 µPa²·s (SEL_{24h})	0.05
		207 dB re 1 µPa (PK)	0.11
	TTS	186 dB re 1 µPa²·s (SEL_{24h})	4.5

The following fish types, associated with the Exmouth Plateau KEF, have been identified for this assessment:

- Deep water demersal fish species.
- Pelagic fish species.
- Shark species.

Demersal fish species

As shown in **Table 6-4**, for all fish with a swim bladder both involved and not involved in hearing (Group II and III fish, which would represent most demersal fish) mortality/PMI and recoverable injury thresholds within the entire water column were reached within 110 m based on the application of the PK threshold. These ranges are reported in Koessler et al., (2021) as maximum-over-depth distances and the ranges at the seafloor may be less. Therefore, injury effects could occur to demersal fish in close proximity to the seismic source within or adjacent to the Active Source Area. However, as discussed above, the thresholds for mortality and injury are considered highly conservative. While injury or mortality to fish in the immediate proximity of the seismic source is theoretically possible, free-swimming fish such as the demersal species are expected to be able to avoid the seismic source as it approaches there position or ramps up during soft starts.

Based on the maximum predicted R_{max} distance to TTS of 4.5 km within the entire water column (SEL_{24h} threshold – refer to **Table 6-4**), individuals in demersal fish communities within the Active Source Area could experience TTS effects. The radii that corresponds to SEL_{24h} typically represent an unlikely worst-case scenario for SEL-based exposure since, more realistically, fish would not stay in the same location or at the same range for a period of 24-hours. Therefore, this method is highly conservative and a reported radius of SEL_{24h} criteria does not necessarily mean that animals travelling within this radius of the source will suffer hearing impairment. It is possible that some demersal fishes may not avoid the approaching seismic source completely and some level of TTS is possible, but the effects are temporary and recoverable, and the potential for such effects to have significant implications on fish fitness and survival is low.

The majority of studies relevant to behavioural responses in demersal fish species (e.g. Pearson et al., 1992; Santulli et al., 1999; McCauley et al., 2000a, 2003; McCauley and Salgado Kent, 2007; Woodside, 2011; Fewtrell and McCauley, 2012; Miller and Cripps, 2013; Bruce et al., 2018; Meekan et al., 2021), indicate that exposure to a mobile seismic source and significant changes in behaviour are likely to be limited to durations of minutes or hours and occur within hundreds of metres of the seismic source as it passes.

Popper et al. (2014) suggest that the potential for significant behavioural impacts in the Group II category of fishes is high in the near-field (tens of metres), moderate at intermediate distances (hundreds of metres) and low in the far field (thousands of metres). Therefore, the awareness of fishes to the seismic sound and any resultant behavioural responses may be limited to a few hours as the seismic source approaches from several kilometres away and passes, while significant startle or avoidance responses are more likely to be limited to a shorter period (less than an hour) when the seismic source passes close by. Consistent with the studies reviewed earlier in this section, behaviours may return to normal within less than an hour (sometimes just minutes) of the survey vessel passing.

Further, the implications for demersal fishes at a population level are expected to be limited. McCauley (1994) suggests that behavioural changes in fishes may only be localised and temporary, without significant repercussions at a population level. Hawkins and Popper (2017) highlight that some responses to man-made sound may have minimal or no consequences for fish populations. For example, short-term startle responses to sounds that rapidly diminish with repeated presentation, or that do not change the overall behaviour of fishes are unlikely to affect key life functions. In addition, anthropogenic sound events that are transient in nature, such as a seismic survey, and result in short-term impacts do not necessarily translate into long-term consequences to populations (Hawkins and Popper, 2017). Meekan et al. (2021) noted that if behavioural changes to demersal fish species did take place, they had no measurable short- (days) to long-term (weeks) impacts on behaviour or abundance.

Demersal fish communities within the Operational Area may exhibit some temporary behavioural responses to noise emissions from the seismic source; however, this is not likely to have any impact at the ecosystem level.

Pelagic fish species

Pelagic fish species likely to be present in the Operational Area include tuna, billfish and small pelagic species such as lanternfishes. Many species of tuna and billfish do not possess a swim bladder.

As shown in **Table 6-4**, the maximum predicted R_{max} distances to mortality/PMI and recoverable injury for fish with no swim bladder (Group I fish) within the entire water column was within 60 m (PK threshold). For all fish with a swim bladder (Group II and III fish) the maximum predicted R_{max} distance to mortality/PMI within the entire water column was within 110 m. The maximum distance to the TTS threshold in the water column for all fish hearing groups (Group I, II, III) was within 4.5 km.

All pelagic fish species, particularly large, fast-swimming fish species such as tuna and billfish are highly unlikely to experience TTS effects as they are not restricted by seabed habitat and can swim away from a seismic source. Individuals would have to remain within ranges of approximately 4.5 km of the operating seismic source for several hours to be exposed to sound levels that could cause TTS. Pelagic fishes are most likely to exhibit behavioural responses (avoidance) by moving away from an operating seismic source that approaches within a few tens of metres of them. Behaviour may return to normal within minutes. However, it is acknowledged that the behaviours and distributions of the pelagic species could be affected for hours or days following exposure as a result of potential disturbance to more sound-sensitive prey species, such as herrings, sardine’s, sprat and shads.

Sharks

Four shark species (great white shark, oceanic whitetip shark, shortfin mako shark and longfin mako shark) were identified in the EPBC PMST search as potentially occurring within the Operational Area. No sound exposure thresholds currently exist for acoustic impacts from seismic sources that are specific to sharks, which are sensitive only to particle motion. As a conservative and precautionary approach, the Popper et al. (2014) exposure guidelines for fish with no swim bladder for injury; 213 dB re 1 µPa (PK) and 219 dB re 1 µPa²·s (SEL_{24h}); and TTS (186 dB re 1 µPa²·s (SEL_{24h}), have been used for this assessment.

As shown in **Table 6-4**, the maximum predicted R_{max} distances to mortality/PMI/recoverable injury for fish with no swim bladder (incl. sharks) within the entire water column was within 60 m (PK threshold). TTS thresholds across the water column for fish without a swim bladder could be reached within 4.5 km. It is important to appreciate that individual sharks would have to remain within a range of 4.5 km of the operating seismic source (which is also moving) for several hours to be exposed to sound levels that could cause TTS.

It is expected that the potential effects to sharks associated with acoustic noise will be the same as for other pelagic fish species, resulting in minor and temporary behavioural change such as avoidance. This aligns with the Popper et al. (2014) guidelines, which detail that there is the potential for high risk of behavioural impacts in fish species near the seismic source (tens of metres), moderate risk within hundreds of metres, and low risk at thousands of metres from the seismic source.

Fish, Sharks and Rays – Impact Assessment Conclusion

The potential impacts of noise emissions from the seismic source on fish, sharks and rays during the acquisition of the survey are considered to be localised and of no lasting effect, and restricted to temporary behavioural changes (avoidance) in any isolated individuals that may transit the area in close proximity to the operating seismic source. Based on the duration (up to 80-days) of seismic acquisition, and the proposed control measures, predicted noise levels from seismic acquisition are not considered likely to cause mortality/PMI, recoverable injury or significant TTS effects to fish communities or result in any ecologically significant impacts at a population level.

Cetaceans

Species Sensitivity and Sound Exposure Thresholds

Marine mammals and especially cetaceans rely on sound for important life functions including individual recognition, socialising, detecting predators and prey, navigation and reproduction (Weilgart, 2007; Erbe et al., 2015; Erbe et al., 2018). Underwater noise can affect marine mammals in various ways including interfering with communication (masking), behavioural changes, a shift in the heating threshold, physical damage and stress (Erbe, 2012; Rolland et al., 2012).

When exposed to intense or moderately intense noise levels (e.g. seismic airguns), marine mammals can experience physiological impacts such as physical damage to the auditory apparatus, for example loss of hair calls or permanently fatigued hair cell receptors, which could cause permanent or temporary loss of hearing sensitivity. While the loss of hearing sensitivity is usually strongest in the frequency range of the emitted noise, it is not limited to the frequency bands where the noise occurs but can affect a broader hearing range. This is because animals perceive sound structured by a set of auditory bandwidth filters that proportionately increase in width with frequency.

Exposure to sufficiently intense sound may lead to an increased hearing threshold in any living animal capable of perceiving acoustic stimuli. If this shift is reversed and the hearing threshold returns to normal, the effect is called a temporary threshold shift (TTS). The onset of TTS is often defined as threshold shift of 6 dB above the normal hearing threshold (Southall et al., 2007). If the threshold shift does not return to normal, the residual shift is called a permanent threshold shift (PTS). PTS is hearing loss from which marine fauna do not recover (permanent hair cell or receptor damage).

Threshold shifts can be caused by acoustic trauma from a very intense sound of short duration, as well as from exposure to lower level sounds over longer time periods (Houser et al., 2017). Injury to the hearing apparatus of a marine animal may result from a fatiguing stimulus measured in terms of sound exposure level (SEL), which considers the sound level and duration of the exposure signal. Intense sounds may also damage the hearing apparatus independent of duration, so an additional metric of peak pressure level (PK) is needed to assess acoustic exposure injury risk.

In marine mammals, the onset level and growth of TTS is frequency specific, and depends on the temporal pattern, duty cycle and the hearing test frequency of the fatiguing stimuli. Sounds generated by seismic airguns have been proven to cause noise-induced threshold shifts in marine mammals at high received levels. However, there is considerable individual difference in all TTS-related parameters between subjects and species tested so far. Furthermore, TTS requires relatively high noise levels and thus occurs at shorter distances compared with behavioural effects, which are likely to occur at much lower levels (Dunlop et al., 2017).

There are no published data on the sound levels that cause PTS in marine mammals. Hence, PTS effects in marine mammals should be viewed as theoretical, as they have never actually been demonstrated in either captive or wild animals.

In response to noise from seismic airguns marine mammals were observed to exhibit localised spatial avoidance and temporary displacement, however different species of cetaceans may adopt different strategies for responding to acoustic disturbance (Stone and Tasker, 2006).

The sound exposure thresholds applied for cetaceans in the acoustic modelling study, and in this impact assessment, are summarised in **Table 6-5**. Noise thresholds have been defined for both the per-pulse sound energy released (PK), as well as the total sound energy (accumulated) (SEL) that marine fauna is subjected to over a defined period of time. For recent regulatory assessments of seismic surveys the period of total sound energy integration (i.e. accumulation) has been typically defined as 24-hours; hence, this was the period used for modelling and in this assessment (SEL_{24h}). The PK and frequency-weighted accumulated SEL presented in **Table 6-5** are from the U.S. National Oceanic and Atmospheric Administration (NOAA) Technical Guidance (NMFS, 2018) for the onset of PTS and TTS in marine mammals and are consistent with a detailed review published by Southall et al. (2019). The marine mammal behavioural threshold presented in **Table 6-5** is based on the current NOAA (2019) criterion for marine mammals of 160 dB re 1 μPa sound pressure level (SPL) for impulsive sound sources.

Table 6-5: Acoustic effects thresholds applicable to cetaceans

Hearing group	NOAA (2019)	NMFS (2018), Southall et al. (2019)			
	Behaviour	PTS onset thresholds* (received level)		TTS onset thresholds* (received level)	
	Unweighted SPL (L_{pk}; dB re 1 µPa)	Weighted SEL_{24h} (L_E,24h; dB re 1 µPa²·s)	PK (L_{pk}; dB re 1 µPa)	Weighted SEL_{24h} (L_E,24h; dB re 1 µPa²·s)	PK (L_{pk}; dB re 1 µPa)
Low-frequency (LF) cetaceans	160	183	219	168	213
High-frequency (HF) cetaceans		185	230	170	224

* Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS and TTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered. L_p–denotes sound pressure level period and has a reference value of 1 µPa. L_{pk}, flat–peak sound pressure is flat weighted or unweighted and has a reference value of 1 µPa. L_E - denotes cumulative sound exposure over a 24-hour period and has a reference value of 1 µPa^{2}s.

Impact Assessment

The type and scale of the effect of seismic sound on cetaceans will depend on a number of factors including; the level of exposure, physical environment, location of the animal in relation to the sound source, how long the animal is exposed to the sound, the exposure history, how often the sound is repeated (repetition period) and the ambient sound level. The context of the exposure plays a critical and complex role in the way an animal might respond (Gomez et al., 2016; NMFS, 2016). Without appropriate control measures in place, noise emissions from the seismic source have the potential to impact cetaceans by causing injury or changes to hearing (PTS and TTS) as a result of high sound levels at close range to the seismic source, or behavioural disturbance impacts (refer to the sound exposure thresholds for PTS, TTS and behavioural disturbance described above).

Based on the information presented in **Section 4.6.3**, there are no BIAs for cetaceans identified within the Operational Area, however a pygmy blue whale migration and foraging BIA are located 14 km south-east and 154 km south of the Operational Area, respectively. A humpback whale migration BIA is located 138 km south-east of the Operational Area. An additional seven cetacean species listed under the EPBC Act (three threatened and migratory, and four migratory), including baleen and toothed whales were identified as potentially occurring within the Operational Area. The pygmy blue whale may be encountered within the Operational Area during their northbound migration from April to July, and southbound migration from October to January. Similarly, other migratory cetacean species including the humpback, fin, sei and killer whale, may occur within or adjacent to the Operational Area during the acquisition of the survey, however, the presence of these species is likely to be limited to infrequent occurrences of individuals or small groups.

Considering the NMFS (2018) SEL_{24h} threshold criterion, LF cetaceans could reach PTS thresholds within 380 m from the nearest survey line based on the application of the multiple pulse SEL_{24h} threshold, but within 30 m based on the single pulse PK metric (**Table 6-6**). TTS thresholds could be reached within 60.7 km based on the application of the multiple pulse SEL_{24h} threshold, and within 60 m based on the single pulse PK metric (**Table 6-6**). For HF cetaceans, PTS and TTS thresholds were not reached within the limits of the modelling resolution or 20 m (i.e. either the threshold will not be exceeded, or the range to exceedance will be limited to the immediate proximity of the seismic source).

Table 6-6: Maximum predicted horizontal distances (R_{max}) to PTS, TTS and behavioural response thresholds in cetaceans

Hearing Group	Sound Exposure Threshold	R_{max} distance (km)*
PTS		
LF cetaceans	219 dB re 1 µPa (PK)	0.03
	183 dB re 1 µPa².s (SEL_{24h})	0.38
HF cetaceans	230 dB re 1 µPa (PK)	-
	185 dB re 1 µPa².s (SEL_{24h})	-
TTS		
LF cetaceans	213 dB re 1 µPa (PK)	0.06
	168 dB re 1 µPa².s (SEL_{24h})	60.7
HF cetaceans	224 dB re 1 µPa (PK)	-

	170 dB re 1 µPa².s (SEL_{24h})	-
Behavioural Response		
LF cetaceans	160 dB re 1 µPa (SPL)	7.28
HF cetaceans		

N.B. A dash indicates the threshold was not reached within the limits of the modelling resolution (20 m).

The 24-hour SEL is a cumulative metric that reflects the dosimetric (measured dose) impact of noise levels within 24-hours, based on the conservative assumption that an animal is consistently exposed to such noise levels at a fixed position. This represents a conservative worst-case scenario. More realistically, whales would not stay in the same location and may not remain within range of the survey line for 24-hours. This would particularly be the case for an animal migrating through offshore waters that do not represent a migratory or foraging BIA. Therefore, a reported radius for SEL_{24h} criterion does not mean that a whale travelling within this radius of the source will experience PTS or TTS, but rather that an animal could be exposed to the sound levels associated with these effects if it remained in that range for 24-hours (Koessler et al., 2021).

It is highly unlikely that an individual whale (e.g. pygmy blue whale) would remain within a range of 380 m (predicted distance for PTS for LF cetaceans, based on the SEL_{24h} metric) from the operating seismic source (which is moving) for a full 24-hour period, or even for a few hours. Should an individual remain within the range for potential impact, some recoverable TTS could occur. However, the likelihood of TTS occurring is reduced to some degree by the implementation of control measures including a shut-down zone of 500 m and a low-power zone of 2 km under Part A of the EPBC Policy Statement 2.1, which reduces the potential for close range sound exposures where the greatest sound contribution is received.

For both LF and HF cetaceans, a behavioural response could occur within 7.28 km of the seismic source.

Based on the noise modelling results in Koessler et al. (2021), received sound levels at the pygmy blue whale foraging BIA and the humpback whale migration BIA are predicted to be below 130 dB re 1 µPa SPL. No significant behavioural responses are expected and the BIAs are well beyond the maximum range in which TTS effects could occur.

The Blue Whale Conservation Management Plan (Action Area 2) states that anthropogenic noise in BIAs should be managed such that any blue whale continues to utilise the area without injury (DoE, 2015a). Although TTS in cetaceans has previously been regarded as hearing impairment, not injury, advice from NOPSEMA and DAWE is that TTS should be considered a form of injury to pygmy blue whales and this should be prevented within the BIAs. Therefore, the potential for TTS effects (and therefore injury) to pygmy blue whales and management of this risk warrants further evaluation.

Pygmy blue whales migrate as solitary animals or in small groups along the continental slope, typically at depths between 500 m and 1000 m on the way to the Banda and Molucca seas near Indonesia, where calving is understood to occur (Double et al., 2014). The northern migration typically passes north-western Australia between approximately April to July with the return southern migration between October and January.

The modelled range to TTS effects in LF cetaceans, such as the pygmy blue whale, of 60.7 km may be overly conservative for the following reasons:

- The 60.7 km range to TTS is based on the modelled maximum-over-depth range and may correspond with water depths that are greater than the depths at which pygmy blue whales typically swim and dive to.
- As explained above, the SEL_{24h} criterion is a cumulative metric that reflects the dosimetric impact of sound energy accumulated over a 24-hour period and assumes that an animal is consistently exposed to such noise levels at a fixed location. The radii that correspond to SEL_{24h} typically represent an unlikely worst-case scenario for SEL-based exposure since, more realistically, marine fauna would not stay in the same location or at the same range for 24 hours (Koessler et al., 2021). It is noted that the accumulation of sound energy is not linear and rapid growth in accumulated exposures may occur over a matter of hours as the seismic source approaches an animal's location, but the criterion and modelling are still limited by the assumption that animals remain in a fixed location for this period.

To account for the movement of pygmy blue whales within the water column, Woodside commissioned JASCO to undertake animal movement (animat) modelling. The JASCO Animal Simulation Model Including Noise Exposure (JASMINE) was used to predict the exposure of animats (pygmy blue whales) to sound arising from the seismic activity. Given that the Scarborough 4D B1 MSS is adjacent to the migration BIA for pygmy blue whales, migratory behaviour was the only behavioural profile considered. The behavioural profile applied for pygmy blue whales was derived from a range of sources that used multi-sensor tags to record fine-scale dive and movement behaviour (Owen et al. 2016, Möller et al. 2020). Where information was unavailable for pygmy blue whales, parameters were derived from blue whale (*B. musculus*) tagging data (Goldbogen et al. 2011). Owen et al. (2016) monitored the fine-scale movement and diving behaviours of a migrating sub-adult pygmy blue whale off the west coast of WA. To reduce energy expenditure during migration, the whale dives to a depth that is likely to allow it to avoid surface wave drag and maximize horizontal movement. The mean depth of migratory dives (82% of all dives) was 14 m ± 4 m, and the whale spent 94% of observed time and completed 99% of observed migratory dives at water depths of less than 24 m. The mean maximum depth of exploratory dives was 107 ± 81 m (range 23–320 m) and did not appear to be related to seafloor depth. The behaviour of migrating pygmy blue whales was modelled to represent the animals migrating along the west coast of Australia, to and from Indonesia (Double et al., 2014; DoE, 2015a). The speed for travel for migratory behaviour (1.17 ± 0.60 m/s) and exploratory dives (0.88 ± 0.14 m/s) were calculated from data presented in Möller et al. (2020).

The estimated sound fields produced by source and propagation models for the seismic survey were incorporated into a sound exposure model to estimate the radial distance within which 95% of the exposure exceedances occur ($ER_{95\%}$). The maximum distance within which exposure exceedances occur (ER_{max}) was also included given the sensitivity of pygmy blue whales and the limited knowledge about their behaviour within the migratory BIA. Noise effect metrics included peak pressure level (PK), sound exposure levels (SEL_{24h}), and sound pressure level (SPL).

The animat modelling indicated that no whales within the pygmy blue whale migration BIA were exposed to sound levels exceeding the threshold criteria for PTS, TTS and a behavioural response within the 95th percentile exposure ranges ($ER_{95\%}$) and maximum exposure ranges (ER_{max}) (Koessler et al., 2021; **Appendix G**). However, to provide context a second simulation was run that did not limit the distribution of whales to the migration BIA. A summary of these results are presented in **Table 6-7** below.

Table 6-7: Summary of animat simulation results for migrating pygmy blue whales. The 95th percentile exposure ranges ($ER_{95\%}$) and maximum exposure ranges (ER_{max}) in kilometres and probability of animats being exposed above thresholds with the $ER_{95\%}$ and ER_{max} ranges

Threshold			Maximum acoustic radial distance to threshold (km)	$ER_{95\%}$		ER_{max}	
Description		Threshold level (dB)		Distance (km)	Probability of exposure (%)	Distance (km)	Probability of exposure (%)
TTS	PK	213[1]	0.06	0.05	88	0.06	84
	SEL_{24h}	168[2]	60.7	15.02	42	21.73	32
PTS	PK	219[1]	0.03	0.04	73	0.04	71
	SEL_{24h}	183[3]	0.38	0.06	80	0.13	65
Behavioural response		160[3]	7.28	6.54	71	7.33	67

[1] PK (*L*pk; dB re 1 μPa)
[2] LF-weighted SEL_{24h} (L_E,24h; dB re 1 μPa^2 ·s)
[3] SPL (*L*p; dB re 1 μPa)

As shown in **Table 6-7**, maximum exposure ranges (ER_{max}) to SEL_{24h} thresholds were 130 m and 21.73 km for PTS and TTS respectively. For PK thresholds, ER_{max} distances were 40 m to PTS and 60 m to TTS.

The 95th percentile exposure ranges ($ER_{95\%}$) to SEL thresholds for PTS were 60 m, and for TTS were 15.02 km. For PK thresholds, $ER_{95\%}$ distances were 40 m to PTS and 50 m to TTS.

Based on these results, the conservative range for potential TTS effects in pygmy blue whales is approximately 22 km from the seismic source, compared with the 60.7 km range previously predicted in Koessler et al. (2021) when animal movement was not factored into the model. The closest point of approach from the Active Source Area and the pygmy blue whale migration BIA is 29.9 km, and therefore, pygmy blue whales will continue to utilise the migration BIA without injury or significant behavioural disturbance.

The potential for masking impacts to migrating pygmy blue whales within the migration BIA is limited, as the intermittent nature and relatively short duration of the seismic pulses is unlikely to result in any significant masking of whale calls, and migrating whales would be exposed to the seismic pulses for less than a day, therefore, this sound exposure would not cause long-term masking for these individuals.

Additional adaptive management procedures will be implemented to manage potential impacts to pygmy blue whales if higher numbers than expected are encountered during the survey (refer to Control 4.5 in ALARP table below).

Cetaceans - Impact Assessment Conclusion

Based on the assessment above, the implementation of controls and the absence of any TTS effects within the pygmy blue whale migration BIA, the potential impacts of noise emissions from the seismic source on cetaceans during the acquisition of the survey are considered to be slight and short-term. Impacts to cetaceans are likely to be restricted to temporary behavioural changes (avoidance) in individuals moving through the Operational Area, with predicted noise levels from the seismic acquisition not considered likely to cause injury effects.

Marine Reptiles

Species Sensitivity and Sound Exposure Thresholds

Acute noise, or temporary exposure to loud noise, may result in the avoidance of important habitats and in some situations physical damage to turtles. However, there is a scarcity of data regarding the responses of turtles to acoustic exposure, and no studies of hearing loss due to exposure to loud sounds. Marine turtles have the best hearing sensitivity and low frequencies in the range of 100-700 Hz (Bartol and Musick, 2003; Finnernan et al., 2017), and are known to have poor auditory sensitivity (Bartol and Ketten, 2006; Dow Piniak et al., 2012). Accordingly, PTS and TTS thresholds for turtles are likely more similar to those of fishes than to marine mammals (Popper et al., 2014).

McCauley et al. (2000b) observed the behavioural response of caged sea turtles—green (*Chelonia mydas*) and loggerhead (*Caretta caretta*)—to an approaching seismic airgun. For received levels above 166 dB re 1 μPa (SPL), the turtles increased their swimming activity and above 175 dB re 1 μPa (SPL) they began to behave erratically, which was interpreted as an agitated state.

The 166 dB re 1 μPa level has been used as the threshold level for a behavioural response to sea turtles by NMFS and applied in the Arctic Programmatic Environmental Impact Statement (PEIS) (NSF, 2011) and the Recovery Plan for Marine Turtles in Australia (DoEE, 2017a). The 175 dB re 1 μPa level from McCauley et al. (2000b) is recommended as the threshold for behavioural disturbance.

Some additional data suggest that behavioural responses occur closer to an SPL of 175 dB re 1 μPa, and TTS or PTS at even higher levels (Moein et al., 1995), but the received levels were unknown and the NSF (2011) PEIS maintained the earlier NMFS criteria levels of 166 and 180 dB re 1 μPa (SPL) for behavioural response and injury, respectively. Popper et al. (2014) suggested injury to turtles could occur for sound exposures above 207 dB re 1 μPa (PK) or above 210 dB re 1 μPa²·s (SEL_{24h}). Sound levels defined by Popper et al. (2014) show that animals are very likely to exhibit a behavioural response when they are near an airgun (tens of metres), a moderate response if they encounter the source at intermediate ranges (hundreds of metres), and a low response if they are far (thousands of metres) from the airgun.

The sound exposure thresholds applied for marine turtles in the acoustic modelling study, and in this impact assessment, are summarised in **Table 6-8**. The peak pressure levels (PK) and frequency-weighted accumulated sound exposure levels (SEL) presented in **Table 6-8** are as reported in Finnernan et al. (2017) for PTS and TTS effects in turtles. The behavioural response threshold presented in **Table 6-8** is based on the NMFS and applied in the Arctic Programmatic Environmental Impact Statement (PEIS) (NSF, 2011), and the behavioural disturbance threshold is based on the level reported in McCauley et al. (2000b).

Table 6-8: SPL, SEL_{24h}, and PK thresholds for acoustic effects on marine turtles

Effect Type	Criterion	Unweighted SPL (L_{pk}; dB re 1 μPa)	Weighted SEL_{24h} (L_E,24h; dB re 1 μPa²·s)	PK (L_{pk}; dB re 1 μPa)
Behavioural response	NSF (2011)	166	N/A	
Behavioural disturbance	McCauley et al. (2000a, 2000b)	175		
PTS onset thresholds* (received level)	Finneran et al. (2017)	N/A	204	232
TTS onset thresholds* (received level)			189	226

* Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS and TTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered. L_p denotes sound pressure level period and has a reference value of 1 μPa. L_{pk}, flat denotes peak sound pressure is flat weighted or unweighted and has a reference value of 1 μPa. L_E denotes cumulative sound exposure over a 24-hour period and has a reference value of 1 μPa^{2}s.

Impact Assessment

As presented in **Section 4.6.2**, there are no BIAs or Habitat Critical to the survival of marine turtles within the Operational Area. The nearest BIAs and Habitat Critical are for flatback turtles, located approximately 135 km south-east and 147 km south-east of the Operational Area, respectively. The Recovery Plan for Marine Turtles (DoEE, 2017a) specifies a 60 km internesting buffer for flatback turtles, and 20 km internesting buffer for green, hawksbill and loggerhead turtles. The 60 km internesting buffer for flatback turtles (DoEE, 2017a) is based primarily on longshore movements in nearshore coastal waters or travel between island rookeries and the adjacent mainland (Whittock et al., 2014).

Whittock et al. (2016) defined suitable internesting habitat as water 0–16 m deep and within 5–10 km of the coastline, while unsuitable internesting flatback habitat was defined as waters >25 m deep and >27 km from the coastline. There is no evidence to date to indicate that flatback turtles swim out into deep offshore waters during the internesting period (Whittock et al., 2016).

It is important to note that flatback turtle hatchlings do not undertake oceanic migrations offshore to deep, pelagic waters. Instead juveniles grow to maturity in shallow coastal waters close to their natal beaches (Musick and Limpus, 1996).

Additionally, one other marine turtle species and the short-nosed sea snake were also identified as potentially occurring within the Operational Area. However, there are no BIAs nearby, and therefore their occurrence within or adjacent to the Operational Area is considered unlikely, as are any impacts to these species as a result of underwater sound from the seismic source.

Table 6-9 presents the results of the acoustic modelling study for the maximum R_{max} distances to PTS (injury), TTS, behavioural response and behavioural disturbance thresholds in turtles, for all modelled source scenarios. The results for the thresholds applied for PTS and TTS consider both metrics (single pulse PK and multiple pulse SEL_{24h}).

Table 6-9: Maximum predicted horizontal distances (R_{max}) to PTS, TTS, behavioural response and behavioural disturbance thresholds in turtles, for all modelled scenarios

Hearing group	Sound effect threshold	R_{max} distance (km)
Marine turtles	Behavioural response	
	166 dB re 1 µPa (SPL)	3.87
	175 dB re 1 µPa (SPL)	0.76
	PTS	
	232 dB re 1 µPa (PK)	-
	204 dB re 1 µPa².s (SEL_{24h})	0.05
	TTS	
	226 dB re 1 µPa (PK)	-
	189 dB re 1 µPa².s (SEL_{24h})	0.28

N.B. A dash indicates that the threshold is not reached within the limits of the modelling resolution (20 m).

As shown in **Table 6-9**, based on the application of the multiple pulse SEL_{24h} thresholds, marine turtles could experience PTS within 50 m of the active source, and experience TTS within 280 m of the active source. Single pulse PK PTS thresholds were not reached within the limits of the modelling resolution for PTS or TTS.

The SEL_{24h} is a cumulative metric that reflects the doisimetric impact of noise levels within 24-hours based on the assumption that an animal is consistently exposed to such noise levels at a fixed position, and represents an unlikely scenario. More realistically, marine turtles would not stay in the same location for 24-hours, but rather a shorter period, depending upon their behaviour and the proximity and movements of the source. Therefore, a reported radius for SEL_{24h} criteria does not mean that marine reptiles travelling within this radius of the source will be impaired, but rather that an animal could be exposed to the sound level associated with impairment (either PTS or TTS) if it remained in that location for 24-hours (Koessler et al., 2021; **Appendix G**).

No PTS or TTS effects to marine turtles are expected given the small distances to SEL_{24h} thresholds, 50 m and 280 m respectively, and the low likelihood of marine turtles being present within the offshore waters of the Operational Area.

Based on the 166 dB re 1 µPa SPL behavioural threshold criterion a behavioural response could occur within 3.87 km, and based on the 175 dB re 1 µPa SPL behavioural threshold criterion a behavioural disturbance could occur within 760 m.

Given that there are no marine turtle BIAs or Habitat Critical within the Operational Area, and the nearest are located 135 km south-east of the Operational Area, marine turtles are unlikely to occur within the area of potential impact. Should any marine turtles occur within 3.87 km of the seismic source, they may experience some behavioural disturbance, however it is expected that turtles within this area will not be evenly distributed and are likely to be moving in and out of the area, and similarly, the sound levels within this potential impact area with change as the seismic vessel moves throughout the survey for a period of up to 80-days.

Marine Reptiles - Impact Assessment Conclusion

Based on the assessment above, the potential impacts of noise emissions from the seismic source on marine reptiles (turtles) during the acquisition of the survey are considered to be slight and short-term. Impacts are likely to be restricted to temporary behavioural changes (avoidance) to transient turtles that may pass within 3.87 km of the seismic source. Turtles would be exposed to noise levels above behavioural threshold levels for a short period of time as the vessel moves through the survey area (up to 80-days).

Seabirds

Impact Assessment

Very little is known about the effects of intense underwater sound (e.g. seismic surveys) on seabirds. However, impacts to seabirds have not been observed previously during seismic surveys (Turnpenny and Nedwell, 1994), and it is generally thought that noise produced from activities associated with seismic surveys may impact only those species of birds that spend large quantities of time underwater, either swimming or plunge diving while foraging for food (US DoIMMS, 2004). Pichegru et al. (2017) found that penguins showed a strong avoidance of their preferred foraging areas during seismic activities, foraging significantly further from the survey vessel when in operation and increasing overall foraging effort.

As outlined in **Section 4.6.4**, 25 species of birds were identified by the EPBC Act PMST as potentially occurring within the Operational Area or EMBA, including three threatened species. There are no BIAs for birds located within the Operational Area.

Birds foraging within the Operational Area have the potential to be exposed to increased sound levels generated by the operating seismic source, while diving for small pelagic fishes near the sea surface. Such behaviours may result in a startle response during diving. Birds resting on the surface of the water in proximity to the seismic vessel have limited potential to be affected by sound emissions underwater due to the limited transmission of sound energy between the water/air interface, but may be startled by seismic pulses in close proximity to the seismic source. However, given the likely avoidance response from fish and other prey species in waters immediately surrounding the seismic source, birds are unlikely to forage near the operating seismic source. In the unlikely event that birds dive and forage near the seismic source, this is likely to only affect individual birds, resulting in a startle response with the affected birds expected to move away from the area as a result.

Seabirds– Impact Assessment Conclusion

In the absence of foraging BIAs it is not likely that seabirds would be impacted by the seismic survey. The behaviour and distribution of some fish may be affected for short periods during and after exposure to the seismic source, which may result in short-term and localised changes in the distribution of target prey species for some bird species. However, it is expected that the behaviours and distribution of prey at any one time will remain largely unaffected within the Operational Area. Furthermore, it is expected that wedge-tailer shearwaters and roseate terns will not be displaced from the wider areas of the breeding BIA. Therefore, impacts to seabird populations are extremely unlikely to occur.

Commercial Fisheries

Noting that no commercial fisheries operate within or near the Operational Area (refer to **Section 4.9.2**) and the Operational Area does not provide suitable habitat or water depths for target fish or crustacean species, no physical or behavioural impacts are predicted to commercial fish stocks and no impacts are predicted to commercial fishery catch rates.

Commercial Fisheries – Impact Assessment Conclusion

Based on the assessment above and the implementation of the identified control measures, the consequence of occasional short-term and localised disturbance to the target species and catch rates of commercial fisheries is of no lasting effect (less than one month) and impacts will not be significant to commercial fisheries.

Marine Protected Areas

Impact Assessment

As described in **Section 4.8**, the Operational Area does not overlap with any Commonwealth or State Marine Parks. However, Australian Marine Parks (AMPs) are located in the wider EMBA that are part of the North-west and South-west Marine Park Networks

The nearest marine park is the Gascoyne AMP, located 33 km south of the Operational Area and approximately 44 km of the Active Source Area at the closest point. Maximum received sound levels at the boundary of the Gascoyne AMP are predicted to be approximately 140 dB re 1 µPa (SPL).

The potential impacts to the natural, social and economic values of the Gascoyne AMP are summarised as follows.

- Exmouth Plateau KEF – The Operational Area and Active Source Area are located within the KEF. As assessed above, the potential impacts to benthic communities will be highly localised, temporary and negligible in the context of natural variability. The productivity, ecological function and value of the KEF will not be affected.
- Continental slope demersal fish communities KEF – The KEF is located over 150 km from the Active Source Area. Underwater sound emissions will not affect the demersal fish communities in this KEF.
- Canyons linking Cuvier abyssal plain and Cape Range peninsula KEF – The KEF is located over 105 km from the Active Source Area. Underwater sound emissions will not affect the benthic invertebrate or fish communities in this KEF.
- Commonwealth waters adjacent to Ningaloo Reef KEF – The KEF is located over 170 km from the Active Source Area. Underwater sound emissions will not affect the coral reef communities, deep water filter feeder communities or marine fauna that aggregate or migrate within the KEF.
- Humpback whale migratory pathway – As assessed above, received sound levels at the humpback whale migration BIA are predicted to be below 130 dB re 1 µPa SPL. No significant behavioural response is expected and the BIA is well beyond the maximum range in which TTS effects could occur.

- Pygmy blue whale migratory pathway and possible foraging habitat – As assessed above, the animat modelling demonstrates that TTS effects are not expected to occur in the migration BIA. Impacts to cetaceans are likely to be limited to temporary behavioural changes (avoidance) in individuals migrating through the Operational Area. Received sound levels at the pygmy blue whale foraging BIA are predicted to be below 130 dB re 1 µPa SPL. No significant behavioural response is expected and the foraging BIA is well beyond the maximum range in which TTS effects could occur.
- Internesting habitats for marine turtles – As assessed above, no impacts are expected to turtles within designated internesting habitats, which are located over 150 km from the Active Source Area.

Given that the other marine parks within the EMBA are located a greater distance from the Operational Area no impacts will occur as a result of underwater sound from the survey.

The objectives of the North-west Marine Parks Network Management Plan are to provide for:

a) the protection and conservation of biodiversity and other natural, cultural and heritage values of marine parks in the North-west Network
b) ecologically sustainable use and enjoyment of the natural resources within marine parks in the North-west Network, where this is consistent with objective (a).

The Petroleum Activities Program will be undertaken in a manner that is consistent with the management objectives for the AMPs and the North-west Marine Park Network. No long-term impacts are predicted and the values will be conserved and protected.

Marine Protected Areas – Impact Assessment Conclusion

Based on the proposed timing and duration (up to 80-days) of the seismic acquisition and the control measures proposed, predicted noise levels from seismic acquisition are not considered likely to cause any ecologically significant impacts to the natural values of the AMPs.

Cumulative Assessment

Previous Seismic Surveys

Cumulative impacts from successive seismic surveys in the same area can occur when timing between the surveys is less than the recovery rate of any potential receptors, which can be in the order of minutes to hours for some receptors (e.g. zooplankton and fish), or weeks to months for others (e.g. benthic invertebrates), as described above. A summary of the marine seismic surveys that have been undertaken in the last five years (2016-2021) within approximately 150 km of the Scarborough 4D B1 MSS Active Source Area is presented in **Table 6-10** and **Figure 6-4**. As shown in **Table 6-10** and **Figure 6-4**, there is no spatial overlap between the Scarborough 4D B1 MSS Operational Area and any other seismic survey Operational Areas.

Table 6-10: Previous seismic surveys completed within 150 km of the Scarborough 4D B1 MSS from 2016-2021

Survey Name	Operator	Acquisition Period(s)	Spatial overlap
Cimatti 4D MSS	Woodside Energy Ltd	13/04/2020 – 23/04/2020	None
Laverda 4D MSS	Woodside Energy Ltd	09/03/2020 – 11/04/2020	None
Harmony 4D MSS	Woodside Energy Ltd	12/02/2020 – 04/03/2020	None
Pluto 4D MSS	Woodside Energy Ltd	05/01/2020 – 09/02/2020	None
Bianchi-Hockey 3D MSS	Quadrant Northwest Pty Ltd	23/01/2017 – 09/03/2017	None
Exmouth SLB15 MC 3D MSS	Schlumberger Australia	07/12/2016 – 01/05/2017	None
Gorgon OBN MSS	Chevron Australia Pty Ltd	03/11/2015 – 07/04/2016	None

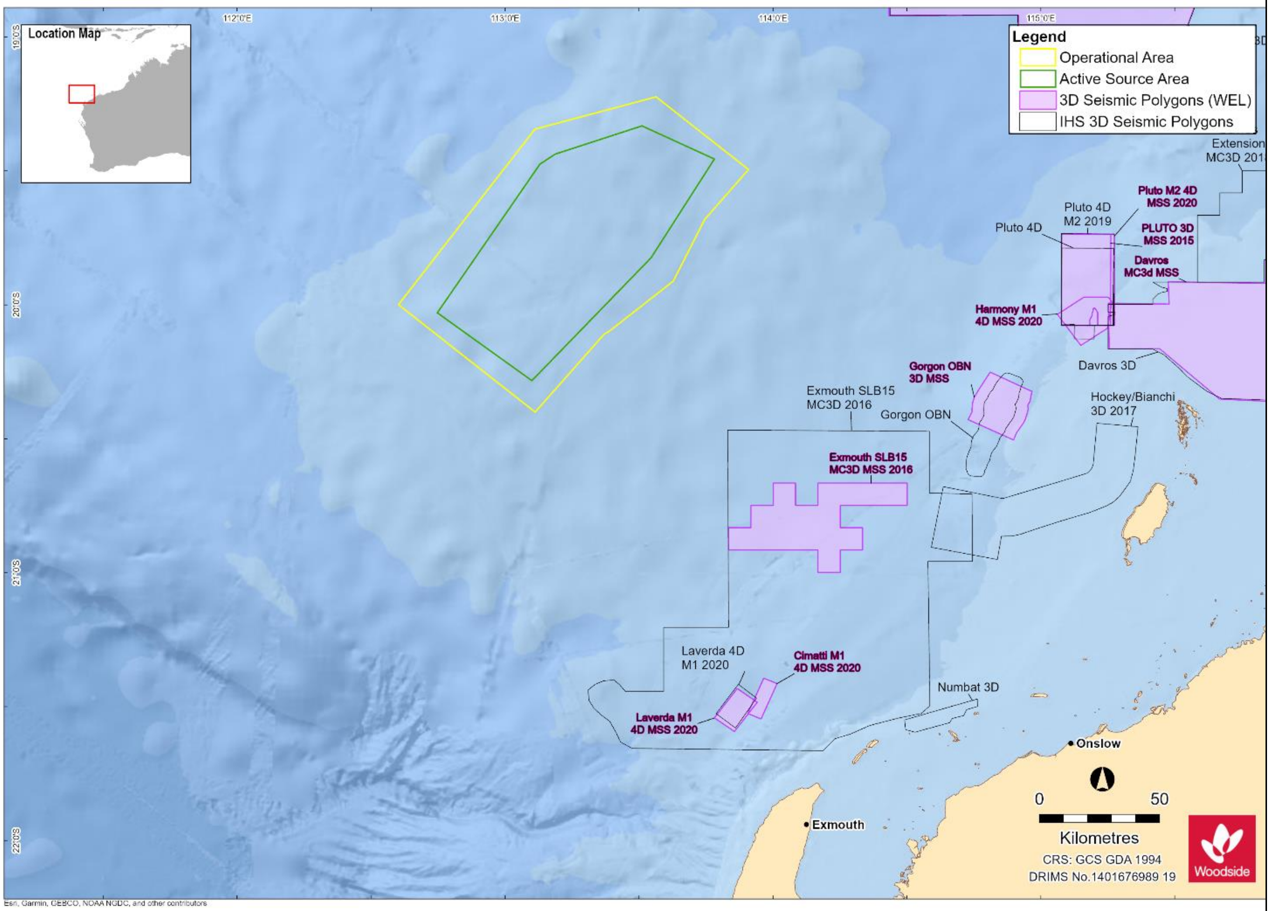


Figure 6-4: Previous seismic surveys that have occurred in the region

<u>Marine fauna</u>

The footprint of any significant underwater noise effects to marine fauna resulting from the proposed seismic survey has been assessed as being within approximately 22 km from the seismic source, based on the maximum range to TTS and behavioural effects for any receptor, in this case pygmy blue whales. However, a 150 km buffer has been selected as a conservative criterion to assess potential cumulative impacts. The maximum recovery rate for marine fauna receptors is in the order of weeks to months, particularly for sharks, marine turtles and cetaceans. Given that there have been no seismic surveys completed over the same area of seabed as the Scarborough 4D B1 MSS in the past five years, ecological receptors are expected to have recovered.

Therefore, cumulative impacts to marine fauna are not expected to occur as a result of any of the identified previous seismic surveys in the region and the proposed Scarborough 4D B1 MSS.

<u>Commercial fisheries</u>

There is only one Commonwealth managed fishery (Western Deepwater Trawl Fishery) and one State managed fishery (West Coast Deep Sea Crustacean Managed Fishery) that have historically had catch/effort within the Operational Area, however there has been no recent fishing catch/effort within the Operational Area from 2008-2019 (Patterson et al., 2020) and 2010-2019 (DPIRD, 2021), respectively (refer to **Section 4.9.2**).

There are three previous seismic surveys within 150 km of the Scarborough 4D B1 MSS Operational Area (Cimatti 4D MSS, Laverda 4D MSS and Exmouth SLB15 MC 3D MSS) with partial overlap with the Western Deepwater Trawl Fishery management boundary and West Coast Deep Sea Crustacean Managed Fishery management boundary. The most recent seismic survey (Cimatti 4D MSS) was completed in late-April 2020. It is acknowledged that the behaviours and distribution of pelagic fish species could be affected for hours to days following exposure, as a result of potential to disturbance to more sound-sensitive prey species. Crustaceans were found to recover from impacts from seismic noise exposure within weeks to months after exposure. No long-term impacts on the abundance or community structure of either species were not found. Therefore, it is expected that any impacts to commercially targeted fish or crustacean species will have recovered. Given the lack of recent fishing effort within the Operational Area, the Scarborough 4D B1 MSS is expected to have limited to no impact to this commercial fishery, and no cumulative impacts are expected to occur.

Concurrent Seismic Surveys

Over the scheduled duration of the Scarborough 4D B1 MSS there are four other seismic surveys proposed in the broader NWMR. **Table 6-11** presents the seismic surveys that may occur within the same EP timeframes, and have either been accepted by NOPSEMA or have been submitted to NOPSEMA for public comment period or assessment. The below assessment does not assess cumulative impacts from seismic surveys in the region that occur after the Scarborough 4D B1 MSS or that have not yet submitted an Environmental Plan to NOPSEMA.

Table 6-11: Other potential seismic surveys occurring in the region

Survey Name	Operator	Survey Location	Survey Timing	EP Status
Capreolus-2 3D MSS	TGS-Nopec Geophysical Company Pty Ltd	~ 275 km east of the Operational Area	1/10/2020 – 31/12/2024	The EP is accepted and valid to 2024
INPEX 2D MSS (WA-532-P, WA-533-P, WA-50-L)	INPEX	~ 700 km east of the Operational Area	1/11/2021 – 31/05/2022 Contingency: 1/11/2022 – 31/05/2023; 1/11/2023 – 31/12/2023	The EP is accepted and valid to 2023
Archer 3D MSS	Santos WA Northwest Pty Ltd	~450 km east of the Operational Area	1/02/2021 – 31/07/2021; 1/02/2022 – 31/07/2022	The EP is accepted and valid to 2022
Keraudren Extension 3D MSS	Santos WA Northwest Pty Ltd	~500 km east of the Operational Area	1/02/2020 – 31/07/2020; 1/02/2021 – 31/07/2021; 1/02/2022 – 31/07/2022	The EP is accepted and valid to 2022

The individual sound fields produced by separate concurrent seismic surveys has the potential to interact where sound waves from the separate seismic sources may be received either in synchrony (“in synch”) or out of synchrony (“out of synch”). The way in which these sound waves might react was considered by JASCO Applied Sciences and ERM for the Santos Keraudren Extension 3D MSS EP (Santos, 2020a). An increase in sound levels may occur temporarily at locations where the received signals from each source occur in synch. However, in most instances, pulses will be out of synch and increased received PK-PK sound levels will not occur often.

Given that different seismic sources are unlikely to be discharged at exactly the same time, different surveys will have different source impulse intervals. Additionally, given that each pulse will be a few hundred milliseconds in duration with several seconds in between, pulses will generally be out of synch with one another. Pulses may still line up occasionally for a brief moment at some locations, and when they do, the amplitudes will then be too unequal for the sum level to differ much from the stronger of the two components. However, in the unlikely case that two pulses interact and are exactly synchronised with each other, then the combined SPL would be 3 dB higher than the individual SPL, which represents a doubling of sound energy. Further explanation is provided in Santos (2020a).

A minimum separation distance of at least 40 km will be maintained between the Scarborough 4D B1 MSS and any other concurrently operating seismic source during data acquisition activities to prevent acoustic interference and preserve seismic data integrity. As a result of this separation, underwater sound from the seismic source is not expected to combine to significantly raise the SPL to levels which receptors may be exposed. Modelling of the seismic source for the Scarborough 4D B1 MSS shows that sound levels will be below 150 dB re 1µPa at 20 km from the source (half way between two seismic sources at their minimum separation distance) (Koessler et al. 2021; **Appendix G**). A combination of seismic sound from two similar seismic sources at this distance would therefore be expected to result in an SPL of no greater than 153 dB re 1µPa.

While the overall sound levels are not expected to be significantly increased, it is acknowledged that the result of multiple seismic vessels operating concurrently will represent a wider spatial area of potential exposure to seismic sound for receptors, as well as the potential for receptors to be exposed to separate sound fields from multiple surveys. There are no planned seismic surveys with overlap with the Scarborough 4D B1 MSS Operational Area.

Zooplankton

Based on the maximum worst case mortality exposure suggested by McCauley et al. (2017) and modelling completed by CSIRO (Richardson et al., 2017), impacts to zooplankton are only expected to be significant within a short range (< 15 km) of seismic survey areas. The maximum predicted distances to mortality for zooplankton during the Scarborough 4D B1 MSS was approximately 110 m (**Table 6-2**). Beyond 22 days of acquisition, Richardson et al. (2017) found that no further relative increase in zooplankton mortality occurs, due to recruitment of zooplankton via currents from adjacent areas, and conditions return to normal within a few days of a survey ceasing. At the regional scale, these impacts are not expected to be significant (Richardson et al., 2017). Further, natural mortality rate in zooplankton can be high, and therefore limited impacts are expected relative to the natural variation in zooplankton concentrations and mortality rate.

There are no significant, discernible cumulative impacts to zooplankton, expected to occur given the minimum separation distance of 40 km between the Scarborough 4D B1 MSS and any other operating seismic sources. The cumulative impacts to zooplankton are expected to be negligible.

Benthic Invertebrates

The maximum worst case impacts reported for invertebrates include sub-lethal impacts such as statocyst impairment, temporary reduced immune response function, temporary impaired reflexes, and potentially some chronic effects that lead to mortality of a very small number of sessile benthic invertebrates over and above natural mortality rates. Repeated exposures to seismic noise for some sessile invertebrates, such as bivalves, have been observed to result in additional chronic mortality in the weeks and months following exposure compared with invertebrates exposed to just one pass of a seismic source (i.e. an increase of approximately 2-5%) (Day et al., 2016b). However, such effects may still be within the range of naturally occurring mortality rates documented in the wild (Day et al., 2017). Therefore, given that repeat exposures will affect only a small proportion of benthic organisms, and the natural cycle of death and recruitment will occur in parallel, the impacts of repeated seismic exposure may not be detectable from natural fluctuations in benthic invertebrates.

The Scarborough 4D B1 MSS seismic source will be operated in water depths >800 m, where benthic invertebrate diversity and abundance are expected to be low, and it is not expected that there would be any impact to benthic invertebrates from noise emissions from the seismic source. Impacts to benthic invertebrates during other seismic surveys are expected to occur at close range to the seismic source, within a few hundred metres.

Given the minimum separation distance of 40 km between the Scarborough 4D B1 MSS and other operating seismic sources, no significant, discernible cumulative impacts to benthic invertebrates are expected to occur.

Fish, Sharks and Rays

No significant, discernible cumulative impacts to fish, sharks and rays are expected to occur given the minimum separation distance of 40 km between the Scarborough 4D B1 MSS and any other operating seismic sources. Behavioural impacts to fish are expected to occur within tens to hundreds of metres of a seismic source (Popper et al., 2014), returning to normal within minutes to hours or days, depending on the species, hearing sensitivity and situational context.

Individual groups of fishes in each seismic survey Active Source Area may be subject to occasional behavioural disturbances, however no cumulative overlap of strong behavioural responses is expected to occur. Some changes in fish abundance and distribution could occur as a result of sound exposure from multiple operating seismic sources, although these changes are expected to return to normal within hours to days.

Whale sharks may experience localised disturbance when passing each of the other seismic survey Operational Areas, particularly as they overlap with a whale shark foraging BIA. However, as all vessels will maintain a minimum separation distance of 40 km, and the Scarborough 4D B1 MSS Active Source Area does not overlap with the whale shark foraging BIA, separate and isolated incidents of disturbance are not expected to result in significant cumulative impacts.

Cetaceans

There are no significant, discernible cumulative impacts to cetaceans, expected to occur given the minimum separation distance of 40 km between the Scarborough 4D B1 MSS and any other operating seismic sources. As above, combined seismic sound from two similar seismic sources at a distance of half the minimum separation distance (20 km) would be expected to result in an SPL lower than the defined behavioural response thresholds for cetaceans of 160 dB re 1µPa (**Table 6-5**). Any behavioural avoidance or deviations are expected to be small relative to the long distances (i.e. thousands of kilometres) over which cetaceans usually travel during their migrations.

Table 6-12 provides an assessment of cumulative impacts to migrating pygmy blue whales. There are no other potential seismic surveys occurring near the pygmy blue whale foraging BIA, located 154 km south of the Scarborough 4D B1 MSS Operational Area.

Table 6-12: Assessment of cumulative impacts to migrating pygmy blue whales

	Pygmy blue whales
Woodside Scarborough 4D B1 MSS	The Scarborough 4D B1 MSS Operational Area is located approximately 14 km north-west of the pygmy blue whale migration BIA. At its closest point, the Active Source Area is 29.9 km from the migration BIA. TTS effects to pygmy blue whales were predicted to occur up to 22 km from the seismic source (**Table 6-7**). Therefore, no TTS effects are predicted to migrating pygmy blue whales within the migration BIA. Short-term behavioural impacts may occur up to 7.3 km from the seismic source (**Table 6-6**). Therefore, short-term behavioural impacts to migrating pygmy blue whales are not expected within the migration BIA.

TGS Capreolus-2 3D MSS (TGS, 2020)	The Capreolus-2 3D MSS overlaps with the pygmy blue whale migration BIA. The seismic source will not be operated within 24 km of the pygmy blue whale migration BIA during the migration periods for the species (April to August and October to December). Maximum predicted distances to TTS thresholds for pygmy blue whales within the migration BIA is 24 km. Therefore, no TTS effects are predicted to migrating pygmy blue whales within the migration BIA. Short-term behavioural impacts may occur up to 9.5 km from the seismic source. Therefore, short-term behavioural impacts to migrating pygmy blue whales are not expected within the migration BIA.
INPEX 2D MSS (INPEX, 2021)	The INPEX 2D MSS overlaps with the pygmy blue whale migration BIA. The seismic source will not be operated within 24 km of the pygmy blue whale migration BIA during the migration periods for the species (April to August and October to December). The maximum predicted distance to TTS thresholds for pygmy blue whales is approximately 23 km. Therefore, no TTS effects are predicted to migrating pygmy blue whales within the migration BIA. Short-term behavioural impacts may occur up to 6.5 – 8 km from the seismic source in continental slope waters. Migrating pygmy blue whales may deviate from their normal course by several kilometres to avoid the seismic sound source, however this distance does not constrain the migration path of pygmy blue whales. Therefore, occasional and localised short-term behavioural impacts are predicted to migrating pygmy blue whales within the migration BIA.
Santos Keraudren Extension 3D MSS (Santos, 2020a)	The Keraudren Extension 3D MSS Operational Area is located approximately 30 km north-west of the pygmy blue whale migration BIA, and the Active Source Area is located over 100 km from the pygmy blue whale migration BIA. Timing of the survey also only coincides with part of the northbound migration. Maximum predicted distances to TTS thresholds for pygmy blue whales is 31 km. Therefore, no TTS effects are predicted to migrating pygmy blue whales within the migration BIA. Short-term behavioural impacts may occur up to 9 km from the seismic source. Therefore, short-term behavioural impacts to migrating pygmy blue whales are not expected within the migration BIA.

Based on the assessment provided in **Table 6-12**Table 6-12, no significant cumulative TTS or behavioural impacts are expected to pygmy blue whales within the migration BIA. No TTS or behavioural impacts as a result of the Scarborough 4D B1 MSS seismic survey are expected to migrating pygmy blue whales, and the other concurrent planned seismic surveys in the region do not constrain the migration route for pygmy blue whales (only partial overlap with the Operational Areas and migration BIAs). It is expected that pygmy blue whales will continue to utilise the migration routes without injury or displacement.

Other cetacean species that may occur within the region, for example humpback, fin and sei whales, are expected to be transient and no changes to migration or other life stages are expected. Localised disturbances may occur when passing the concurrent seismic surveys, however these isolated incidents of disturbance are not expected to result in significant cumulative impacts.

<u>Marine Reptiles</u>

No significant, discernible cumulative impacts to marine turtles are expected to occur given the minimum separation distance of 40 km between the Scarborough 4D B1 MSS and any other operating seismic sources. Any behavioural avoidance or deviations are expected to be small relative to the long distances over which marine turtles usually travel.

Marine turtles may experience a short-term behavioural response up to approximately 4 km from the Scarborough 4D B1 MSS operating source, based on the NMFS criterion of 166 dB re 1 µPa SPL (**Table 6-9**). The Scarborough 4D B1 MSS Operational Area is located 135 km north-west of the nearest internesting buffer for flatback turtles, and 147 km north-west of the nearest Habitat Critical for flatback turtles (refer to **Section 4.6.2**).

Given that there is no expected impact to marine turtles as a result of the Scarborough 4D B1 MSS, no cumulative behavioural effects to marine turtles are expected within internesting buffer BIAs or Habitat Critical areas. Localised disturbances to marine turtles may occur when passing the concurrent seismic surveys, however these isolated incidents of disturbance are not expected to result in significant cumulative impacts.

<u>Commercial Fisheries</u>

Cumulative impacts to commercial fisheries may occur if multiple seismic surveys occur concurrently or in quick succession within a fishery, resulting in displacement of commercial fishing vessels or changes in catch rates due to

behavioural changes in target fish or crustacean species. The expected range and duration of impacts to fish abundance, distribution and catch rates is relatively small compared to wider areas within which the fisheries operate. There is only one Commonwealth managed fishery (Western Deepwater Trawl Fishery) and one State managed fishery (West Coast Deep Sea Crustacean Managed Fishery) that have historically had catch/effort within the Operational Area, however there has been no recent fishing catch/effort within the Operational Area from 2008-2019 (Patterson et al., 2020) and 2010-2019 (DPIRD, 2021), respectively (refer to **Section 4.9.2**). There are no concurrent seismic surveys proposed in the region that overlap with the Western Deepwater Trawl Fishery or the West Coast Deep Sea Crustacean Managed Fishery. In the absence of any other surveys, and lack of recent fishing effort within the Scarborough 4D B1 MSS Operational Area, cumulative impacts to commercial fisheries are not expected.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[4]***	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				

Application of EPBC Policy Statement 2.1 Part A Standard Management Procedures to whales and Part B.4, as outlined below:
• Observation zone: 3 km+
• Shut-down zone: 2 km
• Observation and compliance reporting:
  ○ Use of trained vessel crew in marine fauna observations and monitoring compliance to Policy Statement 2.1.
  ○ Records kept of marine fauna observations during all surveys.
• Pre start-up visual observation (30 minutes)
• Soft start procedure (30 minutes)
• Start-up delay procedure (if sighting occurs)
• Operations procedure
• Stop work (shut down) procedure
• Night-time and low visibility procedure
	F: Yes.
	CS: Minimal cost. Standard.
		Reduces the likelihood of individual whales being within proximity of the acoustic source where PTS or TTS could occur.	Benefits outweigh cost/sacrifice.	Yes
				C 5.1

Application of EPBC Act Policy Statement 2.1 Part B.1 – MMOs: • Employ two dedicated MFOs to undertake observations for EPBC Act Policy Statement 2.1.	F: Yes. CS: Minimal cost. Standard practice.	Two dedicated MFOs provides improved marine fauna identification, distance estimation and implementation of EPBC Act Policy Statement 2.1. Two MFOs on board provides contingency in the event one is unavailable and for managing work shift fatigue.	Benefits outweigh cost/sacrifice.	Yes **C 5.2**

1 Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[4]***	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Application of EPBC Act Policy Statement 2.1 Part B.5 – PAM: • A PAM system will be installed aboard the survey vessel to detect odontocete whales (specifically sperm and beaked whales). • Employ two dedicated PAM operators where ever possible.	F: Yes CS: Minimal cost.	Two dedicated PAM operators provides improved marine fauna identification and implementation of EPBC Act Policy Statement 2.1. Two PAM operators on board provides contingency in the event one is unavailable and for managing work shift fatigue.	Benefits outweigh cost/sacrifice.	Yes **C 5.3**
The seismic source will not be discharged outside of the Active Source Area.	F: Yes CS: CS: Minimal cost. Standard practice.	Limits the effects of underwater sound to the extent that is assessed in this EP.	Benefits outweigh cost/sacrifice.	Yes **C 5.1**
Good Practice				
Seismic source validation.	F: Yes CS: Source modelling can be undertaken at minimal cost and relatively quickly.	If the seismic source selected for the Petroleum Activities Program is different to the source modelled and assessed in Koessler et al., (2021; **Appendix G**), then additional source modelling will be undertaken to confirm whether the sound levels are consistent with levels assessed as acceptable in this EP.	Benefits outweigh cost/sacrifice.	Yes **C 4.1**
Application of EPBC Act Policy Statement 2.1 Part B.6 – Adaptive Management measures to minimise the potential impacts to pygmy blue whales from seismic noise. The following adaptive measures will be implemented: • If there are three or more sightings of pygmy blue whales within the 3 km observation zone within a 24-hour period, then the seismic operations must not be undertaken thereafter at night-time or during low visibility conditions. • Seismic operations cannot resume at night-time or during low visibility	F: Yes CS: Increased costs of the survey during no seismic operations, prolonging the survey duration. Any delays to the seismic program could result in significant cost and operational implications. It would also extend the duration of the	PTS or TTS effects to pygmy blue whales are not predicted to occur from exposure to a single impulse. However, adaptive management measures are considered conservative and appropriate to provide protection to pygmy blue whales that may be exposed to	Benefits outweigh cost/sacrifice.	Yes **C 5.4**

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[4]	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
conditions, until there has been a cumulative 24-hour period of seismic operations (daylight hours with good visibility) during which less than three pygmy blue whales are sighted within the 3 km observation zone.	survey, potentially increasing impacts to other receptors. However, observation zone has been selected to be protective of pygmy blue whales.	multiple pulses at close range.		
No operation of the seismic source within 25 km of the pygmy blue whale migration BIA.	F: Yes CS: Minimal cost. The Active Source Area is located >25 km from the pygmy blue whale migration BIA.	ANIMAT modelling (**Appendix G**) predicts that the maximum range at which pygmy blue whales may experience TTS is at 21.73 km. Preventing operation of the seismic source within 25 km of the pygmy blue whale migration BIA provides some additional conservatism and prevents TTS effects and injury to pygmy blue whales in the migration BIA.	Benefits outweigh cost/sacrifice.	Yes **C 5.5**
A 40 km separation distance between the Petroleum Activities Program and any identified concurrent seismic survey	F: Yes CS: In the event that other surveys are present in the region, a 40 km separation distance may result in delays due to vessel downtime or loss of survey area.	The Bureau of Ocean Energy Management (BOEM, 2014) published an environmental review of geological and geophysical survey activities in the south Atlantic Ocean. To minimise impacts to marine life by providing a 'corridor' between vessels, the environmental impact statement from this review included a requirement for a 40 km geographic separation distance (based on worst case scenarios) between the sources of	Benefits outweigh cost/sacrifice.	Yes **C 7.1**

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[4]***	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
		simultaneous seismic surveys.		
Professional Judgement – Eliminate				
None identified				
Professional Judgement – Substitute				
None identified				
Professional Judgement – Engineered Solution				
None identified				
ALARP Statement On the basis of the environmental impact assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type B), Woodside considers the adopted controls appropriate to manage the impacts and risks of noise emissions generated from seismic source. As no reasonable additional/alternative controls were identified that would further reduce the impacts and risks without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability		
Receptor	***Acceptability Criteria and Assessment***	***Statement of Acceptability***
Migratory and threatened cetaceans	**Principles of ESD** The impact assessment has considered the relevant principles of ESD: • The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making. • Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations. **Internal Context** The Petroleum Activities Program is consistent with Woodside corporate policies, culture, processes, standards, structure and systems as outlined in the Demonstration of ALARP and Environmental Performance Outcomes, including: • Woodside Health, Safety, Environment and Quality Policy (**Appendix A**) • Woodside Risk Management Policy (**Appendix A**). **External Context** During stakeholder consultation with relevant persons no specifically relating to cetaceans were raised. **Other Requirements** The proposed control measures exceed the required standards and control measures set out in EPBC Policy Statement 2.1. Part A Standard Management Measures (DEWHA, 2008). The proposed activity and control measures are not inconsistent with the requirements of recovery plans or wildlife conservation plans/advice as demonstrated in **Section 6.7**. The impact assessment has determined that seismic acquisition may be undertaken in a manner that is not inconsistent with the requirements of the Conservation Management Plan for the Blue Whale, specifically that '*Anthropogenic noise in biologically important areas will be managed such that any blue whale continues to utilise the area without injury, and is not displaced from a foraging area*'. Acoustic modelling and ANIMAT modelling have demonstrated that injury and TTS effects will not occur in the pygmy blue whale migration BIA and sound levels will not result in displacement from foraging areas. The impact assessment and proposed control measures are consistent with NOPSEMA Acoustic Impact Evaluation and Management Guideline (N-04750-IP1765 Rev2 Dec 2018). No significant or long-term impacts are expected to occur to key habitats of EPBC Act listed species included as values of the Montebello and Gascoyne AMPs.	The predicted level of impact for migratory and threatened cetaceans is considered to be of an acceptable level given that the: • the Petroleum Activities Program is consistent with the relevant principles of ESD • the proposed controls have considered the environmental consequence and are consistent with Woodside's internal policies, procedures and standards • feedback from stakeholders has been taken into consideration • legislative requirements/industry standards have been adopted • the Petroleum Activities Program will be managed in a manner that prevents physical injury or displacement of pygmy blue whales from migration and foraging BIAs • the Petroleum Activities Program will be managed in a manner that prevents physical injury to other cetacean species • the Petroleum Activities Program will be managed in a manner that is consistent with management objectives for relevant WHAs, AMPs, recovery plans and conservation plans/advices • the predicted level of impact has been reduced to ALARP. **Environmental Performance Consideration** To manage impacts to migratory and threatened cetaceans to an acceptable level, the following EPOs have been applied: **EPO 4:** Far-field source levels for the selected seismic source for the Scarborough 4D B1 MSS are consistent with levels assessed in this EP. **EPO 5**: Undertake seismic acquisition in a manner that prevents physical injury to whales.

<table>
<tr><th colspan="3">Demonstration of Acceptability</th></tr>
<tr><th>Receptor</th><th>Acceptability Criteria and Assessment</th><th>Statement of Acceptability</th></tr>
<tr><td></td><td></td><td>EPO 6: Limit underwater sound production from the seismic source to the area defined and assessed in this EP.
EPO 7: Undertake seismic acquisition in a manner that reduces potential cumulative impacts resulting from the Petroleum Activities Programme and other seismic survey operations as far as reasonably practicable.</td></tr>
<tr><td>Migratory and threatened marine turtles</td><td>Principles of ESD
The Petroleum Activities Program is consistent with the relevant principles of ESD:
• The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making.
• Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.
Internal Context
The Petroleum Activities Program is consistent with Woodside corporate policies, culture, processes, standards, structure and systems as outlined in the Demonstration of ALARP and Environmental Performance Outcomes, including:
• Woodside Health, Safety, Environment and Quality Policy (Appendix A)
• Woodside Risk Management Policy (Appendix A).
External Context
During stakeholder consultation with relevant persons no specifically relating to turtles were raised.
Other requirements
The proposed control measures are not inconsistent with the applicable objectives and actions of the Recovery Plan for Marine Turtles (DoEE, 2017a). Specifically, controls measures will ‘manage anthropogenic activities to ensure marine turtles are not displaced from identified habitat critical to the survival’ of marine turtles and ‘given that the impacts of noise are unknown, a precautionary approach [will] be applied to seismic work, such that surveys planned to occur inside important internesting habitat should be scheduled outside the nesting season’. Received noise levels from seismic acquisition are not likely to cause injury impacts, displace any individuals from Habitat Critical or internesting BIAs, or result in any ecologically significant impacts at a population level for any species of marine turtle that may be present within or adjacent to the Operational Area during the Petroleum Activities Program.</td><td>The predicted level of impact for migratory and threatened marine turtles is considered to be of an acceptable level given that the:
• the Petroleum Activities Program is consistent with the relevant principles of ESD
• the proposed controls have considered the environmental consequence and are consistent with Woodside’s internal policies, procedures and standards
• feedback from stakeholders has been taken into consideration
• legislative requirements/industry standards have been adopted
• the Petroleum Activities Program will be undertaken in a manner that prevents displacement of marine turtles from Habitat Critical/important internesting habitats during nesting/internesting periods
• the Petroleum Activities Program will be managed in a manner that is consistent with management objectives for relevant WHAs, AMPs, recovery plans and conservation plans/advices
• the predicted level of impact has been reduced to ALARP.
Environmental Performance Considerations
The Petroleum Activities Program will not disturb or displace any individuals from Habitat Critical or internesting BIAs, or result in any ecologically significant impacts at a population level for any species of marine turtle.
The following EPOs have been applied:</td></tr>
</table>

Demonstration of Acceptability		
Receptor	***Acceptability Criteria and Assessment***	***Statement of Acceptability***
	The impact assessment and proposed control measures are consistent with NOPSEMA Acoustic Impact Evaluation and Management Guideline (N-04750-IP1765 Rev2 Dec 2018). Nesting and internesting marine turtle habitats are identified as a natural value of the Montebello and Gascoyne AMPs. No significant impacts to internesting marine turtles are predicted and the Activity will be undertaken consistent with marine park objectives.	**EPO 4:** Far-field source levels for the selected seismic source for the Scarborough 4D B1 MSS are consistent with levels assessed in this EP. **EPO 6:** Limit underwater sound production from the seismic source to the area defined and assessed in this EP.
Migratory and threatened fishes and elasmobranchs (including whale sharks)	**Principles of ESD** The Petroleum Activities Program is consistent with the relevant principles of ESD: • The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making. • Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations. **Internal Context** The Petroleum Activities Program is consistent with Woodside corporate policies, culture, processes, standards, structure and systems as outlined in the Demonstration of ALARP and Environmental Performance Outcomes, including: • Woodside Health, Safety, Environment and Quality Policy (**Appendix A**) • Woodside Risk Management Policy (**Appendix A**). **External Context** During stakeholder consultation with relevant stakeholders no concerns specifically relating to fish were raised. **Other Requirements** There are no legislative requirements applicable to managing the effects of seismic surveys in relation to sharks. Seismic noise has not been identified as a threat to whale sharks (or other shark species identified as possibly present in the region) in recovery plans or wildlife conservation plans/advice. Noise pollution is not identified as a pressure to whale sharks in the Marine Bioregional Plan for the NWMR (DSEWPaC, 2012a). The impact assessment and proposed control measures are consistent with NOPSEMA Acoustic Impact Evaluation and Management Guideline (N-04750-IP1765 Rev2 Dec 2018).	The predicted level of impact for migratory and threatened fishes and elasmobranchs (including whale sharks) is considered to be of an acceptable level given that the: • the Petroleum Activities Program is consistent with the relevant principles of ESD • the proposed controls have considered the environmental consequence and are consistent with Woodside's internal policies, procedures and standards • feedback from stakeholders has been taken into consideration • legislative requirements/industry standards have been adopted • the Petroleum Activities Program will not will not result in physical injury to migratory and threatened fishes and elasmobranchs (including whale sharks) • the Petroleum Activities Program will be managed in a manner that is consistent with management objectives for relevant WHAs, AMPs, recovery plans and conservation plans/advices • the predicted level of impact has been reduced to ALARP. **Environmental Performance Considerations** The Petroleum Activities Program will not result in physical injury to migratory and threatened fishes and elasmobranchs (including whale sharks). The following EPOs have been applied:

<table>
<tr><th colspan="3">Demonstration of Acceptability</th></tr>
<tr><th>Receptor</th><th>Acceptability Criteria and Assessment</th><th>Statement of Acceptability</th></tr>
<tr><td></td><td></td><td> EPO 4: Far-field source levels for the selected seismic source for the Scarborough 4D B1 MSS are consistent with levels assessed in this EP. EPO 6: Limit underwater sound production from the seismic source to the area defined and assessed in this EP. </td></tr>
<tr><td>Fish spawning and commercial fisheries</td><td> Principles of ESD The Petroleum Activities Program is consistent with the relevant principles of ESD: The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making.
Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations. Internal Context The Petroleum Activities Program is consistent with Woodside corporate policies, culture, processes, standards, structure and systems as outlined in the Demonstration of ALARP and Environmental Performance Outcomes, including: Woodside Health, Safety, Environment and Quality Policy (Appendix A)
Woodside Risk Management Policy (Appendix A). External Context During stakeholder consultation with relevant persons no concerns specifically relating to fish spawning or commercial fisheries were raised. Potential impacts to fish spawning ahve been considered in this EP through review of overlap of behavioural response zones for fish and potential spawning areas, and demonstration that impacts and risks will be managed to levels that are ALARP. The potential impacts of noise emissions from the seismic source on spawning of key indicator commercial fish species are considered to be slight and short-term, and the Activity is not likely to result in any ecologically significant impacts at a population level for any key indicator commercial fish species that may be spawning within or adjacent to the Operational Area during acquisition activities. Similarly, the potential impacts on commercial catch rates are considered to be slight, as the activity is not likely to result in any ecologically significant impacts at a population level for any key indicator species and the Petroleum Activities Program is not located in an area targeted by commercial fisheries. Other Requirements </td><td> The predicted level of impact for fish spawning and commercial fisheries is considered to be of an acceptable level given that the: the Petroleum Activities Program is consistent with the relevant principles of ESD
the proposed controls have considered the environmental consequence and are consistent with Woodside's internal policies, procedures and standards
feedback from stakeholders has been taken into consideration
legislative requirements/industry standards have been adopted
the Petroleum Activities Program will not result in changes to the spawning biomass or changes in recruitment of commercially important species that may be discernible from normal natural variation
the Petroleum Activities Program will not impact commercial fishery catch rates
the predicted level of impact has been reduced to ALARP. Environmental Performance Considerations The Petroleum Activities Program will not result in changes to the spawning biomass or changes in recruitment of commercially important species that may be discernible from normal natural variation. The Petroleum Activities Program will not impact commercial fishery catch rates. The following EPOs have been applied: </td></tr>
</table>

<table>
<tr><th colspan="3">Demonstration of Acceptability</th></tr>
<tr><th>Receptor</th><th>Acceptability Criteria and Assessment</th><th>Statement of Acceptability</th></tr>
<tr><td></td><td>There are no legislative requirements applicable to managing the effects of seismic surveys in relation to fish spawning and commercial fisheries.
The proposed control measures are consistent with key mitigation strategies for seismic surveys published in the WA Department of Fisheries Guidance statement on undertaking seismic surveys in Western Australian waters (DoF, 2013) – e.g. use of soft starts; minimise the sound intensity and exposure time of surveys.
Woodside has also considered DPIRD’s ecological risk assessment of seismic impacts to marine finfish and invertebrates (Webster et al., 2018) during the assessment of impacts and risks to fish spawning and commercial fisheries, noting that the DPIRD risk assessment considers worst-case potential impacts to individual finfish and invertebrates assuming they do not move to avoid an approaching seismic source. This is not representative of real-life sound exposures and does not represent impacts at a population level. Woodside has, therefore, considered additional information to assess impacts to fish spawning and fish stock populations.
The impact assessment and proposed control measures are consistent with NOPSEMA Acoustic Impact Evaluation and Management Guideline (N-04750-IP1765 Rev2 Dec 2018).</td><td>EPO 4: Far-field source levels for the selected seismic source for the Scarborough 4D B1 MSS are consistent with levels assessed in this EP.
EPO 6: Limit underwater sound production from the seismic source to the area defined and assessed in this EP.</td></tr>
<tr><td>AMPs</td><td>Principles of ESD
The Petroleum Activities Program is consistent with the relevant principles of ESD:
• The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making.
• Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.
Internal Context
The Petroleum Activities Program is consistent with Woodside corporate policies, culture, processes, standards, structure and systems as outlined in the Demonstration of ALARP and Environmental Performance Outcomes, including:
• Woodside Health, Safety, Environment and Quality Policy (Appendix A)
• Woodside Risk Management Policy (Appendix A).
External Context
N/A
Other Requirements
The proposed controls and consequence/residual risk level are consistent with:</td><td>The predicted level of impact for AMPs is considered to be of an acceptable level given that the:
• the Petroleum Activities Program is consistent with the relevant principles of ESD
• the proposed controls have considered the environmental consequence and are consistent with Woodside’s internal policies, procedures and standards
• feedback from stakeholders has been taken into consideration
• legislative requirements/industry standards have been adopted
• the Petroleum Activities Program will not be inconsistent with the principles or management objectives of the North-west Marine Parks Network Management Plan (DNP, 2018a)
• the Petroleum Activities Program will be undertaken in a manner that is consistent with the zone management categories outlined in the North-west</td></tr>
</table>

Demonstration of Acceptability		
Receptor	***Acceptability Criteria and Assessment***	***Statement of Acceptability***
	• Australian IUCN Reserve Management Principles and objectives of the IUCN Category VI Zone, as outlined in the North-west Marine Parks Network Management Plan (DNP, 2018a) • the zone management categories outlined in the North-west Marine Parks Network Management Plan and values of the Montebello and Gascoyne AMPs.	Marine Parks Network Management Plan and values of the Montebello and Gascoyne AMPs • the predicted level of impact has been reduced to ALARP. **Environmental Performance Considerations** The Petroleum Activities Program will not impact the values or management objectives of AMPs or the North-west Marine Park Network. The following EPOs have been applied: **EPO 4:** Far-field source levels for the selected seismic source for the Scarborough 4D B1 MSS are consistent with levels assessed in this EP. **EPO 6:** Limit underwater sound production from the seismic source to the area defined and assessed in this EP.
Other environmental values (ecosystems/habitats, species and socio-economic)	**Principles of ESD** The Petroleum Activities Program is consistent with the relevant principles of ESD: • The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making. • Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations. **Internal Context** The Petroleum Activities Program is consistent with Woodside corporate policies, culture, processes, standards, structure and systems as outlined in the Demonstration of ALARP and Environmental Performance Outcomes, including: • Woodside Health, Safety, Environment and Quality Policy (**Appendix A**) • Woodside Risk Management Policy (**Appendix A**). **External Context** N/A **Other Requirements** No additional legislative requirements applicable to managing the effects of seismic surveys in relation to other identified environment values have been identified.	The predicted level of impact is considered to be of an acceptable level given that the: • the Petroleum Activities Program is consistent with the relevant principles of ESD • the proposed controls have considered the environmental consequence and are consistent with Woodside's internal policies, procedures and standards • feedback from stakeholders has been taken into consideration • legislative requirements/industry standards have been adopted • the Petroleum Activities Program will be managed in a manner that prevents any long term impacts to ecosystems/habitats, species and socio-economic values • the Petroleum Activities Program will be managed in a manner that is consistent with management objectives for relevant WHPs, AMPs, recovery plans and conservation plans/advices

Demonstration of Acceptability		
Receptor	***Acceptability Criteria and Assessment***	***Statement of Acceptability***
		• the predicted level of impact has been reduced to ALARP. **Environmental Performance Considerations** The Petroleum Activities Program will not result in long term impacts to ecosystems/habitats, species and socio-economic values. The following EPOs have been applied: **EPO 4:** Far-field source levels for the selected seismic source for the Scarborough 4D B1 MSS are consistent with levels assessed in this EP. **EPO 6:** Limit underwater sound production from the seismic source to the area defined and assessed in this EP.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 4 Far-field source levels for the selected seismic source for the Scarborough 4D B1 MSS are consistent with levels assessed in this EP.	**C 4.1** Seismic source validation.	**PS 4.1** In the event that a seismic source is selected for the Scarborough 4D B1 MSS that is significantly different to the modelled source[5], additional acoustic source modelling will be undertaken using the JASCO AASM model to confirm that the far-field horizontal source level specifications of the seismic source selected for the Scarborough 4D B1 MSS are comparable to those assessed in this EP.	**MC 4.1.1** Acoustic source modelling report for selected seismic source
EPO 5 Undertake seismic acquisition in a manner that prevents physical injury to whales	**C 5.1** Application of EPBC Policy Statement 2.1 Part A Standard Management Procedures and Part B.4 to whales, as outlined below: • observation zone: 3 km+ • shut-down zone: 2 km • observation and compliance reporting: ○ Use of vessel crew to supplement dedicated MFOs in marine fauna observations and monitoring compliance to Policy Statement 2.1. ○ Records kept of marine fauna observations during all surveys. • pre start-up visual observation (30 minutes) • soft start procedure (30 minutes) • start-up delay procedure (if sighting occurs) • operations procedure • stop work procedure • night-time and low visibility procedure.	**PS 5.1** EPBC Policy Statement 2.1 – Part A Standard Management Procedures and Part B.4 as outlined below: • observation zone: 3 km+ • shut-down zone: 2 km • observation and compliance reporting: ○ Use of vessel crew to supplement dedicated MFOs in marine fauna observations and monitoring compliance to Policy Statement 2.1. ○ Records kept of marine fauna observations during all surveys. • pre start-up visual observation (30 minutes) • soft start procedure (30 minutes) • start-up delay procedure (if sighting occurs) • operations procedure • stop work procedure • night-time and low visibility procedure.	**MC 5.1.1** Records demonstrate compliance with Policy Statement 2.1 Part A Standard Management Procedures and Part B.4.

[5] "Significantly different" is defined as a difference of 3 dB or greater than the modelled peak source pressure levels in the broadside, endfire and vertical directions (see Table 9 in Koessler et al., 2021; Appendix G), as determined by seismic contractor in-house modelling of their proposed array (e.g. Gundalf, Nucleus+ outputs).

	C 5.2 Application of EPBC Policy Statement 2.1 Part B.1 – MFOs: • Employ two dedicated MFOs to undertake observations for EPBC Act Policy Statement 2.1.	**PS 5.2** Two dedicated MFOs will be employed to undertake observations for EPBC Act Policy Statement 2.1.	**MC 5.2.1** Records demonstrate two dedicated MFOs are on board and undertake observations in accordance with EPBC Act Policy Statement 2.1.
	C 5.3 Application of EPBC Policy Statement 2.1 Part B.5 – PAM: • A PAM system will be installed aboard the survey vessel to detect odontocete whales (specifically sperm and beaked whales). • Employ two dedicated PAM operators wherever possible.	**PS 5.3.1** EPBC Policy Statement 2.1 Part B.5 – PAM. • PAM observations are undertaken on a 24-hour basis by two competent and experienced PAM Operators trained in the PAM system software used. • During daylight hours, PAM detections will be validated against MFO observations and ranges to determine the error (if any) in PAM detection distances. • At night and during periods of low visibility PAM will be used to trigger: o shutdown for any sperm and beaked whales detected in the 2 km shutdown zone.	**MC 5.3.1** Records demonstrate that an operational PAM system is aboard the survey vessel. Calibration records of PAM detections and visual observations during daylight hours. PAM Master Observation Sheet provides acoustic detection record for the surveys. Records (CV) verify the PAM Operators are competent to a standard equivalent to those in the International Association of Geophysical Contractors (IAGC) Guidance on the Use of Towed Passive Acoustic Monitoring during Geophysical Operations (IAGC, 2014).

		PS 5.3.2 If the PAM system has malfunctioned or become damaged during daylight/periods of good visibility, operations may continue for 20 minutes without PAM while the PAM operator diagnoses the issue. If the diagnosis indicates that the PAM equipment must be repaired to solve the problem, operations may continue for an additional 2 hours without PAM monitoring as long as all of the following conditions are met: • The PAM operator believes it can be repaired within this period • It is a period of good visibility • No marine mammals were detected solely by PAM in the relevant mitigation zones in the previous 2 hours • Two MFOs maintain watch at all times during operations when PAM is not operational • The time and location of all operations without an active PAM system are documented. Operations with an active source, but without an active PAM system, do not exceed a cumulative total of 4 hours in any 24 hour period. If the PAM system becomes non-operational at night or during periods of low visibility the seismic source will be shut down and acquisition will cease until such time as the system can be restored.	**MC 5.3.2** Records demonstrate that operations with an active source, but without an active PAM system do not exceed a cumulative total of 4 hours in any 24 hour period.

	C 5.4 Adaptive Management Measures to minimise the minimum potential impacts to pygmy blue whales from seismic noise. The following adaptive management measures procedures will be implemented: • If there are three or more sightings of pygmy blue whales within the 3 km observation zone within a 24-hour period, then the seismic operations must not be undertaken thereafter at night-time or during low visibility conditions. • Seismic operations cannot resume at night-time or during low visibility conditions, until there has been a cumulative 24-hour period of seismic operations (daylight hours with good visibility) during which less than three pygmy blue whales are sighted within the 3 km observation zone.	**PS 5.4** Adaptive Management Measures to minimise the minimum potential impacts to pygmy blue whales from seismic noise. The following adaptive management measures procedures will be implemented: • If there are three or more sightings of pygmy blue whales within the 3 km observation zone within a 24-hour period, then the seismic operations must not be undertaken thereafter at night-time or during low visibility conditions. • Seismic operations cannot resume at night-time or during low visibility conditions, until there has been a cumulative 24-hour period of seismic operations (daylight hours with good visibility) during which less than three pygmy blue whales are sighted within the 3 km observation zone.	**MC 5.4.1** Records demonstrate compliance with pygmy blue whale adaptive management measures as described.
	C 5.5 No operation of the seismic source within 25 km of the pygmy blue whale migration BIA.	**PS 5.5** No operation of the seismic source within 25 km of the pygmy blue whale migration BIA.	**MC 5.5.1** Records demonstrate compliance with the 25 km buffer from the migration BIA.
EPO 6 Limit underwater sound production from the seismic source to the area defined and assessed in this EP.	**C 6.1** No operation of the seismic source outside of the Active Source Area.	**PS 6.1** No operation of the seismic source outside of the Active Source Area.	**MC 6.1.1** Records demonstrate compliance with seismic source operation exclusively within the Active Source Area.
EPO 7 Undertake seismic acquisition in a manner that reduces potential cumulative impacts resulting from the Petroleum Activities Programme and other seismic survey operations as far as reasonably practicable.	**C 7.1** A 40 km separation distance between the Petroleum Activities Program and any identified concurrent seismic survey	**PS 7.1** A 40 km separation distance between the Petroleum Activities Program and any identified concurrent seismic survey	**MC 7.1.1** Records demonstrate compliance with the 40 km separation distance. Records demonstrate consultation with other seismic companies of seismic surveys and titleholders with acreage within 40 km of the Operational Area prior to commencement of the activity.

6.5.4 Routine Acoustic Emissions: Vessels and AUV

Context		
Project Vessels – **Section 3.6.5** AUV Nodes **– Section 3.6**	Physical Environment – **Section 4.4** Biological Environment – **Section 4.5**	Stakeholder Consultation – **Section 5**

Impact Evaluation Summary														
	Environmental Value Potentially Impacted							***Evaluation***						
Source of Impact	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl Odour)	Ecosystems/ Habitat	Species	Socioeconomic	Decision Type	Consequence/Impact	Likelihood	Risk Rating	ALARP Tools	Acceptability	Outcomes
Generation of noise from project vessels, AUV nodes and mechanical equipment during normal operations (excluding seismic survey equipment).						X		A	F	-	-	LCS GP	Broadly acceptable	EPO 8

Description of Source of Impact

During the Petroleum Activities Program, both atmospheric and underwater noise will be generated from the project vessels (seismic vessel and support vessel(s)) and AUV nodes during normal operations.

Project Vessels

Project vessels will generate noise, due to the operation of thruster engines, propeller cavitation, on-board machinery etc. These noises will contribute to and have the potential to exceed ambient noise levels which range from around 90 dB re 1 µPa (root square mean sound pressure level [SPL]) under very calm, low wind conditions, to 120 dB re 1µPa (SPL) under windy conditions (McCauley, 2005).

The sound level and frequency characteristics ('signature') of discernible ships depend on their size, number of propellers, number and type of propeller blades, blade biofouling condition and machinery/transmission maintenance condition. In general, the larger the ship the louder the source level and the lower its frequency. A typical support vessel's peak frequency or band ranges from 1–500 Hz at a peak source level of 170-190 dB re 1 µPa at 1 m. It is expected that similar noise levels will be generated by vessels used for this Petroleum Activities Program.

AUV and Commercial Nodes

Up to 50 seismic nodes (combined AUV and commercial nodes) will be deployed within the Active Source Area to collect seismic data. The AUV nodes use current AUV technology similar to Slocum gliders – these are autonomous vehicles that pump oil between an internal reservoir within the vehicle's housing and an external bladder to move up and down through the water column by changing buoyancy. While generally considered quiet, Slocum gliders produce self-noise in two ways; rudder noise produced by an electric servo-motor that controls the glider's rudder, and pump noise generated by the buoyancy engine pumping oil to and from the external bladder reservoir and glider housing to initiate dives and ascents (Haxel et al., 2019). Haxel et al. (2019) investigated the self-noise produced by a Teledyne Webb Research Slocum G2 glider in an open ocean environment. Short-duration rudder noise was most prominent within the frequency bands of <1 kHz and 2.6-4.4 kHz, with an increase in noise levels up to 30 dB re 1 µPa^2/Hz in these frequency bands (Haxel et al. 2019). Pump noise was characterised by long duration, high amplitude, impulse-like spikes covering the entire frequency range of the recording (Hazel et al. 2019).Küsel et al. (2017) report pump noise at sound levels up to around 135 dB re 1 µPa at 1.

Positioning of the AUV and commercial nodes will be supported by USBL acoustic positioning updates from the surface vessels. USBL transponders typically emit pulses of medium frequency sound, generally within the range 21 to 31 kHz. The estimated SPL would be 180 to 206 dB re 1 µPa at 1 m (Jiménez-Arranz et al., 2017). Transmissions are not continuous but consist of short 'chirps' with a duration that ranges from 3 to 40 milliseconds every one to five seconds.

The AUV nodes will be paired with equivalent commercial nodes to ground truth the technology in terms of the verification of seismic data recorded.

Impact Assessment
Potential Impacts to Environmental Values

Receptors

The Operational Area is located in water depths ranging from about 800 m to 1150 m. The fauna associated with this area will be predominantly pelagic fish species, with the potential for the transient presence of other species such as cetaceans, turtles and whale sharks (refer to **Section 4**).

There are no cetacean BIAs within the Operational Area, however the pygmy blue whale migration and feeding BIAs, and humpback whale migration BIA are located within the EMBA, approximately 14 km south-east, 154 km south-east and 138 km south-east of the Operational Area, respectively. Due to the proximity of the migration BIA to the Operational Area, the pygmy blue whale is the species most likely to occur within the Operational Area during their northern migration from April to July, and during their southern migration from October to January. However, the presence of all cetacean species, including the pygmy blue whale, is likely to be limited to infrequent occurrences of individuals or small groups.

There are no marine turtle BIAs or Habitat Critical areas within the Operational Area, however internesting buffer BIAs for the flatback, green, hawksbill and loggerhead turtles partially overlap with the wider EMBA. The nearest internesting buffer and Habitat Critical areas are for flatback turtles, located approximately 135 km south-east and 147 km south-east, respectively. The 80 km internesting buffer for flatback turtles in the Recovery Plan for Marine Turtles in Australia (DoEE, 2017a) is considered very conservative, and it is likely that the EMBA represents unsuitable internesting habitat (>25 m water depth and >27 km from the coastline) (Whittock et al., 2016). The occurrence of all marine turtle species within the Operational Area is expected to be limited to infrequent occurrences of transitory individuals.

The Operational Area does not represent important habitat for whale sharks. However, a whale shark foraging BIA is located approximately 136 km south-east of the Operational Area, and therefore due to the species widespread distribution and highly migratory nature, individuals may transit through the Operational Area.

Potential Impact of Noise

As described in **Section 6.5.3**, elevated underwater noise can affect marine fauna, including cetaceans, turtles, fish, sharks and rays in three main ways (Richardson et al., 1995; Simmonds et al., 2004):

- By causing direct physical effects on hearing or other organs. Hearing loss may be temporary (temporary threshold shift [TTS]; referred to as auditory fatigue), or permanent threshold shift (PTS; injury)
- By masking or interfering with other biologically important sounds (including vocal communication, echolocation, signals and sounds produced by predators or prey)
- Through disturbance leading to behavioural changes or displacement from important areas (e.g. BIAs). The occurrence and intensity of disturbance is highly variable and depends on a range of factors relating to the animal and situation.

The potential impacts associated with noise emissions from the seismic equipment are presented in **Section 6.5.3**, detail on impacts specific to noise from project vessels and AUV nodes are provided below.

Project Vessels

Noise generated by the project vessels is expected to be up to 190 dB re 1 µPa at 1 m. The potential for received levels to exceed weighted thresholds defined for PTS or TTS for marine mammals is considered not credible due to propagation and reduction of sound from the source. Behavioural response thresholds for marine mammals are estimated to be exceeded out to several kilometres from the project vessels. Currently, there are no quantitative sound exposure thresholds for behavioural responses in marine turtles resulting from continuous noise sources.

Marine fauna associated with the Operational Area will be predominantly pelagic fish species, with the potential for species such as whale sharks, rays, marine turtles and cetacean species to transit through the Operational Area. As outlined above, there are no marine fauna BIAs within the Operational Area. Therefore, potential impacts from vessel noise are likely to be restricted to temporary avoidance behaviour to individuals, and are therefore considered localised with no lasting effect.

Compliance with EPBC Regulation 2000 – Part 8 Interacting with Cetaceans to reduce the likelihood of collisions with cetaceans (i.e. vessels are to travel slower) may also further incidentally reduce the noise generated by vessels close to cetaceans and marine turtles—slower vessel speeds may reduce underwater noise.

In summary, potential impacts from vessel noise are likely to be restricted to temporary avoidance behaviour of individuals transiting through the Operational Area with no lasting effect. Individuals may deviate slightly from their activities, but are expected resume normal behaviours as they move away from the activities.

AUV Nodes

Self-noise produced by the AUVs may be audible to marine fauna at very close range to the AUVs, but with source levels in the order of around 135 dB re 1 µPa at 1 m, no significant disturbance is expected. Minor changes in behaviour in fish and other marine fauna that may occur within metres of an AUV may just as easily occur in response to the sight of an approaching AUV as much as the noise it produces. Such responses are expected to be incidental and insignificant.

USBL noise levels from the surface vessels may produce higher noise levels, albeit at frequencies that are above the

auditory range of most fish species. Mid-frequency cetaceans are the fauna group most likely to be able to detect the 21 to 31 kHz frequencies. With source levels of 180 to 206 dB re 1 µPa at 1 m, and assuming spherical spreading of underwater noise within close range of the source, behavioural responses may be limited to a few tens of meters. Relative to the high magnitude impulsive sound produced by the seismic source and continuous noise produced by the vessel engines, noise from AUV nodes and supporting USBL operations are expected to be insignificant.
Summary of Potential Impacts to environmental value(s)
Given the adopted controls, it is considered that noise generated by project vessels and AUV nodes will not result in a potential impact greater than a localised, temporary disruption to a small portion of the population for any marine fauna species exposed, with no lasting effects.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)*** [6]	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
EPBC Regulations 2000 –Part 8 Division 8.1 Interacting with cetaceans including the following measures: • Project vessels will not travel greater than six knots within 300 m of a cetacean or turtle (caution zone) • Project vessels will not approach closer than 50 m for a dolphin or turtle and/or 100 m for a whale (with the exception of animals bow riding). • If the cetacean or turtle shows signs of being disturbed, project vessels will immediately withdraw from the caution zone at a constant speed of less than 6 knots. • Vessels will not travel greater than eight knots within 250 m of a whale shark and not allow the vessel to approach closer than 30 m of a whale shark. ***Exception***: The above requirement does not apply to project vessels operating under limited/constrained manoeuvrability	F: Yes CS: Minimal reduction in vessel speed and manoeuvrability resulting in minimal delay	By managing the interactions with cetaceans and restricting the proximity between vessels and cetaceans, impacts from vessel-generated noise are reduced.	Control is a legislative requirement – must be adopted	Yes **C 8.1**

[6] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)*** [6]	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
including but not limited to seismic vessel towing equipment and acquiring data, and in the event of an emergency				
Good Practice				
None identified.				
Professional Judgement – Eliminate				
Eliminate generation of noise from vessels and AUV nodes.	F: No. The generation of noise from project vessels and AUV nodes cannot be eliminated due to operating requirements. CS: Inability to conduct the Petroleum Activities Program.	Not considered – control not feasible.	Not considered – control not feasible.	No
Eliminate use of vessels.	F: No. The use of vessels is required to conduct the Petroleum Activities Program. CS: Not considered – control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No
Eliminate use of AUV nodes.	F: Yes. Woodside would be able to continue to acquire the seismic survey without the use of AUV nodes, given the seismic vessel will be towing streamer(s) that can listen to/record the seismic signal. However, the use of AUV nodes has the potential to improve both seismic data quality and duration of future seismic surveys. CS: No additional costs. Inability to confirm the functionality and performance of the novel technology on a commercial-scale seismic survey.	Eliminates the potential for the AUV nodes to add to the noise levels generated by the Petroleum Activities Program.	Although the control would eliminate the potential for noise to be generated by the AUV nodes, it would result in the inability for Woodside to confirm the functionality and performance of the novel technology on a commercial-scale seismic survey. Therefore, delaying Woodside's ability to advance technological advancements in acquiring seismic data.	No
Conduct the Petroleum Activities Program away from sensitive receptors	F: No. The location of the petroleum activities is determined by the predicted location of hydrocarbons and the legislative requirement to explore for hydrocarbons CS: Requirement to conduct activity.	Not considered – control not feasible.	Not considered – control not feasible.	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)*** [6]	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Professional Judgement – Substitute				
None identified.				
Professional Judgement – Engineered Solution				
None identified.				
ALARP Statement On the basis of the environmental impact assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to manage the impacts and risks of project vessel noise emissions. As no reasonable additional/alternative controls were identified that would further reduce the impacts and risks without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that, given the adopted controls, project vessel noise disturbance are unlikely to result in a potential impact greater than localised and temporary disruption to a small proportion of the population, with no lasting effects, and no impact on critical habitat or activity. Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice and meet the requirements of Part 8 (Division 8.1) of the EPBC Regulations 2000. The potential impacts and risks are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks of vessel noise emissions to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 8 Minimise impacts of noise generated from the Petroleum Activities Program on threatened and migratory cetacean species listed under the EPBC Act in the Operational Areas	**C 8.1** EPBC Regulations 2000 –Part 8 Division 8.1 Interacting with cetaceans including the following measures: • Project vessels will not travel greater than 6 knots within 300 m of a cetacean or turtle (caution zone) • Project vessels will not approach closer than 50 m for a dolphin or turtle and/or 100 m for a whale (with the exception of animals bow riding). • If the cetacean or turtle shows signs of being disturbed, project vessels will immediately withdraw from the caution zone at a constant speed of less than 6 knots. • Vessels will not travel greater than 8 knots within 250 m of a whale shark and not allow the vessel to approach closer than 30 m of a whale shark. ***Exception:*** The above requirement does not apply to project vessels operating under limited/constrained manoeuvrability including but not limited to seismic vessel towing equipment and acquiring data, and in the event of an emergency.	**PS 8.1** Compliance with EPBC Regulations 2000 – Part 8 Division 8.1 Interacting with cetaceans, to minimize impacts from underwater noise emissions.	**MC 8.1.1** Records demonstrate compliance with the EPBC Regulations 2000 (Part 8 Division 8.1).

6.5.5 Routine Atmospheric Emissions: Fuel Combustion

Context		
Project Vessels – **Section 3.6.5**	Physical Environment – **Section 4.4**	Stakeholder Consultation – **Section 5**

Impact Evaluation Summary														
Source of Impact	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl Odour)	Ecosystems/ Habitat	Species	Socioeconomic	Decision Type	Consequence/Impact	Likelihood	Risk Rating	ALARP Tools	Acceptability	Outcomes
Exhaust emissions from internal combustion engines and incinerators on project vessels within the Operational Area.				X				A	F	-	-	LCS	Broadly Acceptable	EPO 9

Description of Source of Impact
Atmospheric emissions will be generated by the project vessels from internal combustion engines (including all equipment and generators) and incineration activities (including onboard incinerators) during the Petroleum Activities Program. Emissions will include SO_2, NO_x, ozone depleting substances, CO_2, particulates and volatile organic compounds (VOCs).

Impact Assessment
Potential Impacts to Environmental Values
Fuel combustion has the potential to result in localised, temporary reduction in air quality. Potential impacts include a localised reduction in air quality and contribution to greenhouse gas emissions. Given the short duration and exposed location of project vessels (which will lead to the rapid dispersion of the low volumes of atmospheric emissions), the potential impacts are expected to be localised and of no lasting effect.
Summary of Potential Impacts to Environmental Values(s)
Given the adopted controls, it is considered that the release of a small volume of greenhouse gases will not result in a potential impact greater than a temporary impact to local air quality with no lasting effect.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)*** [7]	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Marine Order 97 (Marine Pollution Prevention – Air Pollution), which details requirements for: • International Air Pollution Prevention (IAPP) Certificate,	F: Yes CS: Minimal cost	Legislative requirements to be followed may reduce the consequences of air pollution.	Control based on legislative requirements – must be adopted	Yes **C 9.1**

[7] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)*** [7]	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
required by vessel class • use of low sulphur fuel (shall not exceed 0.50% m/m) • Ship Energy Efficiency Management Plan, where required by vessel class • onboard incinerator to comply with Marine Order 97.				
Good Practice				
None identified.				
Professional Judgement – Eliminate				
Do not combust fuel.	F: No. There are no vessels that do not use internal combustion engines. CS: Not considered, control not feasible.	Not considered, control not feasible.	Not considered, control not feasible.	No
Professional Judgement – Substitute				
None identified.				
Professional Judgement – Engineered Solution				
None identified.				
ALARP Statement On the basis of the environmental risk assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to manage the potential impacts of release of atmospheric emissions within the Operational Area. As no reasonable additional/alternative controls were identified that would further reduce the impacts without grossly disproportionate sacrifice, the impacts are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that, given the adopted controls, atmospheric emissions during the Petroleum Activities Program will not result in a potential impact greater than a temporary decrease in local air quality with low impact to the environment or human health and no lasting effects. Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice. Therefore, Woodside considers the adopted controls appropriate to manage the impacts of the described emissions within the Operational Area to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 9 Fuel combustion emissions and incineration during the Petroleum Activities Program will be in compliance with marine order requirements to restrict emissions to those necessary to perform the activity.	**C 9.1** Marine Order 97 (Marine Pollution Prevention – Air Pollution) which details requirements for: • International Air Pollution Prevention (IAPP) Certificate, required by vessel class • use of low sulphur fuel (shall not exceed 0.50% m/m) • Ship Energy Efficiency Management Plan, where required by vessel class • onboard incinerator to comply with Marine Order 97.	**PS 9.1** Project vessels compliant with Marine Order 97 (marine pollution prevention – air pollution) to restrict emissions to those necessary to perform the activity. Vessel marine assurance process implemented, to ensure suitability and compliance with vessel combustion certification/ Marine Order requirements.	**MC 9.1.1** Records demonstrate compliance with Marine Order 97.

6.5.6 Routine Discharge: Bilge Water, Grey Water, Sewage, Putrescible Wastes and Deck Drainage Water

Context		
Project Vessels – **Section 3.6.5**	Physical Environment – **Section 4.4** Biological Environment – **Section 4.5**	Stakeholder Consultation – **Section 5**

Impact Evaluation Summary

Source of Impact	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl Odour)	Ecosystems/ Habitat	Species	Socioeconomic	Decision Type	Consequence/Impact	Likelihood	Risk Rating	ALARP Tools	Acceptability	Outcomes
Routine discharge of sewage, grey water and putrescible wastes to marine environment from project vessels within the Operational Area			X		X			A	F	-	-	LCS	Broadly acceptable	EPO 10
Routine discharge of deck and bilge water to marine environment from project vessels within the Operational Area			X		X			A	F	-	-			

Description of Source of Impact

The project vessels routinely generate/discharge:

- Small volumes of treated sewage, putrescible wastes and grey water to the marine environment (impact assessment based on approximate discharge of 15 m³ per vessel per day), using an average volume of 75 L/person/day and a maximum of 200 persons on board. However, it is noted that these vessels will have considerably less persons on board.
- Routine/periodic discharge of relatively small volumes of bilge water. Bilge tanks on the project vessels receive fluids from many parts of the vessel. Bilge water can contain water, oil, detergents, solvents, chemicals, particles and other liquids or solids.
- Variable water discharge from project vessel decks directly overboard or via deck drainage systems. Water sources could include rainfall events and/or from deck activities such as cleaning/wash-down of equipment/decks.

Routine discharges generated from the Petroleum Activities Program have the potential to cause temporary and localised reduction in water quality.

Environmental risk relating to the disposal/discharges above regulated levels or incorrect disposal/discharge of waste would be unplanned (non-routine/accidental) and are addressed in **Section 6.6.5.**

Impact Assessment

Potential Impacts to Environmental Values

The main environmental impact associated with ocean disposal of sewage and other organic wastes (i.e. putrescible waste) is eutrophication. Eutrophication occurs when the addition of nutrients, such as nitrates and phosphates, causes adverse changes to the ecosystem, such as oxygen depletion and phytoplankton blooms. Other contaminants of concern occurring in these discharges may include ammonia, E. coli, faecal coliform, volatile and semi-volatile organic compounds, phenol, hydrogen sulphide, metals, surfactants and phthalates.

Woodside monitored sewage discharges at its Torosa-4 Appraisal Drilling campaign which demonstrated that a 10 m³ sewage discharge reduced to about 1% of its original concentration within 50 m of the discharge location. In addition to this, monitoring at distances of 50, 100 and 200 m downstream of the platform 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 (Woodside Energy Limited, 2011). Mixing and dispersion would be further facilitated in deep offshore waters, consistent with the location of the Operational Area, through regional wind and large scale current patterns resulting in the rapid mixing of surface and near surface waters where sewage discharges may occur. Studies investigating 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 (McIntyre and Johnston, 1975). Furthermore, open marine waters do not typically support areas of increased ecological sensitivity, due to the lack of nutrients in the upper water column and lack of light penetration at depth. Therefore, presence of receptors such as fish, reptiles, birds and cetaceans, in significant numbers within the Operational Area is unlikely. Research also suggests that zooplankton composition and distribution are not affected in areas associated with sewage dumping grounds (McIntyre and Johnston, 1975). Plankton communities are expected to rapidly recover from any such short-term, localised impact, as they are known to have naturally high levels of mortality and a rapid replacement rate. Other discharges outlined, which may include other non-organic contaminants (e.g. bilge water) will be rapidly diluted through the same mechanisms as above and are expected to be in very small quantities and concentrations as to not pose any significant risk to any relevant receptors. As such, no significant impacts from the planned discharges that are listed above are anticipated because of the minor quantities involved, the expected localised mixing zone and high level of dilution into the open water marine environment of the Operational Area. The Operational Area is more than 12 nm from land, which exceeds the 12 nm exclusion zones required under the relevant Marine Orders.
Summary of Potential Impacts to Environmental Values(s)
Given the adopted controls, it is considered that routine discharges described will not result in a potential impact greater than localised contamination not significant to environmental receptors, with no lasting effect.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)*** [8]	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Marine Orders 95 – pollution prevention – Garbage (as appropriate to vessel class), which requires putrescible waste and food scraps to pass through a macerator so it is capable of passing through a screen with no opening wider than 25 mm.	F: Yes CS: Minimal cost. Standard practice.	No reduction in consequence would result.	Controls based on legislative requirements – must be adopted.	Yes **C 10.1**
Marine Orders 96 - pollution prevention – sewage (as appropriate to vessel class), specifically: • a valid International Sewage Pollution Prevention (ISPP) Certificate, as required by vessel class • an ASMA approved sewage treatment plant	F: Yes CS: Minimal cost. Standard practice.	No reduction in consequence would result.	Controls based on legislative requirements – must be adopted.	Yes **C 10.2**

[8] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)*** [8]	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
• sewage commuting and disinfecting system • a sewage holding tank sized appropriately to contain all generated waste (black and grey water) • discharge of sewage which is not comminuted or disinfected will only occur at a distance of more than 12 nm from the nearest land • discharge of sewage which is comminuted or disinfected using a certified approved sewage treatment plant will only occur at a distance of more than 3 nm from the nearest land • discharge of sewage will occur at a moderate rate while the vessel is proceeding (>4 knots), to avoid discharges in environmentally sensitive areas.				
Marine Orders 91 – oil (as relevant to vessel class) requirements, which include mandatory measures for the processing of oily water prior to discharge: • machinery space bilge/oily water shall have International Maritime Organisation (IMO) approved oil filtering equipment (oil/water separator) with an on-line monitoring device to measure Oil in Water (OIW) content to be less than 15 ppm prior to discharge	F: Yes CS: Minimal cost. Standard practice.	No reduction in consequence would result.	Controls based on legislative requirements – must be adopted.	Yes **C 10.3**

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)*** [8]	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
• IMO approved oil filtering equipment shall also have an alarm and an automatic stopping device or be capably of recirculating in the event that OIW concentration exceeds 15 ppm • a deck drainage system shall be capable of controlling the content of discharges for areas of high risk of fuel/oil/grease or hazardous chemical contamination • there shall be a waste oil storage tank available, to restrict oil discharges • in the event that machinery space bilge discharges cannot meet the oil content standard of <15 ppm without dilution or be treated by an IMO approved oil/water separator, they will be contained on-board and disposed of onshore • a valid IOPP Certificate, as required by vessel class.				
Good Practice				
None identified.				
Professional Judgement – Eliminate				
Storage, transport and treatment/ disposal onshore treatment of sewage, greywater, putrescible and bilge wastes.	F: No. Would present additional safety and hygiene hazards resulting from the storage, loading and transport of the waste material. CS: Not considered – control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No
Professional Judgement – Substitute				
None identified.				

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)*** [8]	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Professional Judgement – Engineered Solution				
None identified.				
ALARP Statement On the basis of the environmental impact assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to manage the impacts of planned routine discharges from the project vessels. As no reasonable additional/alternative controls were identified that would further reduce the impacts and risks without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement
The impact assessment has determined that, given the adopted controls, planned (routine) discharges from projects vessels are unlikely to result in a potential impact greater than a temporary contamination above background levels and/or national/international quality standards and/or known biological effect concentrations outside a localised mixing zone with no lasting effect. Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice and meet legislative requirements under Marine Orders 91, 95 and 96. Therefore, Woodside considers the adopted controls appropriate to manage the impacts of these discharges to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 10 No impact to water quality greater than a consequence level of F[9] from discharge of sewage, greywater, putrescible wastes, bilge and deck drainage to the marine environment during the Petroleum Activities Program.	**C 10.1** Marine Orders 95 – pollution prevention – Garbage (as appropriate to vessel class), which requires putrescible waste and food scraps to pass through a macerator so it is capable of passing through a screen with no opening wider than 25 mm.	**PS 10.1** Project vessels compliant with Marine Orders 95 – pollution prevention – Garbage.	**MC 10.1.1** Records demonstrate project vessels are compliant with Marine Orders 95 – pollution prevention (as appropriate to vessel class).
	C 10.2 Marine Orders 96 - pollution prevention – sewage (as appropriate to vessel class) specifically: • a valid International Sewage Pollution Prevention (ISPP) Certificate, as required by vessel class • an ASMA approved sewage treatment plant • sewage commuting and disinfecting system • a sewage holding tank sized appropriately to contain all generated	**PS 10.2** Project vessels compliant with Marine Order 96 - pollution prevention – sewage (as appropriate to vessel class).	**MC 10.2.1** Records demonstrate project vessels are compliant with Marine Orders 96 - pollution prevention – sewage (as appropriate to vessel class).

[9] Defined as 'No lasting effect (<1 month) or negligible impact. Localised impact not significant to environmental receptors.'

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
	waste (black and grey water) • discharge of sewage which is not comminuted or disinfected will only occur at a distance of more than 12 nm from the nearest land • discharge of sewage which is comminuted or disinfected using a certified approved sewage treatment plant will only occur at a distance of more than 3 nm from the nearest land • discharge of sewage will occur at a moderate rate while the vessel is proceeding (>4 knots), to avoid discharges in environmentally sensitive areas.		
	C 10.3 Marine Orders 91 – oil (as relevant to vessel class) requirements, which include mandatory measures for the processing of oily water prior to discharge: • machinery space bilge/oily water shall have International Maritime Organisation (IMO) approved oil filtering equipment (oil/water separator) with an on-line monitoring device to measure Oil in Water (OIW) content to be less than 15 ppm prior to discharge • IMO approved oil filtering equipment shall also have an alarm and an automatic stopping device or be capably of recirculating in the event that OIW concentration exceeds 15 ppm • a deck drainage system shall be capable of controlling the content of discharges for areas of high risk of fuel/oil/grease or hazardous chemical contamination	**PS 10.3** Deck drainage and bilge water will be discharged to meet the oil content standard of <15 ppm without dilution	**MC 10.3.1** Records demonstrate discharge specification met for project vessels.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
	• there shall be a waste oil storage tank available, to restrict oil discharges • in the event that machinery space bilge and deck drainage discharges cannot meet the oil content standard of <15 ppm without dilution or be treated by an IMO approved oil/water separator, they will be contained on-board and disposed of onshore • a valid IOPP Certificate, as required by vessel class.		

6.5.7 Routine Light Emissions: External Lighting on Project Vessels

Context		
Project Vessels – **Section 3.6.5**	Physical Environment – **Section 4.4** Biological Environment – **Section 4.5**	Stakeholder Consultation – **Section 5**

Impact Evaluation Summary

Source of Impact	*Environmental Value Potentially Impacted*							*Evaluation*						
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl Odour)	Ecosystems/ Habitat	Species	Socioeconomic	Decision Type	Consequence/Impact	Likelihood	Risk Rating	ALARP Tools	Acceptability	Outcomes
Routine light emissions from project vessels within the Operational Area.						X		A	F	-	-	LCS GP	Broadly acceptable	N/A

Description of Source of Impact

Routine light emissions include light sources that alter the ambient light conditions in an environment. Project vessels (including the seismic vessel) will routinely use external lighting to navigate and conduct safe operations at night throughout the Petroleum Activities Program. External light emissions from project vessels are typically managed to maintain good night vision for crew members. Vessel lighting will also be used to communicate the vessel's presence to other marine users (i.e. navigation/warning lights). Lighting is required for safely operating project vessels and cannot reasonably be eliminated.

The vessels that may be required for the Petroleum Activities Program in the Operational Area are outlined in **Section 3.6.5**. External lighting is located on the vessel decks, with most external lighting directed towards working areas such as the main decks. These areas are typically <20 m above sea level.

Lighting from vessels may appear as a direct light source from an unshielded lamp with direct line of sight to the observer or through sky glow. Direct lighting falling upon a surface is referred to as light spill. Sky glow is the diffuse glow caused by light that is screened from view, but through reflection and refraction creates a glow in the atmosphere. The distance at which direct light and sky glow may be visible from the source depends on the vessel lighting and environmental conditions.

Impact Assessment

Potential Impacts to Environmental Values

Receptors that have important habitat within a 20 km radius of the Operational Area were considered for the impact assessment, based on recommendations of the National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds (NLPG). The 20 km threshold provides a precautionary limit based on observed effects of sky glow on marine turtle hatchlings demonstrated to occur at 15–18 km and fledgling seabirds grounded in response to artificial light 15 km away (NLPG, 2020).

Light emissions can affect fauna in two main ways:

- Behaviour: Many species are adapted to natural levels of lighting and the natural changes associated with the day and night cycle as well as the night-time phases of the moon. However, artificial lighting has the potential to create a constant level of light at night that can override these natural levels and cycles.
- Orientation: Species such as marine turtles and birds may also use lighting from natural sources to orient themselves in a certain direction at night. If an artificial light source is brighter than a natural source, the artificial light may override natural cues, leading to disorientation.

The fauna within and immediately adjacent to the Operational Area are predominantly pelagic fish and zooplankton, with a low abundance of transient species such as marine turtles, whale sharks, cetaceans and migratory shorebirds and seabirds.

Marine Turtles – Hatchlings

Turtle hatchlings emerge from the nest and orient towards the sea. After entering the water, hatchlings use a combination of cues (wave direction and currents) to orient and travel into offshore waters. Impacts to the sea-finding behaviour of hatchlings are more common for light sources behind a beach, as lighting offshore will orient emerging hatchlings towards the sea. Artificial light at close distances can also impact hatchling dispersal once they are in the water. Light spill may 'entrap' hatchling swimming behaviour, reducing the success of their seaward dispersion and potentially increasing their exposure to predators via silhouetting (Salmon et al., 1992).

Flatback turtle hatchlings do not undertake oceanic migrations offshore to deep, pelagic waters. Instead juveniles grow to maturity in shallow coastal waters close to their natal beaches (Musick and Limpus, 1996).

The nearest nesting sites in relation to the Operational Area are Barrow Island and the Montebello Islands (over 200 km east of the Operational Area); therefore, sky glow and light spill from project vessels will not reach any nesting beach. Any impacts to hatchling turtles from artificial light will be limited to possible localised behavioural impacts to isolated individual hatchlings offshore, with no lasting effect to the species.

Marine Turtle – Adults

Although individuals undertaking behaviours such as internesting, migration, mating (adults) or foraging (adults and pelagic juveniles) may occur within Operational Area, marine turtles do not use light cues to guide these behaviours. Furthermore, there is no evidence, published or anecdotal, to suggest that internesting, mating, foraging or migrating turtles are impacted by light from offshore vessels. As such, light emissions from the vessels are unlikely to result in displacement of, or behavioural changes to individuals in these life stages (Pendoley Environmental [PENV], 2020).

Artificial lighting may affect the location where nesting adult turtles emerge onto the beach, the success of nest construction, whether nesting is abandoned, and the seaward return of adults (Salmon et al., 1995a, 1995b; Salmon and Witherington, 1995). Such lighting is typically from residential and industrial development at the coastline, rather than offshore from nesting beaches. Barrow Island and the Montebello Islands (over 200 km east of the Operational Area) are known nesting locations, however, light from the project vessels will not be visible as sky glow or light spill to nesting adult turtles. As such, vessel light sources will not discourage females from nesting, or affect nest site selection, and therefore will not displace females from nesting habitat.

There is no emergent habitat within the Operational Area and therefore nesting aggregations of marine turtles would not be expected. There are no BIAs or Habitat Critical to the survival of marine turtles within the Operational Area. The nearest BIAs and Habitat Critical are for flatback turtles are located approximately 135 km south-east and 147 km south-east of the Operational Area, respectively. The 80 km internesting buffer for flatback turtles in the Recovery Plan for Marine Turtles in Australia (DoEE, 2017a) is considered very conservative. There is no evidence to date to indicate that flatback turtles swim out into deep offshore waters during the internesting period. Additionally, suitable areas of internesting habitat were located close to many known flatback turtle rookeries across the region (Whittock et al., 2016).

The presence of marine turtles in the Operational Area is considered highly unlikely. Light emissions from project vessels are unlikely to result in more than localised behavioural disturbance to isolated transient individuals, with no lasting effect to the species.

Seabirds

Artificial lighting can attract and disorient seabird species resulting in species behavioural changes (e.g. circling light sources or disrupted foraging), injury or mortality near the light source as a result of collision (Longcore and Rich, 2004, Gaston et al., 2014). The Operational Area may be occasionally visited by seabirds; however, there is no emergent land that could be used for roosting or nesting habitat within the Operational Area. The nearest shoreline is Barrow Island (over 200 km east of the Operational Area). In addition, the Operational Area does not overlap with any BIAs or critical habitat for any bird species.

The risk associated with collision from seabirds attracted to the light is considered to be low, given the slow moving speed of project vessels within the Operational Area. Impacts are expected to be limited to temporary behavioural disturbance to isolated individuals, with no lasting effect or displacement from important habitat.

Other Marine Fauna

Lighting from project vessel activities in the Operational Area may result in the localised aggregation of fish around the vessel. These aggregations of fish due to light are considered localised and temporary. Any long-term changes to fish species composition or abundance is considered highly unlikely. Any localised impacts to fish are not expected to impact on any commercial fisheries in the area. Krill or plankton may also aggregate around the source of light. These aggregations of fish, krill or plankton would be confined to a small area. Based on the short duration and localised nature of the Petroleum Activities Program, these aggregations are not expected to attract pygmy blue whales, humpback whales or whale sharks.

Summary of Potential Impacts to Environmental Values(s)

Light emissions from project vessels will not result in an impact greater than a localised and temporary disturbance to marine fauna in the vicinity of the Operational Area with no lasting effect to any species (i.e. Environmental Impact – F).

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)*** [10]	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
None identified.				
Good Practice				
None identified.				
Professional Judgement – Eliminate				
Restrict the Petroleum Activities Program to daylight hours, eliminating the need for external work lights	F: Yes. Restricting the Petroleum Activities Program to daylight hours is technically feasible, although not considered to be reasonably practicable. CS: Significant cost sacrifice. Limiting the survey to daylight hours would significantly increase the duration of the survey, and therefore result in further potential for interference with other marine users (in particular commercial fisheries).	Negligible reduction in consequence given the duration and nature of the activity.	Grossly disproportionate. Implementation of the control requires considerable cost sacrifice for minimal environmental benefit.	No
Professional Judgement – Substitute				
None identified.				
Professional Judgement – Engineered Solution				
None identified.				
ALARP Statement On the basis of the environmental risk assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the potential impacts from routine light emissions from project vessels within the Operational Area to be ALARP. This includes consideration of the nature of light emissions for the duration of the Petroleum Activities Program, and the requirements for external lighting for safe operations. As no reasonable additional/alternative controls were identified that would further reduce the impacts and risks without grossly disproportionate sacrifice, the impacts are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that routine light emissions from project vessels may result in impacts limited to temporary behavioural disturbance to marine fauna within a localised area and with no lasting effect on any species. Further opportunities to reduce the impacts have been investigated above. Regard has been given to relevant conservation advice and wildlife conservation plans during the assessment of potential impacts and the NLPG were taken into consideration during the impact evaluation. Therefore, Woodside considers standard operations appropriate to manage the impacts and risks of routine light emissions to a level that is broadly acceptable.

[10] Qualitative measure

6.6 Unplanned Activities (Accidents, Incidents, Emergency Situations)

6.6.1 Quantitative Spill Risk Assessment Methodology

Quantitative hydrocarbon spill modelling was undertaken by RPS (2019), on behalf of Woodside, using a three-dimensional (3D) hydrocarbon spill trajectory and weathering model, SIMAP (Spill Impact Mapping and Analysis Program), which is designed to simulate the transport, spreading and weathering of specific hydrocarbon types under the influence of changing meteorological and oceanographic forces.

A stochastic modelling scheme was followed in this study, whereby SIMAP was applied to repeatedly simulate the defined credible spill scenarios using different samples of current and wind data. These data samples were selected randomly from an historic time-series of wind and current data representative of the study area. Results of the replicate simulations were then statistically analysed and mapped to define contours of percentage probability of contact at identified thresholds around the hydrocarbon release point.

The model simulates surface releases and uses the unique physical and chemical properties of a hydrocarbon type to calculate rates of evaporation and viscosity change, including the tendency to form oil in water emulsions. Moreover, the unique transport and dispersion of surface slicks and in-water components (entrained and dissolved) are modelled separately. Thus, the model can be used to understand the wider potential consequences of a spill, including direct contact of hydrocarbons due to surface slicks (floating hydrocarbon) and exposure of organisms to entrained and dissolved aromatic hydrocarbons in the water column.

During each simulation, the SIMAP model records the location (by latitude, longitude and depth) of each of the particles (representing a given mass of hydrocarbons) on or in the water column, at regular time steps. For any particles that contact a shoreline, the model records the accumulation of hydrocarbon mass that arrives on each section of shoreline over time, less any mass that is lost to evaporation and/or subsequent removal by current and wind forces.

The collective records from all simulations are then analysed by dividing the study region into a 3D grid. For surface hydrocarbons (floating oil), the sum of the mass in all hydrocarbon particles located within a grid cell, divided by the area of the cell, provides hydrocarbon concentration estimates in that grid cell at each model output time interval. For entrained and dissolved aromatic hydrocarbon particles, concentrations are calculated at each time step by summing the mass of particles within a grid cell and dividing by the volume of the grid cell. The process is also subject to the application of spreading filters that represent the expected mass distribution of each distinct particle. The concentrations of hydrocarbons calculated for each grid cell, at each time step, are then analysed to determine whether concentration estimates exceed defined threshold concentrations.

All hydrocarbon spill modelling assessments undertaken by RPS undergo initial sensitivity modelling to determine appropriate time to add to the simulation after the cessation of the spill. The amount of time following the spill is based on the time required for the modelled concentrations to practically drop below threshold concentrations anywhere in the model domain in the test cases. This assessment is done by post-processing the sensitivity test results and analysing time-series of median and maximum concentrations in the water and on the surface.

6.6.1.1 Hydrocarbon Characteristics

As part of the risk identification process, Woodside identified the range of credible hydrocarbon spill scenarios that may occur from the Petroleum Activities Program. These scenarios are considered in the risk assessments of accidental hydrocarbon spill scenarios (refer to **Section 6.6.2**).

The characteristics of the hydrocarbons, used as the basis for the modelling studies used to inform the assessment, are summarised in**Table 6-13**.

Table 6-13: Hydrocarbon characteristics

Hydrocarbon Type	Initial Density (g/cm³)	Viscosity (cP)	Component BP (°C)	Volatiles <180 °C	Semi volatiles 180–265 °C	Low Volatility (%) 265–380 °C	Residual (%) >380 °C	Aromatic (%) of whole oil <380 °C BP
				Non-Persistent			Persistent	
Marine diesel	0.829 @ 25 °C	4.0 @ 25 °C	% of total	6.0	34.6	54.4	5.0	3.0
			% aromatics	1.8	1.0	0.2	-	-

6.6.1.2 Environment that May Be Affected and Hydrocarbon Contact Thresholds

The outputs of the quantitative hydrocarbon spill modelling are used to assess the environmental risk if a credible hydrocarbon spill scenario occurred, by delineating which areas of the marine environment could be exposed to hydrocarbon levels exceeding the adopted hydrocarbon threshold concentrations (see **Table 6-14**). The summary of all the locations where hydrocarbon thresholds could be exceeded by any of the simulations modelled is defined as the 'environment that may be affected' (EMBA; **Section 4.1**), which is driven by the worst-case credible hydrocarbon spill scenario. For this Petroleum Activities Program the worst-case credible hydrocarbon spill scenario is a vessel collision resulting in fuel tank rupture (see **Section 6.6.2**).

As the weathering of different fates of hydrocarbons (surface, entrained and dissolved) differs due to the influence of the metocean mechanism of transportation, the EMBA combines the potential spatial extent of the different hydrocarbon fates. Note, no shoreline accumulation of hydrocarbons above threshold concentrations resulted from the modelled worst-case credible spill.

The EMBA covers a larger area than that which will be affected during any single spill event, as the model was run for a variety of weather and metocean conditions (100 simulations in total at one release location). The EMBA therefore represents the total extent of all the locations where the adopted hydrocarbon thresholds could be exceeded from all modelling runs. Given the EMBA comprises the results of many individual simulations, the total area covered at the thresholds has been smoothed to create a continuous boundary for the purpose of describing the environment within it.

A conservative approach for defining thresholds for the EMBA was used by adopting the guideline impact thresholds (NOPSEMA 2019) for floating, entrained, dissolved and accumulated hydrocarbons. An additional threshold has been included to define the boundary within which socio-cultural impacts may occur, based on surface hydrocarbons at 1 g/m² impacting the visual amenity of the marine environment. These hydrocarbon thresholds are presented in **Table 6-14** and described in the following subsections.

Table 6-14: Summary of thresholds applied to the quantitative hydrocarbon spill risk modelling results

Hydrocarbon Type	EMBA				Socio-cultural EMBA	Scientific Monitoring Plan EMBA
	Surface hydrocarbon (g/m²)	Dissolved hydrocarbon (ppb)	Entrained hydrocarbon (ppb)	Accumulated hydrocarbon (g/m²)	Surface hydrocarbon (g/m²)	Accumulated hydrocarbon (g/m²)
Marine Diesel	10	50	100	100	1	10

Surface Marine Diesel Hydrocarbon Threshold Concentrations

The spill modelling outputs defined the EMBA for surface hydrocarbon spills (contact on surface waters) using the ≥10 g/m² threshold (dull metallic colours) based on the relationship between film thickness and appearance (Bonn Agreement, 2015) (refer to **Table 6-15**). This threshold concentration, expressed in terms of g/m^2, is geared towards informing potential oiling impacts for wildlife groups and habitats that may break through the surface slick from the water or the air (e.g. emergent reefs, vegetation in the littoral zone and air-breathing marine reptiles, cetaceans, seabirds and migratory shorebirds).

Thresholds for registering biological impacts resulting from contact of surface slicks have been estimated by different researchers at about 10–25 g/m^2 (French et al., 1999; Koops et al., 2004; NOAA, 1996; French-McCay, 2018). Potential impacts of surface slick concentrations in this range for floating hydrocarbons may include harm to seabirds through ingestion from preening of contaminated feathers, or the loss of the thermal protection of their feathers. The 10 g/m^2 threshold is the reported level of oiling to instigate impacts to seabirds, and is also applied to other wildlife, although it is recognised that 'unfurred' animals (where hydrocarbon adherence is less) may be less vulnerable. 'Oiling' at this threshold is taken to be of a magnitude that can cause a response from the most vulnerable wildlife such as seabirds. Due to weathering processes, surface hydrocarbons have a lower toxicity due to changes in their composition over time. Potential impacts to shoreline sensitive receptors may be markedly reduced in instances where there is extended duration until the slick contacts the shoreline.

Woodside recognises that hydrocarbons may be visible at low concentrations of approximately 1 g/m^2. Therefore, the threshold for visible surface oil (1 g/m^2) was used to define an additional boundary within which socio-cultural impacts to the visual amenity of the marine environment may occur. This area is referred to as the socio-cultural EMBA. Any ecological impacts from dissolved and entrained hydrocarbons above prescribed thresholds, as in **Table 6-14**, may also result in socio-cultural impacts. Potential impacts to socio-cultural values assessed within these EMBAs include the following:

- Protected areas.
- National and Commonwealth Heritage Listed places.
- Tourism and recreation.
- Commercial fisheries.

The boundaries of the two EMBAs may differ due to the different thresholds, hydrodynamics and weathering of the released hydrocarbons.

Table 6-15: The Bonn Agreement oil appearance code

Appearance (following Bonn visibility descriptors)	Mass per area (g/m^2)	Thickness (µm)	Volume per area (L/km^2)
Discontinuous true oil colours	50 to 200	50 to 200	50,000 to 200,000
Dull metallic colours	5 to 50	5 to 50	5000 to 50,000
Rainbow sheen	0.30 to 5.00	0.30 to 5.00	300 to 5000
Silver sheen	0.04 to 0.30	0.04 to 0.30	40 to 300

Dissolved Marine Diesel Hydrocarbon Threshold Concentrations

The dissolved aromatic threshold of 50 ppb for diesel has been selected as a medium level threshold to approximate the potential toxic effects, particularly sub-lethal effects to sensitive species, as consistent with the NOPSEMA Oil Spill Modelling Guidance Bulletin (NOPSEMA, 2019). Dissolved hydrocarbons present a narcotic effect resulting from uptake into the tissues of marine organisms. This effect is additive, increasing with exposure concentration or with time of exposure (French-McCay, 2002; NRC, 2005).

Entrained Marine Diesel Hydrocarbon Threshold Concentrations

The spill modelling outputs are used to define the EMBA by defining the spatial variability of entrained hydrocarbons above a set concentration threshold contacting sensitive receptors (expressed in ppb).

Entrained hydrocarbons present a number of possible mechanisms for toxic exposure to marine organisms. The entrained hydrocarbon droplets may contain soluble compounds, hence have the potential for generating elevated concentrations of dissolved aromatic hydrocarbons (e.g. if mixed by breaking waves against a shoreline). Physical and chemical effects of the entrained hydrocarbon droplets have also been demonstrated through direct contact with organisms, for example through physical coating of gills and body surfaces, and accidental ingestion (National Research Council 2005).

The entrained threshold for diesel has been selected to be consistent with the NOPSEMA Oil Spill Modelling Guidance Bulletin (NOPSEMA, 2019). An entrained threshold of 100 ppb is therefore considered to be appropriate given the oil characteristics for informing potential impacts to receptors.

Accumulated Marine Diesel Hydrocarbon Threshold Concentrations

Owens et al. (1994) define accumulated hydrocarbon <100 g/m^2 to have an appearance of a stain on shorelines. French-McCay (2009) defines accumulated hydrocarbons ≥100 g/m^2 to be the threshold that could impact the survival and reproductive capacity of benthic epifaunal invertebrates living in intertidal habitat. A threshold of ≥100 g/m^2 has therefore been adopted to define the EMBA for a marine diesel spill. Further, any ecological impacts at the accumulated thresholds concentration EMBA may also result in socio-cultural impacts.

6.6.1.3 Scientific Monitoring

A planning area for scientific monitoring is also described in **Section 5.5** of the Oil Spill Preparedness and Response Mitigation Assessment (**Appendix D**). This planning area has been defined with reference to the low exposure entrained value of 10 ppb detailed in NOPSEMA Bulletin #1 Oil Spill Modelling (2019). This low exposure threshold is based on the potential for exceeding water quality triggers.

A scientific monitoring program would be activated following a Level 2 or 3 unplanned hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors. This would consider receptors at risk (ecological and socio-economic) for the entire predicted EMBA and in particular, any identified Pre-emptive Baseline Areas (PBAs) for the worst-case credible spill scenario(s) or other identified unplanned hydrocarbon releases associated with the operational activities.

6.6.2 Accidental Hydrocarbon Release: Vessel Collision

Context		
Project Vessels – **Section 3.6.5**	Physical Environment – **Section 4.4** Biological Environment – **Section 4.5** Socio-Economic Environment – **Section 4.9**	Stakeholder Consultation – **Section 5**

Impact Evaluation Summary														
Source of Impact	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl Odour)	Ecosystems/ Habitat	Species	Socio-Economic	Decision Type	Consequence/Impact	Likelihood	Current Risk Rating	ALARP Tools	Acceptability	Outcome
Hydrocarbon release to the marine environment due to a vessel collision (between Project vessels or third party vessels)			X		X	X	X	A	D	1	M	LC S GP	Acceptable	EPO 11

Description of Source of Risk

Background

The seismic vessel may have a fuel distributed into multiple isolated tanks. Individual marine diesel tanks. For the purposes of a conservative indication of the risks associated with a vessel collision for the Petroleum Activities Program, Woodside has assumed a largest marine diesel tank volume of 1062 m^3 for the seismic vessel.

At least one support vessel will accompany the seismic vessel during the Petroleum Activities Program. Typical project support vessels for seismic operations have multiple marine diesel tanks typically ranging between 50 m^3 up to a maximum size of 1062 m^3.

In the unlikely event of a vessel collision involving a Project vessel during the Petroleum Activities Program, the vessel will have the capability to pump marine diesel from a ruptured tank to a tank with spare volume in order to reduce the potential volume of fuel released to the environment.

Project vessels (seismic vessel and support vessel(s)) will be present in the Operational Area for the duration of the Petroleum Activities Program. This presence in the area will result in a navigational hazard for other marine users within the immediate area of the vessel (as discussed in **Section 6.5.1**).

Industry Experience

Registered vessels or foreign flag vessels in Australian waters are required to report events to the Australian Transport Safety Bureau (ATSB), AMSA or Australian Search and Rescue.

From a review of the ATSB marine safety and investigation reports, one vessel collision occurred in 2011–2012 that resulted in a spill of 25–30 L of oil into the marine environment as a result of a collision between a tug and activity support vessel off Barrow Island. Two other vessel collisions occurred in 2010, one in the port of Dampier, where an activity support vessel collided with a barge being towed. Minor damage was reported and no significant injury to personnel or pollution occurred. The second 2010 vessel collision involved a vessel under pilot control in port connected with a vessel alongside a wharf causing it to sink. No reported pollution resulted from the sunken vessel. These incidents demonstrate the likelihood of only minor volumes of hydrocarbons being released during the highly unlikely event of a vessel collision occurring.

From 2010 to 2011, the ATSB's annual publication defines the individual safety action factors identified in marine accidents and incidents: 42% related to navigation action (2011). Of those, 15% related to poor communication and 42% related to poor monitoring, checking and documentation. The majority of these related to the grounding instances.

Credible Spill Scenario

For a vessel collision to result in the worst-case scenario of a hydrocarbon spill potentially impacting an environmental receptor, several factors must align as follows:

- The identified causes of vessel interaction must result in a collision.
- The collision must have enough force to penetrate the vessel hull.
- The collision must be in the exact location of the fuel tank.
- The fuel tank must be full, or at least of volume which is higher than the point of penetration.

The probability of the chain of events described above aligning, to result in a breach of fuel tanks resulting in a spill that could potentially affect the marine environment is considered remote. Given the offshore location of the Operational Area, vessel grounding is not considered a credible risk.

The environmental risk analysis and evaluation identified and assessed a range of potential scenarios that could result in a loss of vessel structural integrity, resulting in damage to fuel storage tank(s) and a loss of marine diesel to the marine environment (**Table 6-16**). The scenarios considered damage to single and multiple fuel storage tanks in a project vessel due to dropped objects and various combinations of vessel-to-vessel collision scenarios.

The scenarios considered comprised of a collision of the support vessel and the seismic vessel with each other or with a third party vessel (i.e. commercial shipping, other petroleum related vessels and commercial fishing vessels). The likelihood of a collision was assessed as being remote, given standard vessel operations and equipment in place to prevent collision at sea, the standby role of a support vessel (low vessel speed) and its operation in close proximity to the seismic vessel (SNA), and the construction and placement of storage tanks. The largest tank of the support vessel is unlikely to exceed 250 m³. For the purposes of this assessment a worst-case instantaneous loss of 1062 m³ from a diesel tank on the seismic vessel has been considered.

Table 6-16: Summary of credible hydrocarbon spill scenario as a result of vessel collision

Scenario	Hydrocarbon Volumes	Preventative and Mitigation Controls	Credibility	Max. Possible Volume loss (m^3)
Hydrocarbon release caused by vessel collision (seismic vessel)	1062 m^3 instantaneous	Typically double wall, tanks which are located mid-ship (not bow or stern). Vessels are not anchored and steam at low speeds when relocating within the Operational Areas or providing stand-by cover. Normal maritime procedures would apply during such vessel movements.	**Credible** A vessel collision could potentially result in a release from a seismic vessel fuel tank.	1062 m^3
Hydrocarbon release caused by vessel collision (support vessel)	250 m^3 instantaneous	Typically double wall, tanks which are located mid-ship (not bow or stern). Vessels are not anchored and steam at low speeds when relocating within the Operational Areas or providing stand-by cover. Normal maritime procedures would apply during such vessel movements.	**Credible** A vessel collision could potentially result in a release from a support vessel fuel tank.	250 m^3

Quantitative Hydrocarbon Risk Assessment

Modelling of an instantaneous surface release of 2000 m^3 of marine diesel was conducted by RPS on behalf of Woodside as part of Woodside's Scarborough project quantitative spill risk assessment (RPS, 2019). While this volume is larger than the 1062 m^3 worst-case spill volume from the seismic vessel, the results of the modelling can be used to demonstrate that a much larger marine diesel spill in the vicinity of the Operational Area has an EMBA that is not predicted to include any surface slicks above threshold volumes resulting in any shoreline contact or accumulation. Basing the impact assessment for a vessel collision scenario on this modelling is considered highly conservative and consequently, the EMBA for a 1062 m^3 surface release of marine diesel within the Operational Area would be considerably smaller than the EMBA described in this EP.

The modelling assessed the extent of a marine diesel spill volume of 2000 m³ for all seasons, using an historic sample of wind and current data for the region (2006-2015, inclusive). A total of 100 simulations were modelled over an annual period, with each simulation tracked for 42-days.

Hydrocarbon Characteristics

Marine diesel is a mixture of both volatile and persistent hydrocarbons. Predicted weathering of marine diesel, based on typical conditions in the region, indicates that about 6% of the oil mass should evaporate within the first 12 hours, and a further 35% is expected to evaporate within the first 24 hours **(Figure 6-5**) (RPS, 2019). After this time the majority of the remaining hydrocarbon is entrained into the upper water column. Seven days following the spill, approximately 35–40% would evaporate, 45% would entrain, 15% would decay and approximately 5% would be dissolved (refer to **Figure 6-5**).

Given the environmental conditions experienced in the Operational Area, marine diesel is expected to undergo rapid spreading and this, together with evaporative loss, is likely to result in a rapid dissipation of the spill. Marine diesel distillates tend not to form emulsions at the temperatures found in the region. The characteristics of the marine diesel are given in **Table 6-13**.

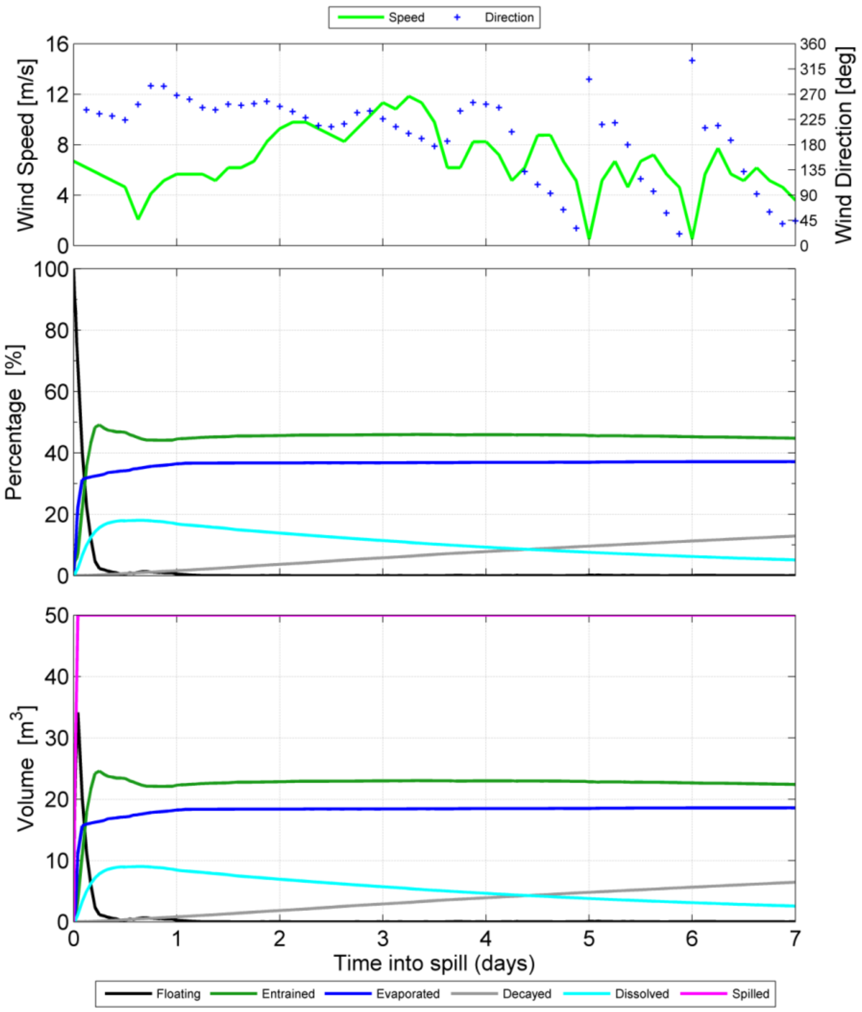


Figure 6-5: Proportional mass balance plot representing weathering of a 2000 m³ surface spill of marine diesel as a one-off release (at a rate of 50 m³/hr) and subject to variable wind at 27 °C water temperature and 25 °C air temperature (RPS, 2019)

Consequence Assessment
Potential Impacts Overview
Environment that May Be Affected The overall EMBA for the Petroleum Activities Program is based on stochastic modelling, which compiles data from 100 hypothetical worst-case spills under a variety of weather and metocean conditions (as described in **Section 6.6.1**). Spill modelling was undertaken based on an instantaneous surface release of 2000 m^3 of marine diesel, which is much greater than the assumed largest marine diesel tank volume of 1062 m^3 for a seismic vessel. Therefore, the EMBA described in this EP is considered highly conservative. The worst-case distances and probabilities of contact to receptor locations have been chosen as a conservative approach. As the weathering of different fates of hydrocarbons (surface, entrained and dissolved) differs due to the influence of the metocean transport mechanism, a different EMBA is discussed for each fate. ***Surface hydrocarbons*** Quantitative hydrocarbon spill modelling results for surface hydrocarbons are shown in **Table 6-17**. The modelling indicates that the spill would be localised and confined to open water, extending up to approximately 113 km (at or above the 10 g/m^3 impact threshold) from the release location. A socio-cultural EMBA for surface hydrocarbons which includes the threshold for visible surface hydrocarbons of 1 g/m^2 may extend up to approximately 116 km from the release site. ***Entrained hydrocarbons*** Quantitative hydrocarbon spill modelling results for entrained hydrocarbons are shown in **Table 6-17**. If a vessel collision scenario occurred, the plume of entrained hydrocarbons would form down-current of the release location, with the trajectory dependent on the prevailing current conditions at the time. The modelling indicates that locations exposed to entrained hydrocarbons at or above the threshold concentration of 100 ppb are restricted to offshore areas up to approximately 921 km from the release site. Concentrations above 100 ppb are not expected to exceed depths of approximately 15 m below mean sea level (BMSL). In the event that this vessel collision scenario occurred, the probability of contact by entrained oil at concentrations above 100 ppb is predicted to be 10% at the Gascoyne AMP and 1% at the Abrolhos Islands AMP and Carnarvon Canyon AMP. ***Dissolved hydrocarbons*** Quantitative hydrocarbon spill modelling results for dissolved hydrocarbons are shown in **Table 6-17**. The modelling indicates that locations exposed to dissolved hydrocarbons at or above the threshold concentration of 50 ppb are restricted to offshore areas up to approximately 249 km from the release site. Concentrations above 50 ppb are not expected to exceed depths of approximately 15 m BMSL. The probability of contact by dissolved hydrocarbons at concentrations above 50 ppb is predicted to be 3% at the Gascoyne AMP. The modelling did not predict dissolved hydrocarbons above the 50 ppb threshold concentration at any other sensitive receptors. ***Accumulated hydrocarbons*** Quantitative hydrocarbon spill modelling results for accumulated hydrocarbons are shown in **Table 6-17**. Accumulated hydrocarbons above threshold concentrations (>100 g/m^2) were not predicted by the modelling to occur. Floating oil at concentrations equal to or greater than 1 g/m^2 are not predicted to contact any shoreline receptors.
Summary of Potential Impacts to Environmental Values
Table 6-17 presents the full extent of the EMBA, i.e. the sensitive receptors and their locations that may be exposed to hydrocarbons (surface, entrained and dissolved) at or above the set threshold concentrations in the unlikely event of a marine diesel spill from a vessel collision during the Petroleum Activities Program. Details of these receptors are outlined in **Section 4.** The potential biological and ecological impacts of an accidental hydrocarbon release as a result of a vessel collision during the Petroleum Activities Program are presented in the following sections.

Table 6-17: Key receptor locations and sensitivities potentially contacted above impact thresholds by the vessel collision scenario with summary hydrocarbon spill contact (table cell values correspond to probability of contact [%])

Environmental setting	Location/name	Environmental, Social, Cultural, Heritage and Economic Aspects presented as per the Environmental Risk Definitions in Woodside's Risk Management Procedure																												Maximum predicted probability of hydrocarbon contact (>1% probability)				
		Physical		Biological																					Socio-economic and Cultural									
		Water Quality	*Sediment Quality*	*Marine Primary Producers*			*Other Communities/Habitats*								*Protected Species*										*Other Species*						Socio-cultural EMBA	Ecological EMBA			
		Open water (pristine)	***Marine sediment (pristine)***	***Coral reef***	***Seagrass beds/macroalgae***	***Mangroves***	***Spawning/nursery areas***	***Open water – productivity/ upwelling***	***Non-biogenic coral reefs***	***Offshore filter feeders and/or deepwater benthic communities***	***Nearshore filter feeders***	***Sandy shores***	***Estuaries/tributaries/creeks/ lagoons (including mudflats)***	***Rocky shores***	***Cetaceans – migratory whales***	***Cetaceans – dolphins and porpoises***	***Dugongs***	***Pinnipeds (sea lions and fur seals)***	***Marine turtles (including foraging and internesting areas and significant nesting beaches)***	***Sea snakes***	***Whale sharks***	***Sharks and rays***	***Sea birds and/or migratory shorebirds***	***Pelagic fish populations***	***Resident/demersal fish***	***Fisheries – commercial***	***Fisheries – traditional***	***Tourism and recreation***	***Protected areas/heritage – European and Indigenous/shipwrecks***	***Offshore oil and gas infrastructure (topside and subsea)***	***Surface hydrocarbon (≥1 g/m²)***	***Surface hydrocarbon (≥10 g/m²) (≥10 g/m²)***	***Entrained hydrocarbon (≥100 ppb)***	***Dissolved aromatic hydrocarbon (≥50 ppb)***	***Accumulated hydrocarbons (>100 g/m²)***
	Gascoyne AMP	✓	✓					✓							✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	1	1	10	3	-
	Abrolhos Islands MP	✓	✓	✓	✓		✓	✓		✓					✓	✓		✓	✓	✓		✓	✓	✓	✓	✓		✓	✓		-	-	1	-	-
	Carnarvon Canyon MP	✓	✓					✓		✓														✓	✓	✓			✓		-	-	1	-	-

N.B. The probability is based on stochastic modelling of 100 hypothetical worst-case spills under a variety of weather and metocean conditions. Hydrocarbons cannot accumulate on open ocean, submerged receptors, or receptors not fully emergent.

Summary of Potential Impacts to Environmental Values(s)
Summary of potential impacts to protected species
Marine mammals (Cetaceans and dugongs)
Marine mammals that have direct physical contact with surface, entrained or dissolved aromatic hydrocarbons may suffer surface fouling, ingestion of hydrocarbons (from prey, water and sediments), aspiration of oily water or droplets, and inhalation of toxic vapours (DWH Natural Resource Damage Assessment Trustees, 2016). This may result in the irritation of sensitive membranes such as the eyes, mouth, digestive and respiratory tracts and organs, impairment of the immune system, neurological damage (Helm et al., 2015), reproductive failure, adverse health effects (e.g. lung disease, poor body condition) and potentially mortality (DWH Natural Resource Damage Assessment Trustees, 2016). In a review of cetacean observations relating to a number of large-scale hydrocarbon spills, Geraci (1988) found little evidence of mortality associated with hydrocarbon spills. However, it was concluded that exposure to oil from the DWH resulted in increased mortality to cetaceans in the Gulf of Mexico (DWH Natural Resource Damage Assessment Trustees, 2016). Geraci (1988) did identify behavioural disturbance (i.e. avoiding spilled hydrocarbons) in some instances for several species of cetacean, suggesting that cetaceans have the ability to detect and avoid surface slicks. However, observations during spills have recorded larger whales (both mysticetes and odontocetes) and smaller delphinids travelling through and feeding in oil slicks. During the DWH spill, cetaceans were routinely seen swimming in surface slicks offshore (and nearshore) (Achinger Dias et al., 2017). Impacts to cetaceans depends on the exposure pathway; with exposure to entrained oil and surface slicks not expected to result in significant impacts due to the relatively volatile, non-persistent nature of the hydrocarbons. Direct toxic effects from external exposure are not expected to occur, although mucous membranes and eyes may become irritated. Indirect toxic effects, such as hydrocarbon ingestion through accumulation in prey may occur. Baleen whales feeding within entrained hydrocarbon plumes may ingest hydrocarbons, potentially resulting in toxic effects (particularly fresh hydrocarbons near the release location). Five threatened and migratory, and six migratory cetacean species were identified by a search of the EPBC Act Protected Matters Database, as potentially occurring in the EMBA (refer to **Section 4.6.3**). No BIAs for cetacean species were identified as occurring within the Operational Area, however a pygmy blue whale migration and foraging BIA, and humpback whale migration BIA occur within the EMBA. The pygmy blue whale is the species most likely to occur within the Operational Area during their northern migration from April to August. However, the presence of all cetacean species, including the pygmy blue whale, is likely to be limited to infrequent occurrences of individuals or small groups. The dugong was also identified by a search of the EPBC Act Protected Matters Database, as potentially occurring in the EMBA (refer to **Section 4.6.3**). The dugong is known to inhabit protected shallow coastal areas, and feed on seagrass in waters less than 10 m. The presence of the species in the EMBA is expected to be limited to infrequent occurrences of individuals or small groups. Surface and entrained hydrocarbons above threshold concentrations are not predicted to impact nearshore waters where dugongs occur. A loss of marine diesel from a vessel collision could result in a disruption to individual marine mammals transiting the EMBA. Such disruption could include behavioural impacts (e.g. avoidance of impacted areas), sub-lethal biological effects (e.g. skin irritation, irritation from ingestion or inhalation) and, in rare circumstances, death. However, such disruptions or impacts are not predicted to impact on the overall population viability of the species within the EMBA.
Marine reptiles (Marine turtles)
Adult sea turtles exhibit no avoidance behaviour when they encounter hydrocarbon slicks (NOAA, 2010). Contact with surface slicks, or entrained hydrocarbon, can therefore, result in hydrocarbon adherence to body surfaces (Gagnon and Rawson, 2010) causing irritation of mucous membranes in the nose, throat and eyes leading to inflammation and infection (NOAA, 2010). Oiling can also irritate and injure skin which is most evident on pliable areas such as the neck and flippers (Lutcavage et al., 1995). A stress response associated with this exposure pathway includes an increase in the production of white blood cells, and even a short exposure to hydrocarbons may affect the functioning of their salt gland (Lutcavage et al., 1995). Hydrocarbons in surface waters may also impact turtles when they surface to breathe and inhale toxic vapours. Their breathing pattern, involving large ‘tidal’ volumes and rapid inhalation before diving, results in direct exposure to petroleum vapours which are the most toxic component of the hydrocarbon spill (Milton and Lutz, 2003). This can lead to lung damage and congestion, interstitial emphysema, inhalant pneumonia and neurological impairment (NOAA, 2010). Contact with entrained hydrocarbons can result in hydrocarbon adherence to body surfaces causing irritation of mucous membranes in the nose, throat and eyes leading to inflammation and infection (Gagnon and Rawson, 2010). There are no BIAs or Habitat Critical to the survival or marine turtles within the Operational Area, however the EMBA partially overlaps with internesting buffer BIAs for flatback, green, hawksbill and loggerhead turtles, and Habitat Critical areas for green, flatback and hawksbill turtles (refer to **Section 4.6.2**). The nearest BIAs and Habitat Critical are for flatback turtles, located approximately 135 km south-east and 147 km south-east of the Operational Area, respectively. The 60 km internesting buffer for flatback turtles in the Recovery Plan for Marine Turtles in Australia (DoEE, 2017a) is considered very conservative. There is no evidence to date to indicate that flatback turtles swim out into deep offshore waters during the internesting period. Additionally, suitable areas of internesting habitat were located close to many known flatback turtle rookeries across the region (Whittock et al., 2016). Flatback turtle hatchlings do not undertake

Summary of Potential Impacts to Environmental Values(s)
oceanic migrations offshore to deep, pelagic waters. Instead juveniles grow to maturity in shallow coastal waters close to their natal beaches (Musick and Limpus, 1996). Due to the absence of potential nesting habitat and the offshore location, the Operational Area is unlikely to represent important habitat for marine turtles (over 200 km from suitable nesting habitat at the Montebello Islands and Barrow Island). In the event of a vessel collision, a marine diesel spill may impact individual marine turtles that have direct contact with hydrocarbons within the spill affected area but the consequences to marine turtle populations are likely to be minor.
Sharks and rays
Impacts to sharks and rays may occur through direct contact with hydrocarbons and contaminate the tissues and internal organs either through direct contact or via the food chain (consumption of prey). In the offshore environment, it is probable that pelagic shark species are able to detect and avoid surface waters underneath hydrocarbon spills by swimming into deeper water or away from the affected areas. Therefore, any impact on sharks and rays is predicted to be minor and only a temporary disruption. Hydrocarbon contact may affect whale sharks through ingestion (entrained/dissolved hydrocarbons), particularly if feeding. A foraging BIA for the whale shark is located within the EMBA (refer to **Section 4.6.1**), approximately 136 km south-east of the Operational Area, representing an area where solitary whale sharks may forage during their migration from Ningaloo (primarily between September and November). Therefore, individual whale sharks that have direct contact with hydrocarbons within the spill affected area may be impacted but the consequences to migratory whale shark populations are likely to be minor.
Seabirds and/or migratory shorebirds
As outlined in **Section 4.6.4**, 25 species of seabirds and/or migratory shorebirds were identified by the PMST as potentially occurring within the EMBA, including 15 threatened species. There are no BIAs for any bird species located within the Operational Area, however the EMBA overlaps with a wedge-tailed shearwater breeding BIA and roseate tern breeding BIA, located approximately 85 km south-east and 205 km south-east of the Operational Area, respectively. Seabirds generally do not exhibit avoidance behaviour to floating hydrocarbons. Physical contact of seabirds with surface slicks is by several exposure pathways, primarily, immersion, ingestion and inhalation. Such contact with hydrocarbons may result in plumage fouling and hypothermia (loss of thermoregulation), decreased buoyancy and potential to drown, inability to fly or feed, anaemia, pneumonia and irritation of eyes, skin, nasal cavities and mouths (AMSA, 2013; IPIECA, 2004) and result in mortality due to oiling of feathers or the ingestion of hydrocarbons. Longer-term exposure effects that may potentially impact seabird populations include a loss of reproductive success (loss of breeding adults) and malformation of eggs or chick (AMSA, 2013). The extent of the EMBA for a surface slick may result in impacts on feeding habitat, however this is not expected to result in a threat to the overall population viability of seabirds or shorebirds. Accumulated hydrocarbons above threshold concentrations (>100 g/m^2) were not predicted to occur at any shorelines. Floating oil at concentrations equal to or greater than 1 g/m^2 are not predicted to contact any shoreline receptors. Therefore, no impacts are expected to important nesting habitat.
Summary of potential impacts to other habitats and communities
Benthic fauna communities
Given the deep water depths of the EMBA (> 100 m) benthic fauna communities located within the EMBA will not be directly exposed or impacted by a marine diesel spill as hydrocarbons (surface, entrained and dissolved) are confined to the upper layers of the water column.
Plankton and fish communities
There is potential for plankton communities to be impacted by a marine diesel spill where entrained hydrocarbons thresholds are exceeded; however communities are expected to recover quickly (weeks/months) due to high population turnover (ITOPF, 2011). Considering the fast population turn-over of open water plankton populations, it is considered that any potential impacts will be low and temporary in nature. Fish populations in the open water offshore environment of the Operational Area and EMBA are highly mobile and can move away from a marine diesel spill. The spill-affected area will likely be confined to the upper surface layers. It is therefore unlikely that fish populations would be exposed to hydrocarbon contamination. Fish populations are likely to be distributed over a wide geographical area so impacts on populations or species level are considered to be negligible. Given the above factors and the rapid dispersion of marine diesel, it is considered that any potential impacts to fish will be negligible.

Summary of Potential Impacts to Environmental Values(s)
Spawning/nursery areas
Fish (and other commercially targeted taxa) in their early life stages (eggs, larvae and juveniles) are at their most vulnerable to lethal and sub-lethal impacts from exposure to hydrocarbons, particularly if a spill coincides with spawning seasons or if a spill reaches nursery areas close to the shore (e.g. seagrass and mangroves) (International Tanker Owners Pollution Federation [ITOPF], 2011a). Fish spawning (including for commercially targeted species such as snapper and mackerel) mostly occurs in nearshore waters at certain times of the year and nearshore waters are also inhabited by higher numbers of juvenile fishes than offshore waters. Modelling indicated that in the unlikely event of a marine diesel spill there is potential for entrained hydrocarbons to occur in the surface water layers above threshold concentrations up to approximately 921 km from the release site, and approximately 35 km from the shoreline at the closest point off Cape Range National Park. Therefore, there is the potential for lethal and sub-lethal impacts to a certain portion of fish larvae in affected areas, depending on concentration and duration of exposure and the inherent toxicity of the hydrocarbon. Losses of fish larvae in worst affected areas are unlikely to be of major consequence to fish stocks compared with significantly larger losses through natural predation, and the likelihood that most nearshore areas would be exposed is low. This is supported by a recent study in the Gulf of Mexico which used juvenile abundance data as indices of the acute, population-level responses of young fishes to the Deepwater Horizon spill. Results indicated that there was no change to the juvenile cohorts following this spill. Additionally there were no significant post-spill shifts in community composition and structure, nor were there changes in biodiversity measures (Fodrie and Heck, 2011). Any impacts to spawning and nursery areas are expected to be slight and short term, as would flow on effects to adult fish stocks into which larvae are recruited.
Coral reef habitat
Exposure to entrained hydrocarbons has the potential to result in lethal or sub-lethal toxic effects to corals and other sensitive sessile benthos within the upper water column, including subtidal corals. Mortality in a number of coral species is possible and this would result in the reduction of coral cover and change in the composition of coral communities. Sub-lethal effects to corals may include polyp retraction, changes in feeding, bleaching (loss of zooxanthellae), increased mucous production resulting in reduced growth rates and impaired reproduction (Negri and Heyward, 2000). In the unlikely event of a marine diesel spill occurring at the time of coral spawning at potentially affected coral locations or in the general peak period of biological productivity, there is potential for a reduction in successful fertilization and coral larval survival due to the sensitivity of coral early life stages to hydrocarbons (Negri and Heyward, 2000). Such impacts are likely to result in the failure of recruitment and settlement of new population cohorts. In addition, some non-coral species may be affected via direct contact with entrained hydrocarbons, resulting in sub-lethal impacts and in some cases mortality. This is with particular reference to the early life-stages of coral reef animals (reef attached fishes and reef invertebrates), which can be relatively sensitive to hydrocarbon exposure. Coral reef fish are site attached, have small home ranges and as reef residents they are at higher risk from hydrocarbon exposure than non-resident, more wide-ranging fish species. The exact impact on resident coral communities will be entirely dependent on actual hydrocarbon concentration, duration of exposure and water depth of the affected communities. The modelling indicates that locations exposed to entrained hydrocarbons at or above the threshold concentration of 100 ppb are restricted to offshore areas up to approximately 921 km from the release site, and dissolved hydrocarbons at or above the threshold concentration of 50 ppb are restricted to offshore areas up to approximately 249 km from the release site. The nearest coral reef habitat (Ningaloo Reef) is located over 30 km outside of the extent of the area exposed to entrained hydrocarbons, and therefore coral reef habitats will not be directly exposed or impacted by a marine diesel spill.
Key Ecological Features
KEFs potentially impacted by a marine diesel spill from a vessel collision event are: • Exmouth Plateau • Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula • Continental slope demersal fish communities • Ancient coastline at 125 depth contour • Wallaby Saddle • Western demersal slope and associated fish communities These KEFs are primarily defined by seabed geomorphological features and/or indicate a potential for increased biological productivity and, therefore, ecological significance. The consequences of a marine diesel spill from a vessel collision may impact the values of the KEFs affected (for the values of each KEF see Woodside's Existing Environment (**Appendix H**). Potential impacts to the above KEFS include: impacts to demersal fish populations and reduced biodiversity. Impacts to benthic habitats are not predicted as hydrocarbons (surface, entrained and dissolved) will be limited to the upper layers of the water column. Most of the KEFs within the EMBA have relatively broad-scale distributions and are unlikely to be significantly impacted.

Summary of Potential Impacts to Environmental Values(s)
Therefore, a worst-case hydrocarbon spill scenario has the potential to result in minor, short-term impacts to the ecological values of KEFs within the EMBA, with impacts predicted to be greatest within surface water layers closest to the potential release location.
Summary of potential impacts to water quality
Water quality would be affected due to hydrocarbon contamination which is described in terms of the biological effect concentrations. These are defined by the EMBA descriptions for each of, entrained and dissolved hydrocarbon fates and their predicted extent (refer to **Table 6-17**). Furthermore, water quality is predicted to have minor long-term and/or significant short-term hydrocarbon contamination above background and/or national/international quality standards.
Summary of potential impacts to marine sediment quality
Given the deep water depths of the EMBA (> 100 m) marine sediment quality will not be directly impacted by a marine diesel spill as hydrocarbons (surface, entrained and dissolved) are confined to the upper layers of the water column.
Summary of potential impacts to protected areas (including AMPs)
The quantitative spill risk assessment results indicate that the open water environment protected within the Gascoyne AMP, Abrolhos Islands AMP and Carnarvon Canyon AMP may be affected by the released hydrocarbons (refer to **Table 6-17**). It is noted that there are no State or Territory protected areas within the EMBA. The Gascoyne AMP has the potential to be contacted by entrained hydrocarbons (10% probability), dissolved hydrocarbons (3% probability) and surface hydrocarbons (1% probability) at or above the defined ecological effect concentrations (100 ppb, 50 ppb and 10 g/m^2, respectively). Additionally, the Abrolhos Islands AMP and Carnarvon Canyon AMP have a 1% probability of being contacted by entrained hydrocarbons at or above the 100 ppb threshold concentration. Impact on the values of the above AMPs (refer to Woodside's Existing Environment (**Appendix H)** are discussed in the relevant sections above for ecological and physical values and below for socio-economic and cultural values. Additionally, such hydrocarbon contact may alter stakeholder understanding and/or perception of the protected marine environment, given these represent areas largely unaffected by anthropogenic influences and contain biological diverse environments.
Summary of potential impacts to socio-economic and cultural values
Fisheries – commercial
Fish exposure to hydrocarbon can result in 'tainting' of their tissues. Even very low levels of hydrocarbons can impart a taint or 'off' flavour or smell in seafood. Tainting is reversible through the process of depuration which removes hydrocarbons from tissues by metabolic processes, although it is dependent upon the magnitude of the hydrocarbon contamination. Fish have a high capacity to metabolise these hydrocarbons while crustaceans (such as prawns) have a reduced ability (Yender et al., 2002). Seafood safety is a major concern associated with spill incidents. Therefore, actual or potential contamination of seafood can affect commercial and recreational fishing, and can impact seafood markets long after any actual risk to seafood from a spill has subsided (Yender et al., 2002). A spill would result in the establishment of an exclusion zone around the spill affected area. There would be a temporary prohibition on fishing activities for a period of time and subsequent potential for economic impacts to affected commercial fishing operators. A loss of marine diesel result from a vessel collision is unlikely to cause significant direct impacts on the target species of Commonwealth and WA commercial fisheries within the defined EMBA. Further details are provided below. **Commonwealth fisheries** The predicted EMBA resulting from a marine diesel spill may impact on the area fished by the Western Deepwater Trawl Fishery (refer to **Section 4.9.2**). This fishery generally targets deepwater bugs, deepwater flathead, boarfish, dory and snapper using demersal (bottom) trawl gear (DoE, 2020). Fishing takes place in waters deeper than 200 m. The temporary nature of the predicted marine diesel spill would infer that it is unlikely the hydrocarbon concentrations in the upper surface layers would lead to potential exposure of bottom dwelling target species to contamination. **WA fisheries** The predicted EMBA resulting from a marine diesel spill may impact the area fished by a number of State fisheries (refer to **Section 4.9.2**). These fisheries generally use a range of gear types and operate in shallow inshore waters to water depths up to 1,200 m, targeting demersal and pelagic finfish species, crustaceans, and a range of other benthic species. In the unlikely event of a marine diesel spill, there is potential for the targeted fish species to be exposed to entrained hydrocarbons in the water column. However, the potential for direct impact would be reduced as target species such as snapper and mackerel are likely to avoid the surface water layer underneath oil slicks. The temporary nature of the predicted marine diesel spill would infer that it is unlikely the hydrocarbon concentrations in the upper surface layers would lead to potential exposure of pelagic fish to contamination. Demersal species (such as finfish) have limited mobility and therefore, will not be able to easily move away from a spill. As such, mortality/sub-lethal effects may impact demersal

Summary of Potential Impacts to Environmental Values(s)
fish located close to the release location. Impacts to benthic species are unlikely as hydrocarbons are confined to the upper surface water layers.
Fisheries – traditional
No designated traditional fisheries have been identified to occur within the EMBA and therefore no impacts to traditional fisheries are predicted to occur.
Tourism and recreational activities
No tourism or recreational activities are expected to take place in the offshore waters of the EMBA and therefore no impacts to these activities are predicted to occur.
Offshore oil and gas activities
There are no other oil and gas facilities located within 50 km of the Operational Area therefore, the risk of vessel collision with oil and gas related activities is low. There are a number of oil and gas facilities that occur within the EMBA (i.e. Pluto Platform, Ngujima Yin FPSO). Avoidance of surface hydrocarbons is a possible response by other vessels. However, such occurrences will likely be limited to close proximity to the release site and other oil and gas activities are unlikely to be impacted.
Commercial shipping
A shipping fairways intersects the north-east corner of the Operational Area (refer to **Figure 4-13**), therefore, loss of marine diesel from a vessel collision may lead to exclusion of commercial shipping near the release location, resulting in operational inconvenience as vessels may be required to deviate course from intended routes.
Cultural heritage
No listed World Heritage Places, Indigenous Sites of Significance, Commonwealth Heritage Places or National Heritage Places were identified in the EMBA. A search of the Australian National Shipwreck Database (**Section 4.9.1.3**), which records all known Maritime Cultural Heritage (shipwrecks, aircraft, relics and other underwater cultural heritage) in Australian waters, indicated that there are nine Underwater Cultural Heritage sites within the EMBA. These heritage sites are located on the seabed, and will not be directly impacted by a marine diesel spill as hydrocarbons (surface, entrained and dissolved) are confined to the upper layers of the water column. Therefore, no impacts to cultural heritage values are expected.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[11]	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Comply with Marine Order 30 (prevention of collisions) 2016, including: • adherence to steering and sailing rules including maintaining lookouts (e.g. visual, hearing, radar, etc.), proceeding at safe speeds, assessing risk of collision and taking action to avoid collision (monitoring radar) • adherence to navigation light display requirements,	F: Yes. CS: Minimal cost. Standard practice.	Legislative requirement to reduce the likelihood of interference with other marine users resulting in a collision.	Controls based on legislative requirements – must be adopted	Yes **C 11.1**

[11] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[11]***	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
including visibility, light position/shape appropriate to activity • adherence to navigation noise signals as required.				
Comply with Marine Order 27 (Safety of navigation and radio equipment) 2016, including: • navigational systems and equipment mentioned in Regulations 19 and 20 of Chapter V of SOLAS for the vessel are type approved and installed on board vessels • navigational systems and equipment mentioned in Regulations 7 to 11 of Chapter IV of SOLAS are installed on board vessels • navigational systems and equipment are maintained in working order • navigational activities and incidents of importance to safety of navigation on the vessel are recorded.	F: Yes. CS: Minimal cost. Standard practice.	Legislative requirement to reduce the likelihood of interference with other marine users resulting in a collision.	Controls based on legislative requirements – must be adopted	Yes **C 11.2**
Comply with Marine Order 21 (safety and emergency arrangements) 2020, including: • adherence to minimum safe manning levels • maintenance of navigation equipment in efficient working order (compass/radar) • navigational systems and equipment required are those specified	F: Yes. CS: Minimal cost. Standard practice.	Legislative requirement to reduce the likelihood of interference with other marine users resulting in a collision.	Controls based on legislative requirements – must be adopted	Yes **C 11.3**

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[11]***	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
in Regulation 19 of Chapter V of SOLAS • AIS that provides other users with information about the vessel's identity, type, position, course, speed, navigational status and other safety-related data.				
Good Practice				
Notify AHO of activities and movements no less than four weeks before the scheduled activity commencement date.	F: Yes CS: Minimal cost. Standard practice.	Notification to AHO will enable them to generate navigation warnings (Maritime Safety Information Notifications (MSIN)) and NTM [including AUSCOAST warnings where relevant)]).	Benefits outweigh cost/sacrifice. Control is also standard practice.	Yes **C 1.1**
Notify AMSA JRCC of activities and movements 24-48 hours before the scheduled activity commencement date.	F: Yes CS: Minimal cost. Standard practice.	Communication of the Petroleum Activities Program to other marine users ensures they are informed and aware, thereby reducing the likelihood of a collision with a third party vessel.	Benefits outweigh cost/sacrifice. Control is also standard practice.	Yes **C 1.2**
Engage with proponents identified as having concurrent activities within the Operational Area prior to commencing the Petroleum Activities Program and develop an operations plan including the following aspects: • communications • work programming • hazard management • emergency response.	F: Yes CS: Minimal cost. Standard practice.	Communication of the Petroleum Activities Program to other marine users ensures they are informed and aware, thereby reducing the likelihood of a collision with a third party vessel.	Benefits outweigh cost/sacrifice. Control is also standard practice.	Yes **C 1.4**
Establish and maintain a 3 nm radius SNA around the seismic vessel and towed array.	F: Yes CS: Minimal cost. Standard practice.	Presence of the SNA will reduce the likelihood of a collision with a third party vessel.	Benefits outweigh cost/sacrifice. Control is also standard practice.	Yes **C 2.1**
Employ at least one support/chase vessel to assist the seismic vessel.	F: Yes CS: Minimal cost. Standard practice.	Use of a support vessel to assist the seismic vessel will reduce the likelihood of a collision with a third party vessel.	Benefits outweigh cost/sacrifice. Control is also standard practice.	Yes **C 2.2**

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[11]	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
In the event of a spill, emergency response activities implemented in accordance with the OPEP.	F: Yes CS: Costs associated with implementing response strategies vary dependent on nature and scale of spill event. Standard practice.	Potentially reduces consequence by implementing response to reduce impacts to the marine environment,	Control based on regulatory requirement – must be adopted.	Yes **C 11.4**
Arrangements supporting the activities in the OPEP will be tested to ensure the OPEP can be implemented as planned.	F: Yes CS: Moderate costs associated with exercises. Standard practice.	No change to impact or risk, however ensures the OPEP can be implemented in the event of a hydrocarbon spill thereby potentially reducing the consequence.	Control based on regulatory requirement – must be adopted.	Yes **C 11.5**
Mitigation: Oil spill response.	Refer to **Appendix D.**			
Professional Judgement – Eliminate				
Eliminate use of vessels.	F: No. The use of vessels is required to conduct the Petroleum Activities Program. CS: Not considered – control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No
Professional Judgement – Substitute				
None identified.				
Professional Judgement – Engineered Solution				
None identified.				
Risk Based Analysis				
A quantitative spill risk assessment was undertaken (see detail above).				

ALARP Statement

On the basis of the environmental risk assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A) Woodside considers the adopted controls appropriate to manage the impacts and risks of an unplanned loss of hydrocarbon resulting from vessel collision. As no reasonable additional/alternative controls were identified that would further reduce the impacts and risks without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.

Demonstration of Acceptability

Acceptability Statement

The impact assessment has determined that an accidental hydrocarbon release as a result of a vessel collision represents a moderate current risk rating and may result in a minor, short-term impact (1-2 years) on ecosystems, species, habitat or physical or biological attributes. Relevant recovery plans and conservation advice have been considered during the impact assessment, and the Petroleum Activities Program is not considered to be inconsistent with the overall recovery objectives and actions of these recovery plans and conservation advice.

The adopted controls are considered consistent with industry legislation, codes and standards, good practice and professional judgement and meet the requirements and expectations of Australian Marine Orders, AMSA and AHO identified during impact assessment and stakeholder consultation. On the basis of the environmental impact assessment outcomes and Woodside's criteria for acceptability outlined in **Section 2.7.2**, this is considered an acceptable level of risk.

Demonstration of Acceptability			
Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 11 No release of hydrocarbons to the marine environment due to a vessel collision during the Petroleum Activities Program.	**C 11.1** Comply with Marine Order 30 (prevention of collisions) 2016, including: • adherence to steering and sailing rules including maintaining lookouts (e.g. visual, hearing, radar, etc.), proceeding at safe speeds, assessing risk of collision and taking action to avoid collision (monitoring radar) • adherence to navigation light display requirements, including visibility, light position/shape appropriate to activity • adherence to navigation noise signals as required.	**PS 11.1** Project vessels compliant with Marine Order 30 (prevention of collisions) 2016 (which requires vessels to be visible at all times).	**MC 11.1.1** Marine Assurance inspection records demonstrate compliance with standard maritime safety procedures (Marine Orders 21, 27 and 30).
	C 11.2 Comply with Marine Order 27 (Safety of navigation and radio equipment) 2016, including: • navigational systems and equipment mentioned in Regulations 19 and 20 of Chapter V of SOLAS for the vessel are type approved and installed on board vessels • navigational systems and equipment mentioned in Regulations 7 to 11 of Chapter IV of SOLAS are installed on board vessels • navigational systems and equipment are maintained in working order • navigational activities and incidents of importance to safety of navigation on the vessel are recorded.	**PS 11.2** Project vessels compliant with Marine Order 27 (Safety of navigation and radio equipment) 2016.	
	C 11.3 Comply with Marine Order 21 (safety and emergency arrangements) 2020, including:	**PS 11.3** Project vessels compliant with Marine Order 21 (safety of navigation and	

Demonstration of Acceptability			
	• adherence to minimum safe manning levels • maintenance of navigation equipment in efficient working order (compass/radar) • navigational systems and equipment required are those specified in Regulation 19 of Chapter V of SOLAS • AIS that provides other users with information about the vessel's identity, type, position, course, speed, navigational status and other safety-related data.	emergency procedures) 2016.	
	C 11.4 In the event of a spill, emergency response activities implemented in accordance with the OPEP.	**PS 11.4** In the event of a spill the OPEP requirements are implemented.	**MC 11.4.1** Records of completed incident documentation.
	C 11.5 Arrangements supporting the activities in the OPEP will be tested to ensure the OPEP can be implemented as planned.	**PS 11.5.1** Exercises/tests will be conducted in alignment with the frequency identified in **Table 7-5**.	**MC 11.5.1** Testing of arrangement records confirm that emergency response capability has been maintained.
		PS 11.5.2 Woodside's procedure demonstrates a minimum level of trained personnel, for core roles in the OPEP, are maintained.	**MC 11.5.2** Emergency Management dashboard confirms that minimum level of personnel trained for core OPEP roles are available.
	C 1.1 **Section 6.5.1**	**PS 1.1** **Section 6.5.1**	**MC 1.1.1** **Section 6.5.1**
	C 1.2 **Section 6.5.1**	**PS 1.2** **Section 6.5.1**	**MC 1.2.1** **Section 6.5.1**
	C 1.4 **Section 6.5.1**	**PS 1.4** **Section 6.5.1**	**MC 1.4.1** **Section 6.5.1**
	C 2.1 **Section 6.5.1**	**PS 2.1** **Section 6.5.1**	**MC 2.1.1** **Section 6.5.1**
	C 2.2 **Section 6.5.1**	**PS 2.2** **Section 6.5.1**	**MC 2.2.1** **Section 6.5.1**
Detailed preparedness and response performance outcomes, standards and measurement criteria for the Petroleum Activities Program are provided in **Appendix D.**			

6.6.3 Accidental Hydrocarbon Release: Bunkering

Context		
Project Vessels – **Section 3.6.5**	Physical Environment – **Section 4.4** Biological Environment – **Section 4.5**	Stakeholder Consultation – **Section 5**

Impact Evaluation Summary

Source of Impact	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl Odour)	Ecosystems/ Habitat	Species	Socio-Economic	Decision Type	Consequence/Impact	Likelihood	Risk Rating	ALARP Tools	Acceptability	Outcomes
Loss of hydrocarbons to the marine environment from bunkering/refuelling of seismic vessel			x		x	x	x	A	E	1	L	LCS GP	Broadly Acceptable	EPO 12

Description of Source of Risk

Credible Scenario

Bunkering of marine diesel between the support vessel(s) and the seismic vessel may occur within the Operational Area.

Two credible scenarios for the loss of containment of marine diesel during bunkering operations were identified:

- Partial or total failure of a bulk transfer hose or fittings during bunkering, due to operational stress or other integrity issues could spill marine diesel to the deck and/or into the marine environment. This would be in the order of less than 200 L, based on the likely volume of a bulk transfer hose (assuming a failure of the dry break and complete loss of hose volume).
- Partial or total failure of a bulk transfer hose or fittings during bunkering, combined with a failure in procedure to shutoff fuel pumps, for a period of up to five minutes, resulting in approximately 8 m^3 marine diesel loss to the deck and/or into the marine environment.

Quantitative Spill Risk Assessment

Woodside has commissioned RPS to model several small marine diesel spills, including surface spill volumes of 8 m^3 in the offshore waters of north-west WA. The results of these models have indicated that exposure to surface hydrocarbons above the 10 g/m^2 threshold is limited to the immediate vicinity of the release site, with little potential to extend beyond 1 km. Therefore, it is considered that exposure to threshold concentrations from an 8 m^3 surface spill from bunkering activities would be well within the EMBA for the vessel collision scenario detailed in **Section 6.6.2**. Given this, the offshore location of the Operational Area, and the fact that the same hydrocarbon type is involved for both scenarios, specific modelling for an 8 m^3 marine diesel release was not performed for this Petroleum Activities Program.

Hydrocarbon Characteristics

Refer to **Section 6.6.1.1** for a description of the characteristics of marine diesel, including detail on the predicted fate and weathering of a spill to the marine environment.

Consequence Assessment

Potential Impacts to Environmental Values

Previous modelling studies for 8 m^3 marine diesel releases, spilt at the surface as result of bunkering activities, indicated that the potential for exposure to surface hydrocarbons exceeding 10 g/m^2 was confined to within the immediate vicinity (approximately 1 km) of the release sites. Therefore, it is considered that there is no potential for contact with sensitive

receptor locations above surface (10 g/m^2), entrained (100 ppb) or dissolved (50 ppb) threshold concentrations from an 8 m^3 spill of marine diesel within the Operational Area.
Summary of Potential Impacts to Environmental Values(s)
The potential biological and ecological impacts associated with a much larger hydrocarbon spill (2000 m^3) are presented in **Section 6.6.2**, further detail on impacts specific to a spill of marine diesel from a bunkering loss are provided below. The biological consequences of such a small volume spill on identified open water sensitive receptors relate to the potential for minor impacts to megafauna, plankton and fish populations (surface and water column biota) that are within the spill affected area. No impacts to commercial fisheries and/or benthic habitats are expected. Refer to **Section 6.6.2** (potential impacts of unplanned hydrocarbon release to the marine environment from vessel collision) for the detailed potential impacts; however, the extent of the EMBA associated with a marine diesel spill from loss during bunkering will be much reduced in terms of spatial and temporal scales, and hence, potential impacts from bunkering are considered slight and short-term (< 1 year).

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[12]***	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Marine Order 91 (marine pollution prevention – oil) 2014 which requires a Ship Oil Pollution Emergency Plan (SOPEP)/ Spill Monitoring Program Execution Plan (SMPEP) (as appropriate to vessel class).	F: Yes CS: Minimal cost. Standard Practice.	Reduces the likelihood of a spill entering the marine environment. Although no significant reduction in consequence could result, the overall risk is reduced.	Controls based on legislative requirements – must be adopted.	Yes **C 12.1**
Good Practice				
Bunkering equipment controls: • all hoses that have a potential environmental risk following damage or failure shall be placed on the vessel's preventative maintenance system. • all bulk transfer hoses shall be pressure rated at purchase • there shall be dry-break couplings and flotation on fuel hoses • there shall be an adequate number of appropriately stocked, located and maintained spill kits.	F: Yes CS: Minimal cost. Standard practice.	Reduces the likelihood of a spill occurring. Although no significant reduction in consequence could result, the overall risk is reduced.	Benefits outweigh cost/sacrifice. Control is also standard practice.	Yes **C 12.2**
Ensure Contractor procedures include requirements to be	F: Yes	Reduces the likelihood of a spill occurring. Although no significant	Benefits outweigh cost/sacrifice.	Yes **C 12.3**

[12] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[12]	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
implemented during bunkering/refuelling operations, including: • a completed Permit to Work and/or JSA shall be implemented for the hydrocarbon bunkering/refuelling operation • gauges, hoses, fittings and the sea surface shall be visually monitored during the operation • hoses shall be visually inspected as per vessel procedures prior to commencement • bunkering/refuelling will commence in daylight hours. If the transfer is to continue into darkness, the JSA risk assessment must consider lighting and the ability to determine if a spill has occurred • hydrocarbons shall not be transferred in marginal weather conditions.	CS: Minimal cost. Standard practice.	reduction in consequence could result, the overall risk is reduced.	Control is also standard practice.	
Mitigation: Oil spill response.	Refer to **Appendix D.**			
Professional Judgement – Eliminate				
Seismic vessel brought into port to refuel.	F: No. Does not eliminate the fuel transfer risk. It is not operationally practical to transit the seismic vessel back to port for refuelling, based on the frequency of the refuelling requirements and distance from the nearest port (Port Hedland >500 km). CS: Significant due to schedule delay and vessel transit costs and day rates.	Eliminates the risk in the Operational Area; however, moves risk to another location. Therefore, no overall benefit.	Disproportionate. The cost/sacrifice outweighs the benefit gained.	No
Professional Judgement – Substitute				
None identified				
Professional Judgement – Engineered Solution				

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[12]	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
None identified.				
Risk Based Analysis				
A quantitative spill risk assessment was undertaken (see details above).				
ALARP Statement On the basis of the environmental risk assessment outcomes and use of the relevant tools appropriate to the decision type, Woodside considers the adopted controls appropriate to manage the impacts and risks of a bunkering spill. As no reasonable additional/alternative controls were identified that would further reduce the impacts and risks without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement
Loss of hydrocarbons to marine environment during bunkering has been evaluated as having a low current risk rating that is unlikely to result in potential impact greater than minor and temporary exceedance over national/international water quality standards and a localised, minor and temporary disruption to a small proportion of the population and no impact on critical habitat or activity of protected species. Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice. As demonstrated in **Section 6.7**, the residual risk of unplanned hydrocarbon release from bunkering is not inconsistent with the relevant objectives and actions of any applicable recovery plans or threat abatement plans, based on the adopted controls. Regard has been given to relevant conservation advice and wildlife conservation plans during the assessment of potential risks. The potential impacts and risks are considered broadly acceptable if the adopted controls are implemented.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 12 No unplanned loss of hydrocarbons to the marine environment from bunkering greater than a consequence level E[13] during the Petroleum Activities Program.	**C 12.1** Marine Order 91 (marine pollution prevention – oil) 2014, requires SOPEP/SMPEP (as appropriate to vessel class).	**PS 12.1** Appropriate initial responses prearranged and drilled in case of a hydrocarbon spill, as appropriate to vessel class.	**MC 12.1.1** Marine Assurance records demonstrate compliance with Marine Order 91.
		PS 12.2.1 Damaged equipment is replaced prior to failure.	**MC 12.2.1** Records confirm the vessel bunkering equipment is subject to systematic integrity checks as per vessels preventative maintenance schedule.
		PS 12.2.2 Minimised inventory loss in the event of a failure.	**MC 12.2.2** Records confirm presence of dry break couplings and flotation on fuel hoses and are pressure rated.

[13] Defined as 'Slight, short-term impact (< 1 year) on species, habitat (but not affecting ecosystem function), physical or biological attributes'.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
	C 12.2 Bunkering equipment controls: • all hoses that have a potential environmental risk following damage or failure shall be placed on the vessel's preventative maintenance system • all bulk transfer hoses be pressure rated at purchase • there shall be dry-break couplings and flotation on fuel hoses • there shall be an adequate number of appropriately stocked, located and maintained spill kits.	**PS 12.2.3** Ensure adequate resources are available to allow implementation of the SOPEP.	**MC 12.2.3** Records confirm presence of spill kits.
	C 12.3 Ensure Contractor procedures include requirements to be implemented during bunkering/refuelling operations, including: • a completed Permit to Work and/or JSA shall be implemented for the hydrocarbon bunkering/refuelling operation • gauges, hoses, fittings and the sea surface shall be visually monitored during the operation • hoses shall be visually inspected as per vessel procedures prior to commencement • bunkering/refuelling will commence in daylight hours. If the transfer is to continue into darkness, the JSA risk assessment must consider lighting and the ability to determine if a spill has occurred • hydrocarbons shall not be transferred in marginal weather conditions.	**PS 12.3** Compliance with Contractor procedures for managing bunkering/refuelling operations.	**MC 12.3.1** Records demonstrate bunkering/refuelling undertaken in accordance with contractor bunkering procedures.
Detailed oil spill preparedness and response performance outcomes, standards and measurement criteria for the Petroleum Activities Program are presented in **Appendix D.**			

6.6.4 Unplanned Discharge: Deck Spills

Context		
Project Vessels – **Section 3.6.5**	Physical Environment – **Section 4.4** Biological Environment – **Section 4.5**	Stakeholder Consultation – **Section 5**

Impact Evaluation Summary														
Source of Impact	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl Odour)	Ecosystems/ Habitat	Species	Socio-Economic	Decision Type	Consequence/Impact	Likelihood	Risk Rating	ALARP Tools	Acceptability	Outcomes
Accidental discharge of hydrocarbons/ chemicals from Project vessel deck activities and equipment (e.g. cranes and winches) within the Operational Area			x			x		A	F	2	L	LCS GP	Broadly Acceptable	EPO 13

Description of Source of Risk
Deck spills can result from spills from stored hydrocarbons/chemicals or equipment. Project vessels typically store hydrocarbon/chemicals in various volumes. Storage areas are typically set up with effective primary and secondary bunding to contain any deck spills. Releases from equipment are predominantly from the failure of hydraulic hoses, which can either be located within bunded areas or outside of bunded or deck areas (e.g. over water on cranes). Woodside's operational experience demonstrates that spills are most likely to originate from hydraulic hoses and have been less than 100 L, with an average volume <10 L.

Consequence Assessment
Potential Impacts to Environmental Value(s)
No significant impacts from the accidental discharges described are anticipated in the offshore/open water locations of the Operational Area, because of the minor quantities involved (<10 L), the limited duration of vessel activities during the Petroleum Activities Program (up to 80-days), and high level of dilution into the open water marine environment of the Operational Area. The biological consequences of such a small volume spill on identified open water sensitive receptors relate to a minor potential for toxicity impacts to plankton and fish populations (surface and water column biota) and localised reduction in water quality within a small spill affected area. No impacts are predicted to benthic habitat communities in the Operational Area.
Summary of Potential Impacts to Environmental Value(s)
Given the adopted controls, it is considered that minor hydrocarbon/harmful chemical spills to the marine environment will not result in a potential impact to water quality greater than localised contamination above background levels, quality standards or known effect concentrations, and will not result in a potential impact greater than localised and temporary disruption to a small proportion of the population with no impact on critical habitat or activity.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[14]***	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				

[14] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***[14]	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Marine Order 91 (marine pollution prevention—oil) 2014, requires Shipboard Oil Pollution Emergency Plan (SOPEP) (as appropriate to vessel class).	F: Yes. CS: Minimal cost. Standard practice.	Legislative requirements to be followed reduce the likelihood of an unplanned release. The consequence is unchanged.	Controls based on legislative requirements – must be adopted.	Yes **C 12.1**
Good Practice				
Bulk chemical and fuel storage areas are bunded or secondarily contained when they are not being handled/moved temporarily	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of contaminated deck drainage water being discharged to the marine environment.	Benefits outweigh cost/sacrifice. Control is also standard practice.	Yes **C 13.1**
Maintain and locate spill kits in close proximity to hydrocarbon storage areas and deck areas for use to contain and recover deck spills.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of a deck spill from entering the marine environment. The consequence is unchanged.	Benefits outweigh cost/sacrifice.	Yes **C 13.2**
Professional Judgement – Eliminate				
None identified.				
Professional Judgement – Substitute				
None identified				
Professional Judgement – Engineered Solution				
Below-deck storage of all hydrocarbons and chemicals.	F: Not feasible. During operations there is a need to keep small volumes near activities and within equipment requiring use of hydrocarbons and chemicals and can result in increased risk of leaks from transfers via hose or smaller containers. CS: Not considered – control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No
A reduction in the volumes of chemicals and hydrocarbons stored onboard the vessel.	F: Yes. Increases the risks associated with transportation and lifting operations. CS: Project delays if required chemicals not on board. Increases the risks associated with transportation and lifting operations.	No reduction in likelihood or consequence since chemicals will still be required to enable activities to occur.	Disproportionate. The cost/sacrifice outweighs the benefit gained.	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[14]***	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
ALARP Statement On the basis of the environmental risk assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to manage the impacts and risks of the potential unplanned accidental deck spills described above. As no reasonable additional/alternative controls were identified that would further reduce the impacts and risks without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The risk assessment has determined that an unplanned minor discharge of hydrocarbons/chemicals as a result of minor deck spills represents a low current risk rating that is unlikely to result in potential impact greater than localised and temporary disruption to a small proportion of the population and no impact on critical habitat or activity. Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are consistent with the most relevant regulatory guidelines and good oil-field practice/industry best practice. The potential impacts and risks are considered acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks of minor unplanned deck spills to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 13 No unplanned spills to the marine environment from deck activities greater than a consequence level of F[15] during the Petroleum Activities Program.	**C 12.1** **Section 6.6.3**	**PS 12.1** **Section 6.6.3**	**MC 12.1.1** **Section 6.6.3**
	C 13.1 Liquid chemical and fuel storage areas are bunded or secondarily contained when they are not being handled/ moved temporarily.	**PS 13.1** Failure of primary containment in storage areas does not result in loss to the marine environment.	**MC 13.1.1** Records confirm all bulk chemicals and fuel are stored in bunded/ secondarily contained areas when not being handled/moved temporarily.
	C 13.2 Maintain and locate spill kits in close proximity to hydrocarbon storage areas and deck areas for use to contain and recover deck spills.	**PS 13.2** Spill kits to be available for use to clean up deck spills.	**MC 13.2.1** Records confirms spill kits are present, maintained and suitably stocked.

[15] Defined as 'No lasting effect (<1 month). Localised impact not significant to environmental receptor'.

6.6.5 Unplanned Discharge: Loss of Solid Hazardous and Non-Hazardous Wastes (including Dropped Objects)

Context		
Activity Components – **Section 3.6**	Physical Environment – **Section 4.4** Biological Environment – **Section 4.5**	Stakeholder Consultation – **Section 5**

Impact Evaluation Summary

Source of Impact	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl Odour)	Ecosystems/ Habitat	Species	Socioeconomic	Decision Type	Consequence/Impact	Likelihood	Risk Rating	ALARP Tools	Acceptability	Outcomes
Accidental loss of hazardous or non-hazardous wastes (including dropped objects) to the marine environment (excludes sewage, grey water, putrescible waste and bilge water).			X		X	X		A	F	1	L	LCS GP	Broadly Acceptable	EPO 14

Description of Source of Impact

The project vessels will generate a variety of solid wastes including packaging and domestic wastes such as aluminium cans, bottles, paper and cardboard. Hence, there is the potential for solid wastes to be lost overboard to the marine environment. Wastes on-board are managed in accordance with the on-board waste management plan. Some wastes may be incinerated. Based on industry experience, waste items lost overboard are typically wind-blown rubbish such as container lids, cardboard etc. Such losses typically have occurred during back loading activities, periods of adverse weather and incorrect waste storage.

Consequence Assessment

Potential Impacts to Environmental Values

The potential impacts of solid wastes accidentally discharged to the marine environment include direct pollution and contamination of the environment and secondary impacts relating to potential contact of marine fauna with wastes, resulting in entanglement or ingestion and leading to injury and death of individuals. Several migratory and threatened species were identified as occurring within the Operational Area, including cetaceans, marine turtles and sharks. However, these species are expected to be transient as there are no known key aggregation areas within the Operational Area. The temporary or permanent loss of waste materials into the marine environment is highly unlikely to have a significant environmental impact, based on the types, size and frequency of wastes that could occur during the limited time the vessels will be in the Operational Area and the transient nature of the species present. Given this, impacts will have no lasting effect on any habitat, species or water quality.

Summary of Potential Impacts to Environmental Values(s)

Given the adopted controls, it is considered that the accidental discharge of solid waste described will result in localised impacts not significant to environmental receptors, with no lasting effect.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[16]***	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Marine Order 95 – marine pollution prevention—garbage (as appropriate to vessel class), prescribes matters necessary to give effect to Annex V of MARPOL, which prohibits the discharge of all garbage into the sea, except as provided otherwise.	F: Yes. CS: Minimal cost. Standard practice.	Legislative requirements to be followed reduces the likelihood of an unplanned release. The consequence is unchanged.	Controls based on legislative requirements – must be adopted.	Yes **C 14.1**
Good Practice				
Project Vessel Waste Management Plan, which requires: • dedicated waste segregation bins • records of all waste to be disposed, treated or recycled • waste streams to be handled and managed according to their hazard and recyclability class.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of an unplanned release. The consequence is unchanged.	Benefit outweighs cost sacrifice.	Yes **C 14.2**
Lost waste/dropped objects will be recovered, where safe and practicable. Where safe and practicable for this activity, will consider: • risk to personnel to retrieve object • whether the location of the object is in recoverable water depths • object's proximity to subsea infrastructure • ability to recover the object (i.e. nature of object, lifting equipment and suitable weather).	F: Yes, however it may not always be practicable. Assessed on a case by case situation. CS: Minimal cost. Standard practice.	No reduction in likelihood, as this is an unplanned event. Since the equipment may be recovered, a reduction in consequence is possible.	Benefit outweighs cost sacrifice.	Yes **C 14.3**
Professional Judgement – Eliminate				
None identified.				
Professional Judgement – Substitute				
None identified.				

[16] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[16]***	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Professional Judgement – Engineered Solution				
None identified.				
ALARP Statement On the basis of the environmental risk assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to manage the impacts and risks of accidental discharges of waste. As no reasonable additional/alternative controls were identified that would further reduce the impacts and risks without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that, given the adopted controls, accidental discharge of solid waste represents a low current risk rating that is unlikely to result in a potential impact above localised, not significant to environmental receptors with no lasting effects. Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice and meet legislative requirements (Marine Order 95). Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks of these discharges to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 14 No unplanned releases of solid hazardous or non-hazardous waste to the marine environment greater than a consequence level of F[17] during the Petroleum Activities Program.	**C 14.1** Marine Order 95 – marine pollution prevention—garbage (as appropriate to vessel class), prescribes matters necessary to give effect to Annex V of MARPOL, which prohibits the discharge of all garbage into the sea, except as provided otherwise.	**PS 14.1** Project vessels compliant with Marine Order 95.	**MC 14.1.1** Records demonstrate project vessels are compliant with Marine Order 95.
	C 14.2 Project Vessel Waste Management Plan, which requires: • dedicated waste segregation bins • records of all waste to be disposed, treated or recycled • waste streams to be handled and managed according to their hazard and recyclability class.	**PS 14.2** Waste will be managed in accordance with the project vessel waste arrangements.	**MC 14.2.1** Records demonstrate compliance against project vessel waste arrangements.
	C 14.3 Lost waste/dropped objects will be recovered, where safe and practicable. Where safe and practicable for this activity, will consider:	**PS 14.3** Waste dropped to the marine environment will be recovered where safe and practicable to do so.	**MC 14.3.1** Records detail the recovery attempt consideration and status of any waste lost to the marine environment.

[17] Defined as 'No lasting effect (<1 month). Localised impact not significant to environmental receptor'.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
	• risk to personnel to retrieve object • whether the location of the object is known or is in recoverable water depths and feasible to do so • object's proximity to subsea infrastructure • ability to recover the object (i.e. nature of object, lifting equipment and suitable weather).		

6.6.6 Physical Presence: Vessel Collision / Entanglement with Marine Fauna

Context		
Project Vessels – **Section 3.6.5**	Biological Environment – **Section 4.5**	Stakeholder Consultation – **Section 5**

Impact Evaluation Summary

Source of Impact	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl Odour)	Ecosystems/ Habitat	Species	Socioeconomic	Decision Type	Consequence/Impact	Likelihood	Risk Rating	ALARP Tools	Acceptability	Outcomes
Accidental collision between project vessels and threatened and/or migratory marine fauna within the Operational Area.						x		A	E	1	L	LCS GP	Broadly Acceptable	EPO 15
Entanglement of threatened and/or migratory marine fauna with towed seismic equipment within the Operational Area.						x								

Description of Source of Risk

Project Vessels

The project vessels operating in and around the Operational Area may present a potential hazard to cetaceans and other protected marine fauna such as marine reptiles. Vessel movements can result in collisions between the vessel (hull and propellers) and marine fauna, potentially resulting in superficial injury, serious injury that may affect life functions (e.g. movement and reproduction) and mortality. The factors that contribute to the frequency and severity of impacts due to collisions vary greatly due to vessel type, vessel operation (specific activity, speed), physical environment (e.g. water depth) and the type of animal potentially present and their behaviours.

The seismic vessel will be advancing at low speeds around 4-5 knots (7-9 km) during seismic acquisition. The support vessel(s) generally travel at higher speeds.

Seismic Equipment

The seismic vessel will tow seismic geophysical and associated equipment (comprising the acoustic source, header buoys, starboard and port deflectors or baravanes, streamers and tail buoys) within the Operational Area. The seismic vessel may tow up to 14 streamers that could extend approximately 8 km behind the seismic vessel. The streamer(s) will be towed at a depth of approximately 15 – 25 m. The seismic source will be towed at a depth of approximately 6 to 8 m (± 1 m).

The seismic equipment has the potential to present an entrapment/entanglement risk to marine fauna (in particular marine turtles). Anecdotally, there has been no reported cases of marine fauna becoming entangled in seismic equipment in Australian waters.

Consequence Assessment

Potential Impacts to Environmental Values

Vessel disturbance is a key threat to a number of migratory and threatened species identified as occurring within Operational Area, including cetaceans and marine turtles. Relevant conservation actions outlined in these plans are listed in **Section 6.7.**

Cetaceans

Cetaceans are naturally inquisitive marine mammals. The reaction of cetaceans to the approach of a vessel is quite variable. 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, although they generally do not approach and sometimes avoid faster moving ships (Richardson et al., 1995). The Whale and Dolphin Conservation Society (WDCS, 2006) indicates that some cetacean species, such as humpback whales can detect and change course to avoid a vessel.

Collisions between vessels and marine mammals occur more frequently in areas where high vessel traffic and important habitat coincide (WDCS, 2006). In Australia, the majority of vessel strikes to known species involved humpback, southern right whale and sperm whales, in descending order (Peel et al., 2016). Van Warebeek et al. (2007) report just five blue whale ship strikes in the Southern Hemisphere. No vessel strike collisions were reported in the Northern coast of Australia (Peel et al., 2016). The behaviour exhibited by whales prior to vessel collision varies, with some reported as being asleep/unmoving prior to the collision (Peel et al., 2016) and others displaying a 'last-second flight response' (Laist et al., 2001). Individual cetaceans engaged in behaviours such as feeding, mating or nursing may also be more vulnerable to vessel collisions when distracted by these activities (DoEE, 2017b).

The likelihood of vessel/whale collision being lethal is influenced by vessel speed—the greater the speed at impact, the greater the risk of mortality (Jensen and Silber, 2004; Laist et al., 2001). Vanderlaan and Taggart (2007) found that the chance of lethal injury to a large whale as a result of a vessel strike increases from about 20% at 8.6 knots to 80% at 15 knots. Project vessels within the Operational Area are likely to be travelling <8 knots, therefore, the chance of a vessel collision with protected species resulting in a lethal outcome is considered unlikely, as fauna can move away from project vessels.

The Operational Area does not overlap with any cetacean BIAs or critical habitat. Due to the proximity of a pygmy blue whale migration BIA approximately 14 km south-east of the Operational Area, the pygmy blue whale is the species most likely to occur within the Operational Area during their northern migration from April to July, and during their southern migration from October to January. However, the presence of all cetacean species, including the pygmy blue whale, is likely to be limited to infrequent occurrences of individuals or small groups.

According to the data of Vanderlaan and Taggart (2007), it is estimated that the risk of lethal injury to a large whale as a result of a vessel strike is less than 10% at a speed of 4 knots. Vessel-whale collisions at this speed are uncommon and based on reported data contained in the NOAA database (Jensen and Silber, 2004) there only two known instances of collisions when the vessel was travelling at less than 6 knots; both of these were from whale-watching vessels that were deliberately positioned amongst whales. Given the duration of activities within the Operational Area and the slow speeds at which project vessels operate, collisions with cetaceans such as pygmy blue whales are considered highly unlikely.

Marine Turtles

Marine turtles are at potential risk from vessel strike and entanglement with towed seismic equipment. Hazel and Gyuris (2006) reviewed vessel strike data from 1999-2002 on the Queensland east coast and found that during that period at least 65 turtles were killed annually as a result of collisions with vessels. Green turtles, followed by loggerhead turtles comprised the majority of vessel related records, and 72% of cases were adult or sub-adult turtles (Hazel and Gyuris, 2006). In Australian waters, all species of marine turtle have been involved in vessel strikes (DoEE, 2016).

The effect of vessel speed and turtle flee response can be significant. A study by Hazel et al. (2007) found that 60% of green turtles fled from vessels travelling at 2.2 knots (4 km/h) while only 4% fled from vessels travelling at 10.2 knots (19 km/h). When fleeing 75% of turtles moved away from the vessel's track, 8% swam along the vessel track and 18% crossed in front of the vessel. The study concluded that most turtles would be unlikely to avoid vessels travelling at speeds greater than around 2.2 knots (Hazel et al., 2007; DoEE, 2017a). Furthermore, the relatively small size of turtles and the significant time spent below the surface makes their observation by vessel operators extremely difficult or impossible. Green turtles observed by Hazel et al. (2009) generally only exposed the dorsal-anterior part of the head above the surface of the water and never for longer than two seconds.

There is no published literature on marine turtle entanglement with seismic equipment during seismic surveys, however Nelms et al. (2016) state that they received anecdotal reports of turtle entrapments in tail buoys and airgun strings during several offshore seismic surveys off the west coast of Africa. Additionally, there is evidence of marine turtles becoming entangled in discarded seismic cable (Duncan et al., 2017).

There are no BIAs or Habitat Critical to the survival of marine turtles within the Operational Area. Due to the absence of potential nesting habitat and location offshore, the Operational Area is unlikely to represent important habitat for marine turtles. The occurrence of all species of marine reptiles within the Operational Area is expected to be limited to infrequent occurrences of transitory individuals. Given the duration of activities within the Operational Area and the slow speeds at which project vessels operate, collisions or entanglement with transiting marine turtles are considered highly unlikely.

Summary of Potential Impacts to Environmental Value(s)

Given the adopted controls, it is considered that if a collision or entanglement were to occur, it will not result in a potential impact greater than slight, short-term impact on the species (i.e. Environment Impact – E).

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[18]***	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
EPBC Regulations 2000 – Part 8 Division 8.1 Interacting with cetaceans, including the following measures[19]: • Project vessels will not travel faster than six knots within 300 m of a cetacean or turtle (caution zone) • Project vessels will not approach closer than 50 m for a dolphin or turtle and/or 100 m for a whale (with the exception of animals bow-riding). • If the cetacean or turtle shows signs of being disturbed, project vessels will immediately withdraw from the caution zone at a constant speed of less than six knots. • Vessels will not travel faster than eight knots within 250 m of a whale shark and not allow the vessel to approach closer than 30 m of a whale shark. Exception: the above requirement does not apply to project vessels operating under limited/constrained manoeuvrability including but not limited to seismic vessel towing equipment and acquiring data, and in the event of an emergency.	F: Yes. CS: Minimal cost. Standard practice.	Implementation of these controls will reduce the likelihood of a collision between a cetacean, whale shark or turtle occurring. The consequence of a collision is unchanged.	Controls based on legislative requirements – must be adopted.	Yes **C 15.1**
Good Practice				

[18] Qualitative measure

[19] For safety reasons, the distance requirements below are not applied for a vessel holding station or with limited manoeuvrability; e.g. loading, back-loading, bunkering, close standby cover for overside working and emergency situations.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[18]***	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Fit streamer tail buoys with appropriate turtle guards, or use a design that does not represent an entanglement risk for turtles.	F: Yes. CS: Minimal cost. Standard practice.	Implementing this control will reduce the likelihood of turtle entanglement.	Benefits outweigh cost/sacrifice. Control is also standard practice.	Yes **15.2**
Professional Judgement – Eliminate				
Eliminate use of vessels.	F: No. The use of vessels is required to conduct the Petroleum Activities Program. CS: Not considered – control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No
Professional Judgement – Substitute				
The use of dedicated MFOs on support vessel(s) for the duration of the Petroleum Activities Program to watch for cetaceans and marine turtles and provide direction on and monitor compliance with Part 8 of the EPBC Regulations.	F: Yes. Vessel bridge crews already maintain a constant watch during operations, and crew complete specific cetacean observation training. CS: Additional cost of MFOs considered unnecessary.	Given support vessel bridge crews already maintain a constant watch during operations, additional MFOs would not significantly further reduce the risk.	Grossly disproportionate. Implementation of the control requires considerable cost sacrifice for minimal environmental benefit.	No
Professional Judgement – Engineered Solution				
None identified.				
ALARP Statement On the basis of the environmental risk assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to manage the impacts and risks of potential vessel collision/entanglement with protected marine fauna. As no reasonable additional/alternative controls were identified that would further reduce the impacts and risks without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that, given the adopted controls, vessel collision/entanglement with marine fauna represents a low risk rating that is unlikely to result in a potential impact to fauna greater than slight and short term, with no population-level effects. Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice and meet the requirements of Part 8 (Division 8.1) of the EPBC Act Regulations 2000. The residual risk of vessel collision with marine fauna is not inconsistent with the relevant objectives and actions of any applicable recovery plans or threat abatement plans (refer to **Section 6.7**), based on the adopted controls. Regard has been given to relevant conservation advice during the assessment of potential risks. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks of vessel collision with marine fauna to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 15 No vessel strikes with marine fauna	**C 15.1** EPBC Regulations 2000 – Part 8 Division 8.1	**PS 15.1** Compliance with EPBC Regulations 2000 – Part 8	**MC 15.1.1** Records demonstrate no breaches of EPBC

<table>
<tr><th colspan="4">Environmental Performance Outcomes, Standards and Measurement Criteria</th></tr>
<tr><th>Outcomes</th><th>Controls</th><th>Standards</th><th>Measurement Criteria</th></tr>
<tr><td rowspan="3">(whales, whale sharks and turtles) during the Petroleum Activities Program.</td><td rowspan="2">Interacting with cetaceans, including the following measures[20]:
• Project vessels will not travel faster than six knots within 300 m of a cetacean or turtle (caution zone).
• Project vessels will not approach closer than 50 m for a dolphin or turtle and/or 100 m for a whale (with the exception of animals bow-riding).
• If the cetacean or turtle shows signs of being disturbed, project vessels will immediately withdraw from the caution zone at a constant speed of less than six knots.
• Vessels will not travel faster than eight knots within 250 m of a whale shark and not allow the vessel to approach closer than 30 m of a whale shark.
Exception: The above requirement does not apply to project vessels operating under limited/constrained manoeuvrability including but not limited to seismic vessel towing equipment and acquiring data, and in the event of an emergency.</td><td>Division 8.1 (Regulation 8.05 and 8.06) Interacting with cetaceans to minimise potential for vessel strike and application of these regulation to whale sharks and marine turtles.</td><td>Regulations 2000 – Part 8 Division 8.1 Interacting with cetaceans and application of these regulations to whale sharks and marine turtles.</td></tr>
<tr><td>PS 15.1.2
All vessel strike incidents with cetaceans will be reported in the National Ship Strike Database (as outlined in the Conservation Management Plan for the Blue Whale—A Recovery Plan under the EPBC Act 1999, Commonwealth of Australia, 2015).</td><td>MC 15.1.2
Records demonstrate reporting cetacean ship strike incidents to the National Ship Strike Database.</td></tr>
<tr><td>C 15.2
Fit streamer tail buoys with appropriate turtle guards, or use a design that does not represent an entanglement risk for turtles.</td><td>PS 15.2
Streamer tail-buoys to have appropriate turtle guards, or will be of a design that does not represent an entanglement risk for turtles.</td><td>MC 15.2.1
Records confirm that turtle guards have been fitted appropriately (or are not necessary due to design of tail-buoys).</td></tr>
</table>

[20]For safety reasons, the distance requirements below are not applied for a vessel holding station or with limited manoeuvrability; e.g. loading, back-loading, bunkering, close standby cover for overside working and emergency situations.

6.6.7 Physical Presence: Loss of Equipment

Context		
Activity Components – **Section 3.6**	Biological Environment – **Section 4.5** Socio-Economic Environment – **Section 4.9**	Stakeholder Consultation – **Section 5**

Impact Evaluation Summary														
Source of Impact	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl Odour)	Ecosystems/ Habitat	Species	Socio-Economic	Decision Type	Consequence/Impact	Likelihood	Risk Rating	ALARP Tools	Acceptability	Outcomes
Physical loss of seismic equipment (i.e. streamers, acoustic source and AUV nodes).					x		x	A	F	2	L	LCS GP	Broadly Acceptable	EPO 16

Description of Source of Risk
The Petroleum Activities Program will be conducted using a single purpose-built seismic vessel. The seismic vessel will tow seismic equipment (comprising the acoustic source, header buoys, starboard and port spreaders or vanes, streamers and tail buoys). The seismic vessel may tow up to 14 streamers, approximately 8000 m in length, towed approximately 500 m behind the seismic vessel and, therefore, extending approximately 8.5 km behind the vessel. The streamer(s) will be towed at a depth of approximately 15 – 25 m. The seismic source will be towed at a depth of approximately 6 to 8 m. The streamers will be fitted with streamer recovery devices (SRDs) that will automatically deploy inflatable air bags to raise the streamer to the service for retrieval. In addition, up to 50 seismic nodes (combined AUV and commercial nodes) may be deployed in the Active Source Area. When deployed, the nodes will be laid out in a grid of approximately 500 m x 500 m in a 10 km² area) of seabed within the Active Source Area. The AUV nodes will relocate autonomously up to five times, each time landing near a commercial node. The AUV nodes will be moved in a staged approach during the Petroleum Activities Program (i.e. the nodes will not be moving all at the same time, except for during deployment and retrieval). The AUV nodes are expected to be deployed for the duration of the Petroleum Activities Program. The proposed AUV nodes are cylindrical in shape with short wings on the side for flight stabilisation and steering, at approximately 1000 mm long and 300 mm in diameter (weights approximately 30 kg in air and 10 kg in sea water). The AUV nodes are based on current autonomous technology as developed with gliders (e.g. Slocum) that move through the water column by changing buoyancy. The AUV nodes, however are adapted to and settle for periods of time on the seabed to record the seismic signal. As a control, the AUV nodes will be fitted with thrusters to be periodically used for propulsion, navigation assistance, managing low impact landings and to assist with take-offs as required. Recovery devices are included within each AUV node, which will deploy inflatable air bags to raise the node to the surface if the node is unable to do so with its normal functioning. Commercial nodes will be used to 'ground truth' the AUV nodes. The proposed commercial nodes weigh approximately 21 kg (9.5 kg in sea water) and measure approximately 350 mm (L), by 300 mm (W) and 150 mm (H). Commercial nodes are weighted to the seafloor by a concrete pad, approximately 450 mm (L), by 500 mm (W) and 50 mm (H) (weights approximately 25 kg in air and 16 kg in seawater), which will degrade over time. The commercial nodes are deployed to the seabed via gravity and recovered via negative buoyancy with the use of SRD (self-recovery devices) that activate an inflatable air bag type device. Loss of this equipment has the potential to cause minor physical damage to seabed and benthic communities, and temporary disturbance to marine users (i.e. commercial fishers).

Consequence Assessment
Potential Impacts to Environmental Values
Benthic Habitat and Communities In the unlikely event of loss of seismic equipment during the Petroleum Activities Program, potential environmental effects would be limited to physical impacts to the seabed and benthic communities. During normal operations, it is considered highly unlikely for streamers to sink and impact the seabed, given the tow depth of streamers (~ 15 – 25 m) and the application of depth control built into the design (SRDs). Similarly, the AUV/commercial nodes will be fitted with recovery devices. The Operational Area is expected to consist primarily of fine grain, soft sediments. The seabed is likely to be inhabited by a low abundance of filter feeders (primarily echinoderms) and other epifauna and infauna. The Operational Area lies within the Exmouth Plateau KEF. This KEF 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 1000 m (DOEE, n.d.). Additionally, the Operational Area overlaps entirely with the Northwest Province, which typically supports a low abundance, richness and diversity of benthic communities (Heyward et al., 2001). Given the size of seismic equipment, only a relatively small area of the seabed would be disturbed and no lasting impacts to benthic habitats are expected. ***Commercial Fisheries and Other Marine Users*** In the unlikely event that equipment is lost, any commercial fisheries and/or other marine users of the Operational Area may be required to make minor diversions to avoid the equipment, until it can be retrieved (if possible). The potential for such interactions will be limited to a short period of time while the equipment is retrieved (if possible). Should disruption occur, it is expected to affect individual users and cause a temporary disruption through avoidance of a highly localised area. Given the nature and size of the equipment to be used during the survey, lost equipment may result in a minor navigational hazard. Therefore, anticipated impacts are expected to be low.
Summary of Potential Impacts to Environmental Value(s)
Given the adopted controls, it is considered that a loss of seismic equipment (i.e. seismic streamers, acoustic source and AUV/commercial nodes) to the seabed will not result in a potential impact greater than localised disruption to a small area of the seabed, a small portion of the benthic population and no impact on critical habitat or activity.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[21]***	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Comply with Marine Order 21 (safety and emergency arrangements) 2016, including: • adherence to minimum safe manning levels • maintenance of navigation equipment in efficient working order (compass/radar) • navigational systems and equipment required are those specified in Regulation 19 of Chapter V of SOLAS	F: Yes. CS: Minimal cost. Standard practice.	Legislative requirement to reduce the likelihood of interference with other marine users resulting in a collision.	Controls based on legislative requirements – must be adopted	Yes **C 16.1**

[21] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[21]***	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
• AIS that provides other users with information about the vessel's identity, type, position, course, speed, navigational status and other safety-related data.				
Good Practice				
Deploy, retrieve and operate streamers as per predetermined procedures, including: • Streamers will only be deployed in suitable sea state in accordance with contractors Matrix of Permitted Operations (MOPO) or similar.	F: Yes. CS: Minimal cost. Standard practice.	Implementing this control will reduce the likelihood of equipment loss. The consequence is unchanged.	Benefit outweighs cost/ sacrifice.	Yes **C 16.2**
Streamers fitted with steering devices in the form of remote controlled wings/fins, and real-time monitoring equipment.	F: Yes. CS: Minimal cost. Standard practice.	Implementing this control will reduce the likelihood of equipment loss. The consequence is unchanged.	Benefit outweighs cost/ sacrifice.	Yes **C 16.3**
Activate pressure-activated SRDs within streamers and AUVs in the event of loss, to bring the equipment to the surface.	F: Yes. CS: Minimal cost. Standard practice.	Implementing this control will reduce the likelihood of equipment loss. The consequence is unchanged.	Benefit outweighs cost/ sacrifice.	Yes **C 16.4**
Lost equipment will be recovered, where safe and practicable. Where safe and practicable for this activity, will consider: • risk to personnel to retrieve object • whether the location of the equipment is known or in recoverable water depths • equipment's proximity to subsea infrastructure • ability to recover the equipment (i.e. nature of equipment, lifting equipment and suitable weather).	F: Yes, however it may not always be practicable. Assessed on a case by case situation. CS: Minimal cost. Standard practice.	No reduction in likelihood, as this is an unplanned event. Since the equipment may be recovered, a reduction in consequence is possible.	Benefit outweighs cost/ sacrifice.	Yes **C 16.5**

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)[21]***	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Nodes designed with appropriate tracking and monitoring systems including: • AUVs will be pre-programmed with the planned movements prior to deployment • sub-surface positioning can be tracked via USBL while AUV is moving • surface live positioning AUV/commercial nodes is tracked via two GNSS systems. • nodes can be monitored from vessel via health check system; if significant issues are identified buoyancy air-bag will be deployed to bring the node to the surface and tracking systems will allow for retrieval.	F: Yes. CS: Minimal cost.	Implementation of these controls will reduce the likelihood of AUV's being lost and unable to be recovered. The consequence of an AUV being lost to the marine environment is unchanged.	Benefits outweigh the cost/sacrifice.	Yes **C 3.1**
Professional Judgement – Eliminate				
None identified.				
Professional Judgement – Substitute				
Use modified short marine towed streamer(s) (approximately 1.5 to 3 km in length).	F: No. CS: Shorter streamers result in a significant loss of data, especially in deeper waters, and would not enable the survey to image the target depth below mudline.	Not considered – control not feasible.	Not considered – control not feasible.	No
Professional Judgement – Engineered Solution				
None identified.				
ALARP Statement On the basis of the environmental risk assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to manage the impacts and risks to benthic communities from the loss of seismic equipment to the seabed. As no reasonable additional/alternative controls were identified that would further reduce the impacts and risks without grossly disproportionate sacrifice, the impacts and risks are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that, given the adopted controls, potential loss of seismic equipment to the seabed represent a consequence to benthic community/habitat structure limited to no lasting effect. Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good

Demonstration of Acceptability
oil-field practice/industry best practice. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks to marine sediment from loss of seismic equipment to an acceptable level.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 16 No loss of seismic equipment (i.e. streamers, acoustic source and AUV / commercial nodes) with a consequence level greater than F[22] for the duration of the Petroleum Activities Program.	**C 16.1** Comply with Marine Order 21 (safety and emergency arrangements) 2020, including: • adherence to minimum safe manning levels • maintenance of navigation equipment in efficient working order (compass/radar) • navigational systems and equipment required are those specified in Regulation 19 of Chapter V of SOLAS • AIS that provides other users with information about the vessel's identity, type, position, course, speed, navigational status and other safety-related data.	**PS 16.1** Project vessels compliant with Marine Order 21 (safety of navigation and emergency procedures) 2016.	**MC 16.1.1** Records demonstrate compliance with standard maritime safety procedures (Marine Orders 21 and 30).
	C 16.2 Deploy, retrieve and operate streamers as per predetermined procedures, including: • Streamers will only be deployed in suitable sea state in accordance with contractors MOPO or similar.	**PS 16.2** Seismic vessel compliance with predetermined procedures on deployment, retrieval and operation of streamers.	**MC 16.2.1** Records confirm that seismic vessel hold procedures for streamer deployment, retrieval and operation. **MC 16.2.2** Daily report demonstrates that streamers were deployed in accordance with contractors MOPO.
	C 16.3 Streamers fitted with steering devices in the form of remote controlled wings/fins, and real-time monitoring equipment.	**PS 16.3** Ability to control streamer depth and location of streamer in relation to the seabed is known at all times.	**MC 16.3.1** Records confirm streamers are fitted with steerable wings/fins, and real-time monitoring equipment.
	C 16.4 Activate pressure-activated SRDs within streamers the event of loss, to bring the equipment to the surface.	**PS 16.4** Streamers and AUV nodes fitted with SRDs.	**MC 16.4.1** Records confirm streamers are fitted with pressure-activated SRDs.
	C 16.5	**PS 16.5**	**MC 16.5.1**

[22] Defined as 'No lasting effect (<1 month) or negligible impact. Localised impact not significant to environmental receptors.'

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
	Lost equipment will be recovered, where safe and practicable. Where safe and practicable for this activity, will consider: • risk to personnel to retrieve object • whether the location of the equipment is known or is in recoverable water depths • equipment's proximity to subsea infrastructure • ability to recover the equipment (i.e. nature of equipment, lifting equipment and suitable weather).	Lost equipment recovered where safe and practicable to do so.	Records detail the recovery of equipment lost to the marine environment.
	C 3.1 See Section **6.5.2**	**PS 3.1** See Section **6.5.2**	**MC 3.1.1** See Section **6.5.2**
		PS 3.2 See Section **6.5.2**	**MC 3.2.1** See Section **6.5.2**

6.6.8 Physical Presence: Introduction and Establishment of Invasive Marine Species

Context		
Project Vessels – **Section 3.6.5**	Physical Environment – **Section 4.4** Biological Environment – **Section 4.5**	Stakeholder Consultation – **Section 5**

Impact Evaluation Summary

Source of Impact	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl Odour)	Ecosystems/ Habitat	Species	Socioeconomic	Decision Type	Consequence/Impact	Likelihood	Risk Rating	ALARP Tools	Acceptability	Outcomes
Introduction and establishment of invasive marine species (IMS)					X	X	X	A	D	0	L	LCS GP	Broadly Acceptable	EPO 17

Description of Source of Risk

During the Petroleum Activities Program, vessels and submersible equipment have the potential to introduce IMS to the Operational Area.

Vessels

Vessels will be transiting to and from the Operational Area, potentially including traffic mobilising from international waters. There is the potential for project vessels to transfer IMS from either international waters, Australian waters or coastal waters into the Operational Area.

All vessels are subject to some level of marine fouling. Organisms attach to the vessel hull, particularly in areas where organisms can find a good attachment surface (e.g. seams, strainers and unpainted surfaces) or where turbulence is lowest (e.g. niches, sea chests, etc.). Commercial vessels typically maintain anti-fouling coatings to reduce the build-up of fouling organisms. Organisms can also be drawn into ballast tanks during on-boarding of ballast water required to maintain safe operating conditions.

Project vessels have the potential to introduce IMS to the Operational Area through marine biofouling (containing IMS) on vessels, as well as within high-risk ballast water exchange. Cross-contamination between vessels can also occur (e.g. IMS translocated between project vessels) during times when vessels need to be alongside each other.

Submersible Equipment

Submersible equipment required for the activity (seismic array, AUV/commercial nodes) is transported to and used within the Operational Area. There is the potential that this equipment may be used on other projects before being used on this activity. As a consequence, there is the potential for IMS translocation.

Consequence Assessment

Potential Impacts to Environmental Values

IMS are a subset of Non-Indigenous Marine Species (NIMS) that have been introduced into a region beyond their natural biogeographic range, resulting in impacts to social/cultural, human health, economic and/or environmental values. NIMS are species that have the ability to survive, reproduce and establish founder populations. However, not all NIMS introduced into an area will thrive or cause demonstrable impacts. The majority of NIMS around the world are relatively benign and few have spread widely beyond sheltered ports and harbours. NIMS are only considered IMS when they result in impacts to environmental values and/or have social/cultural, economic and/or human health impacts.

Once introduced, IMS may prey on local species (which had previously not been subject to this kind of predation and therefore not have evolved protective measures against the attack), they may outcompete indigenous species for food, space or light and can also interbreed with local species, creating hybrids such that the endemic species is lost. These changes to the local marine environment result in changes to the natural ecosystem.

IMS have also proven economically damaging to areas where they have been introduced and established. Such impacts include direct damage to assets (fouling of vessel hulls and infrastructure) and depletion of commercially harvested marine life (e.g. shellfish stocks). IMS have proven particularly difficult to eradicate from areas once established. If the introduction is detected early, eradication may be effective but is likely to be expensive, disruptive and, depending on the method of eradication, harmful to other local marine life.

Potential IMS have historically been introduced and translocated around Australia by a variety of natural and human means, including marine fouling and ballast water. Potential IMS vary from one region to another depending on various environmental factors such as water temperature, salinity, nutrient levels and habitat type, which dictate their survival and invasive capabilities. IMS typically require hard substrate in the photic zone; therefore, requiring shallow waters to become established. Highly-disturbed, shallow-water environments such as shallow coastal waters, ports and marinas are more susceptible to IMS colonisation, whereas IMS are generally unable to successfully establish in deep-water ecosystems and open-water environments where the rate of dilution and the degree of dispersal are high (Williamson and Fitter, 1996; Paulay et al., 2002; Geiling, 2014).

Project vessels and submersible equipment required to undertake the Petroleum Activities Program have the potential to introduce IMS into the Operational Area. Due to the deep water depths (>800 m) and lack of submerged banks/shoals within the Operational Area and surrounding waters, settlement and establishment of IMS is not considered credible. Furthermore, the likelihood is considered remote, given the open-water environment of the Operational Area, distance from shorelines (>200 km) and/or critical habitat and the control measures proposed to be implemented (as outlined below).

Summary of Potential Impacts to Environmental Value(s)

In support of Woodside's assessment of the risks and consequences of IMS introduction associated with the Petroleum Activities Program, Woodside conducted a risk and impact evaluation of the different aspects of an IMS translocation. The results of this assessment are presented in **Table 6-18.**

As a result of this assessment, Woodside has assessed the potential consequence and likelihood after implementing the identified controls. This assessment concluded that the highest potential consequence is a 'D' and the likelihood is 'Remote' (0), resulting in an overall 'Low' risk.

Table 6-18 Evaluation of risks and impacts from marine pest translocation

IMS Introduction Location	Credibility of Introduction	Consequence of Introduction	Likelihood
Introduced to the Operational Area and establishment on the seafloor.	***Not Credible*** The Operational Area is in deep offshore open waters away from shorelines and/or critical habitat; therefore, they are not conducive to the settlement and establishment of IMS.		
Introduced to the Operational Area and establishment on a project vessel.	***Credible*** There is potential to transfer marine pests between project vessels within the Operational Area	***Environment – not credible*** The translocation of IMS from a colonised project vessel to another vessel via natural dispersion is not credible. This is because of the open-water environment of the Operational Area and distance from shorelines and/or critical habitat. On this basis there is no credible environmental risk. Reputation – D If IMS were on a project vessel, this could potentially impact the vessel operationally through the fouling of intakes and, potentially transfer of an IMS to other support vessels, which would likely result in the quarantine of the vessel until eradication could occur (through cleaning and treatment of infected areas), which would be costly	***Remote (0)*** Interactions between project vessels will be limited during the Petroleum Activities Program, with a 3 nm SNA around the seismic vessel, and interactions limited to short periods of time alongside (i.e. during bunkering activities). Spread of marine pests via ballast water in these open ocean environments is not considered credible due to the lack of suitable habitat for settlement and

		to perform. Such introduction would be expected to have minor impact to Woodside's reputation, particularly with Woodside's contractors, and would likely have a reputational impact on future proposals.	establishment.
Transferred between project vessels and from project vessels to other marine environments beyond the Operational Area (i.e. transfer IMS from seismic vessel to a support vessel and then to another environment).	***Not Credible*** The risk is considered so remote that it is not considered credible for the purposes of the activity. As described above, the transfer of IMS between project vessels was already considered remote, given the offshore open ocean environment. Project vessels will be located in an offshore, open ocean environment, where IMS survival is implausible. Furthermore, this marine pest, once transferred, would need to survive on a new vessel that has good hygiene (i.e. has been through Woodside's risk assessment process), and survive the transport back from the Operational Area to shore. If it survived this trip, it would then need conditions conducive to establishing a viable population in nearshore waters to which the infected vessel travels.		

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS*** [23]	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Project vessels will manage their ballast water using one of the approved ballast water management options, as outlined in the Australian Ballast Water Management Requirements.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of transferring marine pests between project vessels within the Operational Area. No change in consequence would occur.	Controls based on legislative requirements under the *Biosecurity Act 2015* – must be adopted.	Yes **C 17.1**
Good Practice				
Woodside's IMS risk assessment process[24] will be applied to project vessels, immersible equipment and AUVs /Commercial Nodes undertaking the Petroleum Activities Program. Assessment will consider these risk factors: For vessels: • vessel type • recent IMS inspection and cleaning history, including for internal niches	F: Yes. CS: Minimal cost. Good practice implemented across all Woodside Operations.	Identifies potential risks and additional controls implemented accordingly. In doing so, the likelihood of transferring marine pests between project vessels, immersible equipment and AUVs / Commercial Nodes within the Operational Area is reduced. No change in consequence would occur.	Benefits outweigh cost/sacrifice.	Yes **C 17.2**

[23] Qualitative measure

[24] Woodside's IMS risk assessment process was developed with regard to the national biofouling management guidelines for the petroleum production and exploration industry and guidelines for the control and management of a ships' biofouling to minimise the transfer of invasive aquatic species (IMO Guidelines, 2011).

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS*** [23]	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
• out-of-water period before mobilisation • age and suitability of antifouling coating at mobilisation date • internal treatment systems and history • origin and proposed area of operation • number of stationary/slow speed periods >7 days • region of stationary or slow periods • type of activity – contact with seafloor. For immersible equipment: • region of deployment since last thorough clean, particularly coastal locations • duration of deployments • duration of time out of water since last deployment • transport conditions during mobilisation • post-retrieval maintenance regime. Based on the outcomes of each IMS risk assessment, management measures commensurate with the risk (such as treating internal systems, IMS inspections or cleaning) will be implemented to minimise the likelihood of IMS being introduced.				
Professional Judgement – Eliminate				

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS [23]***	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
Do not discharge ballast water during the Petroleum Activities Program.	F: No. Ballast water discharges are critical for maintain vessel stability. Given the nature of the Petroleum Activities Program, the use of ballast (including the potential discharge of ballast water) is considered to be a safety-critical requirement. CS: Not assessed, control not feasible.	Not assessed, control not feasible.	Not assessed, control not feasible.	No
Eliminate use of vessels including the seismic vessel and support vessel(s).	F. No. Given that vessels must be used to complete the Petroleum Activities Program, there is no feasible means to eliminate the source of risk. CS. Loss of the project.	Not assessed, control not feasible.	Not assessed, control not feasible.	No
Professional Judgement – Substitute				
Source project vessels based in Australia only.	F. Potentially. Limiting activities to only use local project vessels could potentially pose a significant risk in terms of the time and duration of sourcing a vessel, as well as the ability of the local vessel to perform the tasks. While the project will attempt to source support vessels locally, it is not always possible. Availability cannot always be guaranteed. There are limited project vessels based in Australian waters and sourcing Australian-based vessels only will cause increases in cost due to pressures of vessel availability. CS: Significant cost and schedule impacts due to supply restrictions.	Sourcing vessels from within Australia will reduce the likelihood of IMS introduction from outside Australian waters; however, it does not reduce the likelihood of introducing species native to Australia but alien to the Operational Area. It also does not prevent the translocation of IMS that have established elsewhere in Australia. Therefore, the consequence is unchanged.	Disproportionate. Sourcing vessels from Australian waters may result in a slight reduction in the likelihood of introducing IMS to the Operational Area, however it does not completely eliminate the risk. Furthermore, the potential cost of implementing this control could be high, given the potential supply issues associated with only locally sourcing vessels.	No
IMS inspection of all vessels	F: Yes CS. Significant cost and schedule impacts. In addition, Woodside's IMS risk assessment process is seen to be more cost-effective as this control allows Woodside to manage the introduction of	Inspection of all vessels for IMS would reduce the likelihood of IMS being introduced to the Operational Area. However, this reduction is unlikely to be significant, given the other control measures implemented. No	Disproportionate. The cost/sacrifice outweighs the benefit gained, as other controls that are proposed to be implemented achieve ALARP position.	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS*** [23]	***Benefit/Reduction in Impact***	***Proportionality***	***Control Adopted***
	IMS through biofouling, while targeting efforts and resources to the areas of greatest concern.	change in consequence would occur.		
Professional Judgement – Engineered Solution				
None identified.				
ALARP Statement On the basis of the environmental risk assessment outcomes and use of the relevant tools appropriate to the decision type (i.e. Decision Type A), Woodside considers the adopted controls appropriate to manage the risks and consequences of IMS introduction. As no reasonable additional/alternative controls were identified that would further reduce the risks and consequences without disproportionate sacrifice, the risks and consequences are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that, given the adopted controls, introduction of IMS to the Operational Area through ballast water or biofouling on vessels or in-water equipment represents a low residual risk that has a remote likelihood of resulting in a potential impact greater than minor and short term (one to two years) to a small proportion of the benthic community. Further opportunities to reduce the impacts and risks have been investigated above. The adopted controls are considered good oil-field practice/industry best practice. The potential impacts and risks are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts and risks of introducing IMS to the Operational Area to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 17 No introduction and establishment of invasive marine species into the Operational Area as a result of the Petroleum Activities Program.	**C 17.1** Project vessels will manage their ballast water using one of the approved ballast water management options, as outlined in the Australian Ballast Water Management Requirements.	**PS 17.1** Project vessels will manage ballast water in accordance with Australian Ballast Water Management Requirements.	**MC 17.1.1** Ballast Water Records System maintained by vessels which verifies compliance against Australian Ballast Water Management Requirements.
	C 17.2 Woodside's IMS risk assessment process[25] will be applied to project vessels, immersible equipment and AUVs undertaking the Petroleum Activities Program. Assessment will consider these risk factors: For vessels:	**PS 17.2.1** Before entering the Operational Area project vessels, immersible equipment and AUVs are determined to be low risk[26] of introducing IMS of concern, and maintain this low risk status to mobilisation.	**MC 17.2.1** Records of IMS risk assessments maintained for all project vessels and relevant immersible equipment entering the Operational Area or IMS management area to undertake the Petroleum Activities Program.

[25] Woodside's IMS risk assessment process was developed with regard to the national biofouling management guidelines for the petroleum production and exploration industry and guidelines for the control and management of a ships' biofouling to minimise the transfer of invasive aquatic species (IMO Guidelines, 2011).
[26] Low risk of introducing IMS of concern is defined as either no additional management measures required or, management measures have been applied to reduce the risk.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
	• vessel type • recent IMS inspection and cleaning history, including for internal niches • out-of-water period before mobilisation • age and suitability of antifouling coating at mobilisation date • internal treatment systems and history • origin and proposed area of operation • number of stationary/slow speed periods >7 days • region of stationary or slow periods • type of activity – contact with seafloor. For immersible equipment: • region of deployment since last thorough clean, particularly coastal locations • duration of deployments • duration of time out of water since last deployment • transport conditions during mobilisation • post-retrieval maintenance regime. Based on the outcomes of each IMS risk assessment, management measures commensurate with the risk (such as treating internal systems, IMS inspections or cleaning) will be implemented to minimise the likelihood of IMS being introduced.	**PS 17.2.2** In accordance with Woodside's IMS risk assessment process, the IMS risk assessments will be undertaken by an authorised environment adviser who has completed relevant Woodside IMS training or by qualified and experienced IMS inspector.	**MC 17.2.2** Records confirm that the IMS risk assessments undertaken by an Environment Adviser or IMS inspector (as relevant).

6.7 Recovery Plan and Threat Abatement Plan Assessment

As described in **Section 2,** NOPSEMA will not accept an EP that is inconsistent with a recovery plan or threat abatement plan for a listed threatened species or ecological community. This section describes the assessment that Woodside has undertaken to demonstrate that the Petroleum Activities Program is not inconsistent with any relevant recovery plans or threat abatement plans. For the purposes of this assessment, the relevant Part 13 statutory instruments (recovery plans and threat abatement plans) are:

- Recovery Plan for Marine Turtles in Australia 2017–2027 (DoEE, 2017a).
- Conservation Management Plan for the Blue Whale 2015–2025 (DoE, 2015a).
- Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) 2014 (DoE, 2014).
- Sawfish and River Shark Multispecies Recovery Plan (DoE, 2015b)
- Threat Abatement Plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans 2018 (DoEE, 2018).

Table 6-19 lists the objectives and (where relevant) the action areas of these plans, and also describes whether these objectives/action areas are applicable to government, the Titleholder, and/or the Petroleum Activities Program. For those objectives/action areas applicable to the Petroleum Activities Program, the relevant actions of each plan have been identified, and an evaluation has been conducted as to whether impacts and risks resulting from the activity are clearly inconsistent with that action or not. The results of this assessment against relevant actions are presented in **Table 6-20** to **Table 6-24.**

Table 6-19: Identification of applicability of recovery plan and threat abatement plan objectives and action areas

EPBC Act Part 13 Statutory Instrument	Applicable to:		
	Government	***Titleholder***	***Petroleum Activities Program***
Marine Turtle Recovery Plan			
Long-term Recovery Objective: Minimise anthropogenic threats to allow for the conservation status of marine turtles to improve so they can be removed from the EPBC Act threatened species list	Y	Y	Y
Interim Recovery Objectives			
Current levels of legal and management protection for marine turtle species are maintained or improved, both domestically and throughout the migratory range of Australia's marine turtles	Y		
The management of marine turtles is supported	Y		
Anthropogenic threats are demonstrably minimised	Y	Y	Y
Trends in nesting numbers at index beaches and population demographics at important foraging grounds are described	Y	Y	
Action Areas			
A. Assessing and addressing threats			
A1. Maintain and improve efficacy of legal and management protection	Y		
A2. Adaptively manage turtle stocks to reduce risk and build resilience to climate change and variability	Y		
A3. Reduce the impacts of marine debris	Y	Y	Y
A4. Minimise chemical and terrestrial discharge	Y	Y	Y
A5. Address international take within and outside Australia's jurisdiction	Y		
A6. Reduce impacts from terrestrial predation	Y		
A7. Reduce international and domestic fisheries bycatch	Y		
A8. Minimise light pollution	Y	Y	Y
A9. Address the impacts of coastal development/infrastructure and dredging and trawling	Y	Y	

EPBC Act Part 13 Statutory Instrument	Applicable to:		
	Government	***Titleholder***	***Petroleum Activities Program***
A10. Maintain and improve sustainable Indigenous management of marine turtles	Y		
B. Enabling and measuring recovery			
B1. Determine trends in index beaches	Y	Y	Y
B2. Understand population demographics at key foraging grounds	Y		
B3. Address information gaps to better facilitate the recovery of marine turtle stocks	Y	Y	Y
Blue Whale Conservation Management Plan			
Long-term recovery objective: Minimise anthropogenic threats to allow for their conservation status to improve so that they can be removed from the EPBC Act threatened species list	Y	Y	Y
Interim Recovery Objectives			
The conservation status of blue whale populations is assessed using efficient and robust methodology	Y		
The spatial and temporal distribution, identification of biologically important areas, and population structure of blue whales in Australian waters is described	Y	Y	Y
Current levels of legal and management protection for blue whales are maintained or improved and an appropriate adaptive management regime is in place	Y		
Anthropogenic threats are demonstrably minimised	Y	Y	Y
Action Areas			
A. Assessing and addressing threats			
A.1: Maintain and improve existing legal and management protection	Y		
A.2: Assessing and addressing anthropogenic noise	Y	Y	Y
A.3: Understanding impacts of climate variability and change	Y		
A.4: Minimising vessel collisions	Y	Y	Y
B. Enabling and Measuring Recovery			

EPBC Act Part 13 Statutory Instrument	Applicable to:		
	Government	***Titleholder***	***Petroleum Activities Program***
B.1: Measuring and monitoring population recovery	Y		
B.2: Investigating population structure	Y		
B.3: Describing spatial and temporal distribution and defining biologically important habitat	Y	Y	Y
Grey Nurse Shark Recovery Plan			
Overarching Objective			
To assist the recovery of the grey nurse shark in the wild, throughout its range in Australian waters, with a view to: improving the population status, leading to future removal of the grey nurse shark from the threatened species list of the EPBC Act ensuring that anthropogenic activities do not hinder the recovery of the grey nurse shark in the near future, or impact on the conservation status of the species in the future	Y	Y	Y
Specific Objectives			
Develop and apply quantitative monitoring of the population status (distribution and abundance) and potential recovery of the grey nurse shark in Australian waters	Y		
Quantify and reduce the impact of commercial fishing on the grey nurse shark through incidental (accidental and/or illegal) take, throughout its range	Y		
Quantify and reduce the impact of recreational fishing on the grey nurse shark through incidental (accidental and/or illegal) take, throughout its range	Y		
Where practicable, minimise the impact of shark control activities on the grey nurse shark	Y		
Investigate and manage the impact of ecotourism on the grey nurse shark	Y		
Manage the impact of aquarium collection on the grey nurse shark	Y		
Improve understanding of the threat of pollution and disease to the grey nurse shark	Y	Y	Y
Continue to identify and protect habitat critical to the survival of the grey nurse shark and reduce the impact of threatening processes within these areas	Y	Y	
Continue to develop and implement research programs to support the conservation of the grey nurse shark	Y	Y	

EPBC Act Part 13 Statutory Instrument	Applicable to:		
	Government	***Titleholder***	***Petroleum Activities Program***
Promote community education and awareness in relation to grey nurse shark conservation and management	Y		
Sawfish and River Sharks Recovery Plan			
Primary Objective			
To assist the recovery of sawfish and river sharks in Australian waters with a view to: improving the population status leading to the removal of the sawfish and river shark species from the threatened species list of the EPBC Act ensuring that anthropogenic activities do not hinder recovery in the near future, or impact on the conservation status of the species in the future	Y	Y	Y
Specific Objectives			
Reduce and, where possible, eliminate adverse impacts of commercial fishing on sawfish and river shark species	Y		
Reduce and, where possible, eliminate adverse impacts of recreational fishing on sawfish and river shark species	Y		
Reduce and, where possible, eliminate adverse impacts of Indigenous fishing on sawfish and river shark species	Y		
Reduce and, where possible, eliminate the impact of illegal, unregulated and unreported fishing on sawfish and river shark species	Y		
Reduce and, where possible, eliminate adverse impacts of habitat degradation and modification on sawfish and river shark species	Y	Y	Y
Reduce and, where possible, eliminate any adverse impacts of marine debris on sawfish and river shark species noting the linkages with the Threat Abatement Plan for the Impact of Marine Debris on Vertebrate Marine Life	Y	Y	Y
Reduce and, where possible, eliminate any adverse impacts of collection for public aquaria on sawfish and river shark species	Y		
Improve the information base to allow the development of a quantitative framework to assess the recovery of, and inform management options for, sawfish and river shark species	Y		
Develop research programs to assist conservation of sawfish and river shark species	Y	Y	
Improve community understanding and awareness in relation to sawfish and river shark conservation and management	Y		

EPBC Act Part 13 Statutory Instrument	Applicable to:		
	Government	***Titleholder***	***Petroleum Activities Program***
Marine Debris Threat Abatement Plan			
Objectives			
Contribute to long-term prevention of the incidence of marine debris	Y	Y	
Understand the scale of impacts from marine plastic and microplastic on key species, ecological communities and locations	Y	Y	Y
Remove existing marine debris	Y		
Monitor the quantities, origins, types and hazardous chemical contaminants of marine debris, and assess the effectiveness of management arrangements for reducing marine debris	Y		
Increase public understanding of the causes and impacts of harmful marine debris, including microplastic and hazardous chemical contaminants, to bring about behaviour change	Y		

Table 6-20: Assessment against relevant actions of the Marine Turtle Recovery Plan

Part 13 Statutory Instrument	Relevant Action Areas/Objectives	Relevant Actions	Evaluation	EPO, Controls and PS
Marine Turtle Recovery Plan	**Action Area A3**: Reduce the impacts from marine debris	**Action**: Support the implementation of the Marine Debris Threat Abatement Plan (TAP) Priority actions at stock level: • G-NWS – understand the threat posed to this stock by marine debris • LH-WA – determine the extent to which marine debris is impacting loggerhead turtles • F-Pil and H-WA – no relevant actions	Refer **Section 6.6.5** **Not inconsistent assessment**: The assessment of accidental release of solid hazardous and non-hazardous wastes has considered the potential risks to marine turtles.	**EPO 13** **C 13.1** **PS 13.1**
	Action Area A4: Minimise chemical and terrestrial discharge	**Action**: Ensure spill risk strategies and response programs adequately include management for marine turtles and their habitats, particularly in reference to 'slow to recover habitats', e.g. nesting habitat, seagrass meadows or coral reefs Priority actions at stock level: • G-NWS – ensure that spill risk strategies and response programs include management for turtles and their habitats • LH-WA, F-Pil – ensure that spill risk strategies and response programs include management for turtles and their habitats, particularly in reference to slow to recover habitats, e.g. seagrass meadows or corals • H-WA – no relevant actions	Refer **Sections 6.6.2, 6.6.3** and **6.6.4** **Not inconsistent assessment**: The assessment of accidental release of chemicals / hydrocarbons has considered the potential risks to marine turtles. Spill risk strategies and response program include management measures for turtles and their nesting habitats.	Refer **Section 7.10**. Detailed oil spill preparedness and response performance outcomes, standards and measurement criteria for the Petroleum Activities Program are present in **Appendix D.**
	Action Area A8: Minimise light pollution	**Action**: Artificial light within or adjacent to habitat critical to the survival of marine turtles will be managed such that marine turtles are not displaced from these habitats Priority actions at stock level: • G-NWS – as above • LH-WA – no relevant actions	Refer **Section 6.5.7.** **Not inconsistent assessment**: The assessment of light emissions has considered the potential impacts to marine turtles. Internesting, mating, foraging or migrating turtles are not impacted by light from offshore vessels. Vessel light emissions could cause localised and temporary behavioural disturbance to isolated transient individuals,	N/A

Part 13 Statutory Instrument	Relevant Action Areas/Objectives	Relevant Actions	Evaluation	EPO, Controls and PS
		• F-Pil and H-WA – manage artificial light from onshore and offshore sources to ensure biologically important behaviours of nesting adults and emerging/dispersing hatchlings can continue	which is unlikely to result in displacement of adult turtles from internesting or nesting habitat critical to the survival of marine turtles.	
	Action Area B1: Determine trends at index beaches	**Action**: Maintain or establish long-term monitoring programs at index beaches to collect standardised data critical for determining stock trends, including data on hatchling production Priority actions at stock level: • G-NWS – continue long-term monitoring of index beaches • LH-WA – continue long-term monitoring of nesting and foraging populations • F-Pil and H-WA – no relevant actions	**Not inconsistent assessment**: Woodside contributes to Action Area B1 via its support of the Ningaloo Turtle Program[27].	N/A
	Action Area B3: Address information gaps to better facilitate the recovery of marine turtle stocks	**Action**: Understand the impacts of anthropogenic noise on marine turtle behaviour and biology Priority actions at stock level: • G-NWS – given this is a relatively accessible stock that is likely to be exposed to anthropogenic noise – Investigate the impacts of anthropogenic noise on turtle behaviour and biology and extrapolate findings from the North West Shelf stock to other stocks • LH-WA, F-Pil – no relevant actions • H-WA – investigate mixed stock genetics at foraging grounds	Refer **Section 6.5.3** and **6.5.4.** **Not inconsistent assessment**: The assessment of acoustic emissions has considered the potential impacts marine turtles. Vessel and seismic acoustic emissions could cause localised and short-term behavioural disturbance to isolated transient individuals, which is unlikely to result in displacement of adult turtles from internesting or nesting habitat critical to the survival of marine turtles.	N/A
Assessment Summary The Marine Turtle Recovery Plan has been considered during the assessment of impacts and risks, and the Petroleum Activities Program is not considered to be inconsistent with the relevant actions of this plan.				

27 http://www.ningalooturtles.org.au/media_reports.html

Table 6-21: Assessment against relevant actions of the Blue Whale Conservation Management Plan

Part 13 Statutory Instrument	Relevant Action Areas/Objectives	Relevant Actions	Evaluation	EPO, Controls and PS
Blue Whale Conservation Management Plan	**Action Area A.2**: Assessing and addressing anthropogenic noise	**Action 2**: Assessing the effect of anthropogenic noise on blue whale behaviour **Action 3**: Anthropogenic noise in biologically important areas will be managed such that any blue whale continues to use the area without injury, and is not displaced from a foraging area	Refer **Section 6.5.3.** **Not inconsistent assessment**: The assessment of acoustic emissions has considered the potential impacts to pygmy blue whales.	N/A
	Action Area A.4: Minimising vessel collisions	**Action 3**: Ensure the risk of vessel strikes on blue whales is considered when assessing actions that increase vessel traffic in areas where blue whales occur and, if required, appropriate mitigation measures are implemented	Refer **Section 6.6.6.** **Not inconsistent assessment**: The assessment of vessel collision with marine fauna has considered the potential risks to pygmy blue whales. If the Petroleum Activities Program overlaps with the northbound or southbound migration, individuals may deviate slightly from the migratory route, but will continue on their migration unhindered. Vessel collisions with pygmy blue whales are highly unlikely to occur, given the very slow vessel speeds and presence of MFOs.	**EPO 14** **C 14.1** **PS 14.1.1**
	Action Area B.3: Describing spatial and temporal distribution and defining biologically important habitat	**Action 2**: Identify migratory pathways between breeding and feeding grounds **Action 3**: Assess timing and residency within Biologically Important Areas	**Not inconsistent assessment**: Woodside contributes to Action Area B3 via its support of targeted research initiatives (e.g. satellite tracking of pygmy blue whale migratory movements[28]).	N/A
Assessment Summary The Blue Whale Conservation Management Plan has been considered during the assessment of impacts and risks, and the Petroleum Activities Program is not considered to be inconsistent with the relevant actions of this plan.				

[28] Double, M.C., Andrews-Goff, V., Jenner, K.C.S., Jenner, M.-N., Laverick, S.M., Branch, T.A., Gales, N.J., 2014. Migratory movements of pygmy blue whales (*Balaenoptera musculus brevicauda*) between Australia and Indonesia as revealed by satellite telemetry. PloS One 9, e93578

Table 6-22: Assessment against relevant actions of the Sawfish and River Shark Recovery Plan

Part 13 Statutory Instrument	Relevant Action Areas/Objectives	Relevant Actions	Evaluation	EPO, Controls and PS
Sawfish and River Shark Recovery Plan	**Objective 5**: Reduce and, where possible, eliminate adverse impacts of habitat degradation and modification on sawfish and river shark species	**Action 5c**: Identify risks to important sawfish and river shark habitat and measures needed to reduce those risks	Refer **Sections 6.6.2, 6.6.3** and **6.6.4** **Not inconsistent assessment**: The assessment of accidental release of chemicals / hydrocarbons has considered the potential risks to sawfish and river shark.	Refer **Section 7.10**. Detailed oil spill preparedness and response performance outcomes, standards and measurement criteria for the Petroleum Activities Program are present in **Appendix D**.
	Objective 6: Reduce and, where possible, eliminate any adverse impacts of marine debris on sawfish and river shark species	**Action 6a**: Assess the impacts of marine debris including ghost nets, fishing gear and plastics on sawfish and river shark species	Refer **Section 6.6.5.** **Not inconsistent assessment:** The assessment of accidental release of solid hazardous and non-hazardous wastes has considered the potential risks to sawfish and river sharks.	**EPO 13** **C 13.1** **PS 13.1**
Assessment Summary The Sawfish and River Shark Recovery Plan has been considered during the assessment of impacts and risks, and the Petroleum Activities Program is not considered to be inconsistent with the relevant actions of this plan.				

Table 6-23: Assessment against relevant actions of the Grey Nurse Shark Recovery Plan

Part 13 Statutory Instrument	Relevant Action Areas/Objectives	Relevant Actions	Evaluation	EPO, Controls and PS
Grey Nurse Shark Recovery Plan	**Objective 7**: Improve understanding of the threat of pollution and disease to the grey nurse shark	**Action 7.1**: Review and assess the potential threat of introduced species, pathogens and pollutants	Refer **Sections 6.6.5** and **6.5.6.** **Not inconsistent assessment:** This EP includes an assessment of the impacts from accidental release of solid wastes as well as planned discharges of drilling waste on marine species.	N/A
			Refer **Sections 6.6.2, 6.6.3** and **6.6.4**. **Not inconsistent assessment:** The assessment of accidental release of chemicals / hydrocarbons has considered the potential risks to grey nurse sharks.	Refer **Section 7.10**. Detailed oil spill preparedness and response performance outcomes, standards and measurement criteria for the Petroleum Activities Program are present in **Appendix D**.
Assessment Summary The Grey Nurse Shark Recovery Plan has been considered during the assessment of impacts and risks, and the Petroleum Activities Program is not considered to be inconsistent with the relevant actions of this plan.				

Table 6-24: Assessment against relevant actions of the Marine Debris Threat Abatement Plan

Part 13 Statutory Instrument	Relevant Action Areas/Objectives	Relevant Actions	Evaluation	EPO, Controls and PS
Marine Debris TAP	**Objective 1:** Contribute to long-term prevention of marine debris.	**Action 1.02**: Limit the amount of single use plastic material lost to the environment in Australia.	Refer **Section 6.6.5.** **Not inconsistent assessment**: The assessment of accidental release of solid hazardous and non-hazardous wastes has considered the potential risks to vertebrate wildlife.	**EPO 13** **C 13.1** **PS 13.1**
Assessment Summary The Marine Debris TAP has been considered during the assessment of impacts and risks, and the Petroleum Activities Program is not considered to be inconsistent with the relevant actions of this plan.				

7. IMPLEMENTATION STRATEGY

7.1 Overview

Regulation 14 of the Environment Regulations requires an EP to contain an implementation strategy for the activity. The implementation strategy for the Petroleum Activities Program confirms fit-for-purpose systems, practices and procedures are in place to direct, review and manage the activities so that environmental risks and impacts are continually being reduced to ALARP and are acceptable, and that EPOs and EPSs outlined in this EP are achieved.

Woodside, as Operator, is responsible for ensuring that the Petroleum Activities Program is managed in accordance with this implementation strategy and the WMS (see **Section 1.7.4**).

7.2 Systems, Practice and Procedures

All operational activities are planned and carried out in accordance with relevant legislation and internal environment standards and procedures identified in this EP (**Section 2.4**).

Processes are implemented to verify controls to manage environmental impacts and risks to:

- a level that is ALARP and acceptable
- meet EPOs
- comply with EPSs defined in this EP.

The systems, practices and procedures that will be implemented are listed in the EPSs contained in this EP. Document names and reference numbers may be subject to change during the statutory duration of this EP; this is managed through a change register and management of change process.

7.3 Roles and Responsibilities

Key roles and responsibilities for Woodside and contractor personnel relating to implementing, managing and reviewing this EP are described in **Table 7-1**. Roles and responsibilities for oil spill preparation and response are outlined in **Appendix D** and the *Woodside Oil Pollution Emergency Arrangements (Australia)*.

Table 7-1 Roles and Responsibilities

Title (role)	Environmental Responsibilities
Office-based Personnel	
Woodside Survey Operations Project Manager	• Verify relevant Environmental Approvals for the activities exist before commencing activity. • Monitor and manage the activity so it is performed as per the relevant standards and commitments in this EP. • Notify the Woodside Environment Adviser in a timely manner of any scope changes. • Liaise with regulatory authorities as required. • Review this EP as necessary and manage change requests. • Ensure all project and support vessel crew members complete a Project (Including HSE) induction. • Verify that contractors meet environmental related contractual obligations. • Liaise with contractors to ensure communication and understanding of environment requirements as outlined in this EP. • Confirm environmental incident reporting meets regulatory requirements (as outlined in this EP) and Woodside's HSE Reporting and Investigation Procedure. • Monitor and close out corrective actions identified during environmental monitoring or audits. • Track compliance with performance outcomes and performance standards as per the requirements of this EP.
Woodside Environmental Adviser	• Prepare environmental component of relevant Induction Package. • Review compliance with performance outcomes and performance standards as per the requirements of this EP. • Ensure relevant Environmental Approvals for the activities exist before commencing activity. • Input to environmental component of relevant Induction Package. • Assist with the review, investigation and reporting of environmental incidents as required. • Assist environmental monitoring and inspections/audits are performed as per the requirements of this EP as required. • Liaise with relevant regulatory authorities as required. • Assist in preparing required external regulatory reports, in line with environmental approval requirements and Woodside incident reporting procedures. • Provide advice to relevant Woodside personnel and contractors to help them understand their environment responsibilities. • Support the Survey Operations Project Manager in ensuring communications and understanding of environment requirements as outlined in this EP. • Provide environmental support for activities through regular engagement with WSR.
Woodside Corporate Affairs Adviser	• Prepare and implement the Stakeholder Consultation Plan for the Petroleum Activities Program. • Report on stakeholder consultation. • Continuously liaise and provide notification as required as outlined in the EP.

Woodside Marine Assurance Superintendent	• Source and conduct relevant audit and inspection to confirm vessels comply with relevant Marine Orders and Woodside Marine Charters Instructions requirements.
Woodside Corporate Incident Coordination Centre (CICC) Duty Manager	On receiving notification of an incident, the Woodside CICC Duty Manager shall: • Establish and take control of the Incident Management Team and establish an appropriate command structure for the incident. • Assess the situation, identify risks and actions to minimise the risk. • Communicate impact, risk and progress to the Crisis Management Team and stakeholders. • Develop the Incident Action Plan (IAP) including objectives for action. • Approve, implement and manage the IAP. • Communicate within and beyond the incident management structure. • Manage and review safety of responders. • Address the broader public safety considerations. • Conclude and review activities.
Vessel-based Personnel	
Vessels Master	• Ensure the vessel management system and procedures are implemented. • Ensure personnel commencing work on the vessel receive an environmental induction that meets the relevant requirements specified in this EP. • Ensure personnel are competent to perform the work they have been assigned. • Verify SOPEP drills are conducted as per the vessel's schedule. • Ensure the vessel Emergency Response Team has been given sufficient training to implement the SOPEP. • Ensure any environmental incidents or breaches of relevant EPOs or PSs detailed in this EP, are reported immediately to the Party Chief and Woodside Site Representative. • Ensure corrective actions for incidents or breaches are developed, communicated to the Woodside Site Representative, and tracked to close-out in a timely manner. Ensure close-out of actions is communicated to the Woodside Site Representative.
Party Chief / Manager	• Understand and manage environmental aspects of the seismic operations per this EP and approval conditions. • Provide copies of documents, records, reports and certifications (as requested by Woodside) in a timely manner to assist in compliance reporting. • Ensure any environmental incidents or breaches of EPOs or PSs detailed in this EP, are reported immediately to the Woodside Site Representative and Woodside Survey Operations Project Manager.

Woodside Site Representative	• Ensure project personnel adhere to the requirements of this EP so the EPOs are met, and the PSs detailed in this EP are implemented during seismic operations. • Ensure environmental incidents or breaches of outcomes or standards are reported as per the Woodside event notification requirements. Corrective actions for incidents and breaches must be developed, tracked and closed out in a timely manner. • Ensure periodic environmental inspections are completed. Monitor and close out corrective actions (eCAR) identified during environmental monitoring or audits/inspections. • Ensure any environmental incidents or breaches of EPOs or PSs detailed in this EP, are reported immediately to the Woodside Survey Operations Project Manager. • Review Contractors' procedures, input into Toolbox talks and JSAs. • Provide environmental support for activities through regular engagement with Woodside Environmental Adviser.
Marine Fauna Observer	• Provide training through induction/briefing to all vessel crew likely to assist with marine fauna observations. • Record observations of marine fauna and monitor and report on compliance with acoustic operating requirements.

It is the responsibility of all Woodside employees and contractors to implement the Woodside Corporate Health, Safety, Environment and Quality Policy (refer to **Appendix A**) in their areas of responsibility and that the personnel are suitably trained and competent in their respective roles.

7.4 Training and Competency

Woodside as part of its contracting process assesses a proposed Contractor's environmental management system to determine the level of consistency with the standard AS/NZ ISO 14001. This assessment is conducted for the Petroleum Activities Program as part of the tendering / vendor selection process. The assessment determines whether there is an organisational structure that clearly defines the roles and responsibilities for key positions. The assessment also determines whether there is an up-to-date training matrix that defines any corporate and site/activity-specific environmental training and competency requirements.

All crew will be aware of their roles and responsibilities regarding environmental risks throughout the Petroleum Activities Program. As a minimum, environmental awareness training is required for all personnel, detailing awareness and compliance with the Contractor's environmental policy and environmental management system.

7.4.1 Inductions

Inductions are provided to all relevant personnel (e.g. Contractors and Company representatives) before mobilising to or on arrival at the activity location. The induction covers the HSE requirements and environmental information specific to the activity location. Attendance records are maintained.

The Petroleum Activities Program induction may cover information about:

- description of the activity
- ecological and socio-economic values of the activity location
- regulations relevant to the activity
- Woodside's Environmental Management System – Health Safety, Environment and Quality Policy
- EP importance/structure/implementation/roles and responsibilities
- main environmental aspects/hazards and potential environmental impacts and related performance outcomes
- oil spill preparedness and response
- monitoring and reporting on performance outcomes and standards using measurement criteria
- incident reporting.

In addition, as recreational fishing is prohibited from seismic vessels, this requirement will be covered in the induction.

7.4.2 Petroleum Activity Specific Environmental Awareness

Before the Petroleum Activities Program begins, a Woodside Project Manager will hold a pre-activity meeting with all relevant personnel. The pre-activity meeting provides an opportunity to reiterate specific environmental sensitivities or commitments associated with the activity. Attendance lists are recorded and retained.

During operations, regular HSE meetings will be held on the seismic vessel and support vessel(s). During these meetings, environmental incidents are reviewed and awareness material presented. Attendance lists are recorded and retained.

Additional materials are to be provided to project personnel as required to facilitate/support compliance with performance standards and collection of data related to measurement criteria.

7.4.3 Management of Training Requirements

All personnel on the vessels are required to be competent to perform their assigned positions. This may be in the form of external or 'on the job' training. The vessel Safety Training Coordinator (or equivalent) is responsible for identifying training needs, keeping records of training undertaken, and identifying minimum training requirements.

7.5 Monitoring, Auditing, Management of Non-conformance and Review

7.5.1 Monitoring

Woodside and its Contractors will conduct a program of periodic monitoring during the Petroleum Activities Program – starting at mobilisation and continuing through the duration of the activity to activity completion. This information will be collected using the tools and systems outlined below, developed based on the environmental performance outcomes, controls, standards and measurement criteria in this EP. The tools and systems will collect, as a minimum, the data (evidence) referred to in the measurement criteria in **Section 6.5** and **6.6** and **Appendix D.**

The collection of this data (against the measurement criteria) will form part of the permanent record of compliance maintained by Woodside. It will form the basis for demonstrating that the environmental performance outcomes and standards are met, which will be summarised in a series of routine reporting documents.

7.5.1.1 Source-Based Impacts and Risks

The tools and systems to monitor environmental performance, where relevant, will include:

- daily reports, which include leading indicator compliance
- periodic review of waste management and recycling records
- use of Contractor's risk identification program that requires personnel to record and submit safety and environment risk observation cards on a routine basis (frequency varies with contractor)
- collection of evidence of compliance with the controls detailed in the EP relevant to offshore activities by the Woodside Site Representative (other compliance evidence is collected onshore)
- environmental discharge reports that record volumes of planned and unplanned discharges to ocean and atmosphere
- monitoring of progress against key performance indicators
- internal auditing and assurance program as described in **Section 7.5.2**

Throughout this activity, Woodside will continuously identify new source-based risks and impacts through the Monitoring and Auditing systems and tools described above and in **Section 7.5.1.1.**

7.5.1.2 Management of Knowledge

Review of knowledge relevant to the existing environment is undertaken in order to identify changes relating to the understanding of the environment or legislation that supports the risk and impact assessments for EPs (in-force and in-preparation). Relevant knowledge is defined as:

- Environmental science supporting the description of the existing environment

- Socio-economic environment and stakeholder information
- Environmental legislation.

The frequency and documentation of reviews, communication of relevant new knowledge and consideration of management of change are documented in the WMS Environment Plan Guideline.

Under the Oil Spill Scientific Monitoring Program preparedness, an annual review and update to the environmental baseline studies database is completed and documented. Periodic location-focused environmental studies and baseline data gap analyses are completed and documented. Any subsequent studies scoped and executed as a result of such gap analysis are managed by the Environment Science Team and tracked via the Corporate Environment Baseline Database.

7.5.1.3 Management of Newly Identified Impacts and Risks

New sources of receptor based impacts and risks identified through monitoring and auditing systems and tools and the Woodside Environment Knowledge Management System will be assessed using the Change Management Process (refer to **Section 7.6**).

7.5.2 Auditing

Environmental performance auditing will be performed to:

- Identify potential new, or changes to existing environmental impacts and risk, and methods for reducing those to ALARP.
- Confirm that mitigation measures detailed in this EP are effectively reducing environmental impacts and risk, that mitigation measures proposed are practicable and provide appropriate information to verify compliance.
- Confirm compliance with the environmental performance outcomes and performance standards detailed in this EP.

The internal audits/inspections and reviews, combined with the ongoing monitoring described in **Section 7.5.1**, and collection of evidence for measurement criteria are used to assess environmental performance outcomes and standards.

As part of Woodside's EMS and/or assurances processes, activities are periodically selected for environmental audits as per Woodside's internal auditing process. Audit, inspection and review findings relevant to continuous improvement of environmental performance are tracked through the Environmental Commitments and Actions Register (ECAR). This ECAR is used to track compliance with EP commitments, including any findings and corrective actions.

Non-conformances identified will be reported and/or tracked in accordance with **Section 7.5.3**.

7.5.2.1 Marine Assurance

Marine assurance is undertaken in accordance with the Marine Offshore Vessel Assurance Procedure (Woodside Doc No: W0000PV1400355151). The marine assurance process is managed by the Marine Assurance Team of the Marine Services.

The processes and procedures used are based on industry standards and consideration of guidelines and recommendations from recognised industry organisations such as Oil Companies International Marine Forum and International Maritime Contractors Association.

The Marine Offshore Vessel Assurance Procedure defines the marine offshore assurance activities applicable for all vessels chartered directly by or on behalf of Woodside. The procedure is mandatory for all vessels hired for Woodside operations, including for short-term hires (less than three months in duration).

The Marine Offshore Vessel Assurance Procedure ensures all vessel operators and vessels chartered only operate seaworthy vessels that meet the requirements for a defined scope of work, and are managed with a robust safety management system. The marine offshore vessel assurance process is multi-faceted and encompasses:

- offshore vessel safety management system assessment (OVMSA)
- offshore vessel inspection database (OVID) inspection or similar
- project support for tender review and evaluation, pre/post contract award.

OVID inspections are objective in nature and reflect what was observed while conducting the inspection. The inspection provides observations as opposed to non-conformances. Woodside will maintain records of the marine assurance review.

Where an OVID inspection and/or OVMSA verification review is not available, and all reasonable efforts based on time and resource availability to complete an OVID inspection and/or OVMSA verification review are undertaken (i.e. short-term vessel hire), the Marine Assurance Specialist Offshore may approve using an alternate means of inspection as defined in the Marine Offshore Vessel Assurance Procedure, known as a risk assessment.

7.5.2.2 Risk Assessment

Woodside conducts a risk assessment of vessels where either an OVMSA Verification Review and/or an OVID inspection cannot be completed (i.e. short term vessel hire). This is not a regular occurrence and is typically used when the requirements of the assurance process are unable to be met or the processes detailed are not applicable to a proposed vessel(s). The Marine Vessel Risk Assessment will be conducted by the Marine Assurance Superintendent, or the nominated deputy, where the vessel meets the short term hire prerequisites.

The risk assessment is a semi-quantitative method of determining what further assurance process activity, if any, is required to assure a vessel for a particular task or role. The process compares the level of management control a vessel is subject to against the risk factors associated with the activity or role.

Several factors are assessed as part of a vessel risk assessment, including:

- Management control factors:
  - Company audit score (i.e. management system)
  - vessel HSE incidents
  - vessel Port State Control deficiencies
  - instances of Port State Control vessel detainment
  - years since previous satisfactory vessel inspection
  - age of vessel
  - contractors' prior experience operating for Woodside.
- Activity risk factors:
  - people health and safety risks (a function of the nature of the work and the area of operation)
  - environmental risks (a function of environmental sensitivity, activity type and magnitude of potential environment damage (e.g. largest credible oil spill scenario))
  - value risk (likely time and cost consequence to Woodside if the vessel becomes unusable)

    - reputation risk
    - exposure (i.e. exposure to risk based on duration of project)
    - industrial relations risk.

The acceptability of the vessel or requirement for further vessel inspections or audits is based on the ratio of vessel score to activity risk. If the vessel management control is not deemed to appropriately manage activity risk, a satisfactory company audit and/or vessel inspection may be required before awarding work.

The risk assessment is valid for the period a vessel is on hire and for the defined scope of work.

7.5.3 Management of Non-conformance

Woodside classifies non-conformances with environmental performance outcomes and standards in this EP as environmental incidents. Woodside employees and contractors are required to report all environmental incidents, and these are managed as per Woodside's Health, Safety and Environment Event Reporting and Investigation Procedure (Woodside Doc No. WM0000PG9905421).

An internal computerised database called First Priority is used to record and report these incidents. Details of the event, immediate action taken to control the situation, investigation outcomes and corrective actions to prevent reoccurrence are all recorded. Corrective actions are monitored using First Priority and closed out in a timely manner.

Woodside uses a consequence matrix for classification of environmental incidents, with the significant categories being A, B and C (as detailed in **Section 2.6.1**). Detailed investigations are completed for all categories A, B, C and high potential environmental incidents.

7.5.4 Review

7.5.4.1 Management Review

Within the Environment function, senior management regularly monitors and reviews environmental performance and the effectiveness of managing environmental risks and performance. Within each Function and Business Unit Leadership Team, managers regularly review environmental performance, including through HSE Review meetings.

Risks are also reviewed before the activity commences, including operational, safety and environmental risks of the Petroleum Activities Program, to support continuous improvement as outlined in the Woodside Risk Management Framework (refer to **Section 2.6.1**).

7.5.4.2 Learning and Knowledge Sharing

Learning and knowledge sharing occurs via a number of different methods including:

- HSE meetings
- event investigations
- event bulletins
- post-activity review, including the review of environmental incidents as relevant
- ongoing communication with seismic vessel operators
- formal and informal industry benchmarking
- cross-asset learnings.

7.6 EP Management of Change and Revision

Management of changes are managed in accordance with Woodside's Environmental Approval Requirements Australia Commonwealth Guideline. Management of changes relevant to this EP, concerning the scope of the activity description (**Section 3**) including: review of advances in technology at stages where new equipment may be selected such as vessel contracting; changes in understanding of the environment, DAWE EPBC Act listed threatened and migratory species status, Part 13 statutory instruments (recovery plans, threat abatement plans, conservation advice, wildlife conservation plans) and current requirements for AMPs; and potential new advice from external stakeholders (**Section 5.4**), will be managed in accordance with Regulation 17 of the Environment Regulations.

Risk will be assessed in accordance with the environmental risk management methodology (**Section 2.4**) to determine the significance of any potential new environmental impacts or risks not provided for in this EP. Risk assessment outcomes are reviewed in compliance with Regulation 17 of the Environment Regulations.

Minor changes where a review of the activity and the environmental risks and impacts of the activity do not trigger a requirement for a formal revision under Regulation 17 of the Environment Regulations, will be considered a 'minor revision'. Minor administrative changes to this EP, where an assessment of the environmental risks and impacts is not required (e.g. document references, phone numbers, etc.), will also be considered a 'minor revision'. Minor revisions as defined above will be made to this EP using Woodside's document control process. Minor revisions will be tracked in an MOC Register to ensure visibility of cumulative risk changes, as well as enable internal EP updates/reissuing as required. This document will be made available to NOPSEMA during regulator environment inspections.

7.7 OPEP Management of Change and Revision

Relevant documents from the OPEP (**Section 7.10** and **Table 7-4)** will be reviewed in the following circumstances:

- implementation of improved preparedness measures
- a change in the availability of equipment stockpiles
- a change in the availability of personnel that reduces or improves preparedness and the capacity to respond
- the introduction of a new or improved technology that may be considered in a response for this activity
- to incorporate, where relevant, lessons learned from exercises or events
- if national or state response frameworks and Woodside's integration with these frameworks changes.

Where changes are required to the OPEP, based on the outcomes of the reviews described above, they will be assessed against Regulation 17 to determine if resubmission of the EP, including the OPEP, is required (see **Section 7.6**).

Changes with potential to influence minor or technical changes to the OPEP are tracked in management of change records, project records and incorporated during internal updates of the OPEP or the five-yearly revision.

Woodside will maintain the following records:

- Woodside's HSPU Testing of Arrangements Register.
- Woodside Internal Equipment Maintenance Register.

- OPEP current and available.

Activity OPEPs will be revised at a minimum every five years in accordance with the Woodside Hydrocarbon Spill Preparedness and Response Procedure.

7.8 Record Keeping

Compliance records (outlined in Measurement Criteria in **Sections 6.5** and **6.6**) will be maintained. Record keeping will be in accordance with Regulation 15(7) that addresses maintaining records of emissions and discharge volumes. The records are maintained in the daily seismic reports.

7.9 Reporting

To meet the environmental performance outcomes and standards outlined in this EP, Woodside reports at a number of levels. These reporting arrangements are outlined below.

7.9.1 Routine Reporting (Internal)

7.9.1.1 Daily Progress Reports and Meetings

Daily reports for seismic activities are prepared and issued to key Company support personnel by relevant managers responsible for the activity. The report provides performance information about seismic activities, heath, safety and environment, and current and planned work activities.

Meetings between key personnel are used to transfer information, discuss incidents, agree plans for future activities and develop plans and accountabilities for resolving issues.

7.9.1.2 Regular HSE Meetings

Regular HSE meetings are held with the offshore and Perth-based Project Manager and advisers (as required) to address HSE incidents and initiatives. Minutes of these meetings are produced and distributed as appropriate.

7.9.1.3 Performance Reporting

Daily, weekly and monthly performance reports are developed. These reports cover a number of subject matters, including:

- HSE incidents (including high potential incidents and those related to this EP) and recent activities
- corporate Key Performance Indicator targets, which include environmental metrics
- outstanding actions as a result of audits or incident investigations
- technical high and low lights.

7.9.2 Routine Reporting (External)

7.9.2.1 Start and End Notifications of the Petroleum Activities Program

In accordance with Regulation 29, Woodside will notify NOPSEMA of the commencement of the Petroleum Activities Program at least ten days before the activity commences, and will notify NOPSEMA within ten days of completing the activity.

7.9.2.2 Environmental Performance Review and Reporting

In accordance with applicable environmental legislation for the activity, Woodside is required to report information on environmental performance to the appropriate regulator. Regulatory reporting requirements are summarised in **Table 7-2.**

Table 7-2: Routine external reporting requirements

Report	Recipient	Frequency	Content
Monthly Recordable Incident Report (**Appendix E)**	NOPSEMA	Monthly, by the 15th of each month.	Details of recordable incidents that have occurred during the Petroleum Activities Program for the previous month (if applicable).
Environmental Performance Report	NOPSEMA	After completion all activity close-out actions and documentation. Within three months of completing the activity.	In accordance with the Environment Regulations, the report will address compliance with environmental performance outcomes and performance standards outlined in this EP.

7.9.2.3 End of the Environmental Plan

The EP will end when Woodside notifies NOPSEMA that the Petroleum Activities Program has ended and all of the obligations identified in this EP have been completed, and NOPSEMA has accepted the notification, in accordance with Regulation 25A of the Environment Regulations.

7.9.3 Incident Reporting (Internal)

It is the responsibility of the Woodside Project Manager to ensure reporting of environmental incidents meets Woodside and regulatory reporting requirements as detailed in the Woodside Health, Safety and Environment Event Reporting and Investigation Procedure and this section of this EP.

7.9.4 Incident Reporting (External) – Reportable and Recordable

7.9.4.1 Reportable Incidents

Definition

A reportable incident is defined under Regulation 4 of the Environment Regulations as '*an incident relating to the activity that has caused, or has the potential to cause, moderate to significant environmental damage*'.

A reportable incident for the Petroleum Activities Program is:

- an incident that has caused environmental damage with a Consequence Level of Moderate (C) or above (as defined under Woodside's Risk Table; refer to **Table 2-3**)
- an incident that has the potential to cause environmental damage with a Consequence Level of Moderate (C) or above (as defined under Woodside's Risk Table – refer to **Table 2-3**).

The environmental risk assessment (**Section 6**) for the Petroleum Activities Program identifies those risks with a potential consequence level of C+ for environment.

Any such incidents represent potential events which would be reportable incidents. Incident reporting is performed with consideration of NOPSEMA (2014) guidance stating, 'if in doubt, notify NOPSEMA', and assessed on a case-by-case basis to determine if they trigger a reportable incident as defined in this EP and by the Regulations.

Notification

NOPSEMA will be notified of all reportable incidents, according to the requirements of Regulations 26, 26A and 26AA of the Environment Regulations. Woodside will:

- Report all reportable incidents to the regulator (orally) ASAP, but within two hours of the incident or of its detection by Woodside.
- Provide a written record of the reported incident to NOPSEMA, the National Offshore Petroleum Titles Administrator (NOPTA) and the Department of the responsible Territory Minister (DITT) ASAP after orally reporting the incident.
- Complete a written report for all reportable incidents using a format consistent with the NOPSEMA Form FM0831 – Reportable Environmental Incident (**Appendix E**) which must be submitted to NOPSEMA ASAP, but within three days of the incident or of its detection by Woodside.
- Provide a copy of the written report to the NOPTA and DITT, within seven days of the written report being provided to NOPSEMA.
- AMSA will be notified of oil spill incidents ASAP after their occurrence, and DAWE notified if MNES are to be affected by the oil spill incident.

7.9.4.2 Recordable Incidents

Definition

A recordable incident is defined under Regulation 4 of the Environment Regulations as an incident arising from the activity that *'breaches an environmental performance outcome or environmental performance standard, in the EP for the petroleum activity, and is not a reportable incident'*.

Any breach of the environmental performance outcomes or standards (presented within **Section 6.5** and **6.6**) will be raised as an incident and managed as per the notification and reporting requirements outlined below and the Woodside Health, Safety and Environment Event Reporting and Investigation Procedure.

Notification

NOPSEMA will be notified of all recordable incidents, according to the requirements of Regulation 26B(4), no later than 15 days after the end of the calendar month using the NOPSEMA Form – Recordable Environmental Incident Monthly Summary Report detailing:

- All recordable incidents that occurred during the calendar month.
- All material facts and circumstances concerning the recordable incidents that the operator knows or is able, by reasonable search or enquiry, to find out.
- Any action taken to avoid or mitigate any adverse environment impacts of the recordable incidents.
- The corrective action that has been taken, or is proposed to be taken, to prevent similar recordable incidents.
- The action that has been taken, or is proposed to be taken, to prevent a similar incident occurring in the future.

7.9.4.3 Other External Incident Reporting Requirements

In addition to notifying of and reporting environmental incidents defined under the Environment Regulations and Woodside requirements, **Table 7-3** describes the incident reporting requirements that also apply in the Operational Area.

For oil spill incidents, other agencies and organisations will be notified as appropriate to the nature and scale of the incident, as per procedures and contact lists in the Woodside Oil Pollution Emergency Arrangements (Australia) and Oil Pollution First Strike Plan (refer to **Appendix I**).

Table 7-3 External Incident Reporting Requirements

Event	Responsibility	Notifiable party	Notification requirements	Contact	Contact detail
Any marine incidents during Petroleum Activities Program	Vessel Master	AMSA	Incident Alert Form 18 as soon as reasonably practicable* Within 72 hours after becoming aware of the incident, submit Incident Report Form 19	AMSA	reports@amsa.gov.au
Oil pollution incidents in Commonwealth waters	Vessel Master	AMSA RCC	Without delay as per *Protection of the Sea Act*, part II, section 11(1), AMSA RCC notified verbally via the national emergency 24-hour notification contact of the hydrocarbon spill; follow up with a written Pollution Report ASAP after verbal notification	AMSA RCC	Phone: 1800 641 792 or +61 2 6230 6811 AFTN: YSARYCYX
Any oil pollution incident which has the potential to enter a National Park or requires oil spill response activities to be conducted within a National Park	Woodside	DAWE	Reported verbally, ASAP	Director of National Parks	Phone: 02 6274 2220
Activity causes unintentional death of or injury to fauna species listed as Threatened or Migratory under the EPBC Act	Woodside	DAWE	Within seven days of becoming aware	Secretary of the DAWE	Phone: 1800 803 772 Email: protected.species@environment.gov.au

The pollution activities should also be reported to AMSA via RCC Australia by the Vessel Master are:

- Any loss of significant plastic material (e.g. streamers).
- Garbage disposed of in the sea within 12 nm of land (garbage includes food, paper, bottles, etc.).
- Any loss of hazardous materials.
- For oil spill incidents, other agencies and organisations will be notified as appropriate to the nature and scale of the incident as per procedures and contact lists in the Oil Pollution Emergency Arrangements (Australia) and the Scarborough 4D B1 MSS Oil Pollution First Strike Plan (refer to **Appendix I**).
- External incident reporting requirements under the OPGGS (Safety) Regulations, including under sub-regulation 2.42, notices and reports of dangerous occurrences will be reported to NOPSEMA under the approved activity safety cases.

7.10 Emergency Preparedness and Response

7.10.1 Overview

Under Regulation 14(8), the implementation strategy must contain an Oil Pollution Emergency Plan (OPEP) and provide for updating the OPEP. Regulation 14(8AA) outlines the requirements for the OPEP which must include adequate arrangements for responding to and monitoring oil pollution.

A summary of how this EP and supporting documents address the various requirements of Environment Regulations relating to oil pollution response arrangements is shown in **Table 7-4**.

Table 7-4: Oil pollution and preparedness and response overview

Content	Environment Regulations Reference	Document/Section Reference
Details of (oil pollution response) control measures that will be used to reduce the impacts and risks of the activity to ALARP and an acceptable level	Regulation 13(5), (6), 14(3)	Oil Spill Preparedness and Response Mitigation Assessment (**Appendix D)**
Describes the OPEP	Regulation 14(8)	EP: Woodside's oil pollution emergency plan has the following components: • Woodside Oil Pollution Emergency Arrangements (Australia) • Oil Pollution First Strike Plan (**Appendix I**) • Oil Spill Preparedness and Response Mitigation Assessment (**Appendix D**) In accordance with Regulation 31 of the Environmental Regulations the Woodside Oil Pollution Emergency Arrangements (Australia) was provided with the Julimar Phase 2 Drilling and Subsea Installation EP, accepted by NOPSEMA on 8 November 2019.
Details the arrangements for responding to and monitoring oil pollution (to inform response activities), including control measures	Regulation 14(8AA)	Oil Spill Preparedness and Response Mitigation Assessment (**Appendix D**) • Oil Pollution First Strike Plan (**Appendix I**)

Content	Environment Regulations Reference	Document/Section Reference
Details the arrangements for updating and testing the oil pollution response arrangements	Regulation 14(8), (8A), (8B), (8C)	EP: **Section 7.11** Oil Spill Preparedness and Response Mitigation Assessment (**Appendix D**)
Details of provisions for monitoring impacts to the environment from oil pollution and response activities	Regulation 14(8D)	Oil Spill Preparedness and Response Mitigation Assessment **(Appendix D)**
Demonstrates that the oil pollution response arrangements are consistent with the national system for oil pollution preparedness and control	Regulation 14(8E)	Oil Pollution Emergency Arrangements (Australia)

7.10.2 Emergency Response Training

Regulation 14(5) requires that the implementation strategy includes measures to ensure that employees and contractors have the appropriate competencies and training (**Table 7-5**). Woodside has conducted a risk-based training needs analysis on positions required for effective oil spill response. Following the mapping of training to Woodside identified competencies, training was then mapped to positions based on their required competencies.

Table 7-5: Minimum levels of competency for key IMT positions

IMT Position	Minimum Competency
Corporate Incident Coordinate Centre (CICC) Leader	• Incident and Crisis Leadership Development Program (ICLDP) • Oil Spill Response Skills Enhancement Course (OSREC – internal course) • Participation in L2 oil spill exercise (initial) Participation in L2 oil spill exercise (refresher)
Security & Emergency Manager Duty Manager	• ICLDP • OSREC • IMO2 or equivalent spill response specialist level with an oil spill response organisation (OSRO) • Participation in L2 oil spill exercise (initial) Participation in L2 oil spill exercise (refresher)
Operations, Planning, Logistics, Safety	• OSREC • ICC Fundamentals Course (internal course) • Participation in L2 oil spill exercise (initial) • Participation in L2 oil spill exercise (refresher)
Environment Coordinator	• ICC Fundamentals • OSREC • IMO2 or equivalent spill response specialist level with an OSRO • Participation in L2 oil spill exercise (initial) • Participation in L2 oil spill exercise (refresh
Note on competency/equivalency	
In 2018 Woodside undertook a review of incident and crisis systems, processes and tools to assess whether these were fit-for purpose and has rolled out a change to the Incident and Crisis Management training and the oil spill response training requirements for both ICC and field-based roles. The revised ICC Fundamentals training Program and Incident and Crisis Leaders Development Program (ICLDP) align with the performance requirements of the *PMAOMIR320 – Manage Incident Response Information* and *PMAOM0R418 - Coordinate Incident Response.*	

Regarding training specific equivalency:

- ICLDP is mapped to *PMAOM0R418* (and which is equivalent to IMOIII when combined with Woodside's OSREC course) and ensures broader incident management principles aligned with Australasian Inter-service Incident Management System (AIIMS).
- The revised ICC Fundamentals Course is mapped to *PMAOMIR320* (and which is equivalent to IMOII). The blended learning program offers modules aligned to IMOIII, IMOII, IMOI and AMOSC Core Group Training Oil Spill Response Organisation Specialist Level training.
- OSREC involves the completion of two (2) online AMSA Modules (Introduction to National Plan and Incident management; and Introduction to oil spills) as well as elements of IMOI and IMOII tailored to Woodside specific OSR capabilities.
- Woodside Learning Services (WLS) are responsible for collating and maintaining personnel training records. The HSP Dashboard reflects the competencies required for each oil spill role (IMT/operational).

7.10.3 Emergency Response Preparation

The Corporate Incident Coordination Centre (CICC), based in Woodside's head office in Perth, is the onshore coordination point for an offshore emergency. The CICC is staffed by an appropriately skilled team available on call 24-hours a day. The purpose of the team is to coordinate rescues, minimise damage to the environment and facilities, and to liaise with external agencies. A description of Woodside's Incident Command Structure and arrangements is further detailed in the Woodside OPEA (Australia). Roles and responsibilities for facility emergency response are outlined in the Woodside Oil Pollution Emergency Arrangements (Australia).

Woodside will have an Emergency Response Plan (ERP) in place relevant to the Petroleum Activities Program. The ERP provides procedural guidance specific to the asset and location of operations to control, coordinate and respond to an emergency or incident. The ERP will contain instructions for vessel emergency, medical emergency, search and rescue, reportable incidents, incident notification, contact information and activation of the contractor's emergency centre and Woodside Communication Centre (WCC).

In an emergency of any type, the Vessel Master will assume overall onsite command and act as the Incident Controller (IC). All persons aboard the vessel will be required to act under the IC's directions. The vessel will maintain communications with the onshore Project Manager and/or other emergency services. Emergency response support can be provided by the Contractor's emergency centre or WCC if requested by the IC.

The seismic vessel will have on-board equipment for responding to emergencies including medical, firefighting and hydrocarbon spill response equipment.

7.10.4 Oil and Other Hazardous Materials Spill

A significant hydrocarbon spill during the Petroleum Activities Program is unlikely, but should such an event occur, it has the potential to cause serious environmental and reputational damage if not managed properly. The Woodside Oil Pollution Emergency Arrangements (Australia) document, supported by the Oil Pollution First Strike Plan (**Appendix I**) which provides tactical response guidance to the activity/area. Spill response for this Petroleum Activities Program is described further in **Appendix D.**

The Security and Emergency Management Function is responsible for the management of Woodside's hydrocarbon spill response equipment, and for the maintenance of hydrocarbon spill preparedness and response documentation. In the event of a major spill, Woodside will request that AMSA (administrator of the National Plan) supports Woodside through advice and access to equipment, people and liaison. The interface and responsibilities, as defined under the National Plan, are described in the Woodside Oil Pollution Emergency Arrangements (Australia) document. AMSA and Woodside have a Memorandum of Understanding (MOU) in place to support Woodside in the event of an oil spill.

The seismic vessel and support vessel(s) will have a SOPEP in accordance with the requirements of MARPOL 73/78 Annex I. These plans outline responsibilities, specify procedures and identify resources available in a hydrocarbon or chemical spill from vessel activities. The Oil Pollution First Strike Plan is intended to work in conjunction with the SOPEPs and provides immediate actions required to commence a response if hydrocarbons are released to the marine environment.

Woodside has established environmental performance outcomes, performance standards and measurement criteria to be used for oil spill response during the Petroleum Activities Program, as detailed in **Appendix D**.

7.11 Emergency and Spill Response

Woodside categorises incidents in relation to response requirements as follows:

- **Level 1 Incident** – A Level 1 incident can be resolved through the use of existing resources, equipment and personnel. A Level 1 incident is contained, controlled and resolved by site/regionally based teams using existing resources and functional support services.
- **Level 2 Incident –** A Level 2 incident is characterised by a response that requires external operational support to manage the incident. It is triggered in the event the capabilities of the tactical level response are exceeded. This support is provided to the activity via the activation of all, or part of, the responsible ICC.
- **Level 3 Incident –** A Level 3 incident or crisis is identified as a critical event that seriously threatens the organisation's People, the Environment, company Assets, Reputation, Livelihood or essential Services. At Woodside, the Crisis Management Team (CMT) manages the strategic impacts in order to respond to and recover from the threat to the company (material impacts, litigation, legal and commercial, reputation, etc.). The CICC may also be activated as required to manage the operational response to the Level 3 Incident.

7.11.1 Emergency and Spill Response Drills and Exercises

Personnel holding responsibilities in a response will test the arrangements supporting the activities OPEP to ensure they are effective and communicated. Testing of Woodside's capability to respond to incidents will be conducted in alignment with the Emergency and Crisis Management Procedure. The scope, frequency and objective of these tests is described in **Table 7-6.** These arrangements are conducted in accordance with Regulation 14 (8B) of the OPGGS (Environment) Regulations 2009.

The company emergency response testing regime is aligned to existing or developing risks associated with Woodside's operations and activities. Corporate hazards/risks outlined in the corporate risk register, respective Safety Cases or project Risk Registers, are the key reference point for emergency management and crisis management exercising schedule development. External participants may be invited to attend crisis exercises and may include government agencies, specialist service providers, hydrocarbon spill response organisations or industry members with which Woodside has mutual aid arrangements.

The objective is to exercise procedures, skills and teamwork of the Emergency Response and Command Teams in their ability to respond to emergency situations. After each exercise, the team holds a debrief session, during which the exercise is reviewed and reported. Any lessons learnt or areas for improvement are identified and incorporated into emergency procedures where appropriate.

Spill response exercise reports and key participants will be maintained in the Woodside IMS system.

Table 7-6: Testing of response capability

Response Category	Scope	Response Testing Frequency	Response Testing Objective
Level 1 Response	Exercises are project-/ activity-specific	One Level 1 'First Strike' drill conducted within two weeks of activity commencement.	Comprehensive exercises test elements of the Oil Pollution First Strike Plan (**Appendix I**). Emergency drills are scheduled to test other aspects of the Emergency Response Plan.
Level 2 Response	Exercises are vessel specific	A minimum of one Emergency Management exercise per campaign.	Testing both the facility IMT response and/or that of the CICC following handover of incident control.
Level 3 Response	Exercises are relevant to all Woodside assets	The number of CMT exercises conducted each year is determined by the Chief Executive Officer, in consultation with the Vice President of Security and Emergency Management.	Test Woodside's ability to respond to and manage a crisis level incident.

7.11.2 Hydrocarbon Spill Response Testing of Arrangements

Woodside is required to test hydrocarbon spill response arrangements as per regulations 8B and 8C of the Environment Regulations. Woodside's arrangements for spill response are common across its Australian operating assets and activities to ensure the controls are consistent. The overall objective of testing these arrangements is to ensure that Woodside maintains an ability to respond to a hydrocarbon spill, specifically to:

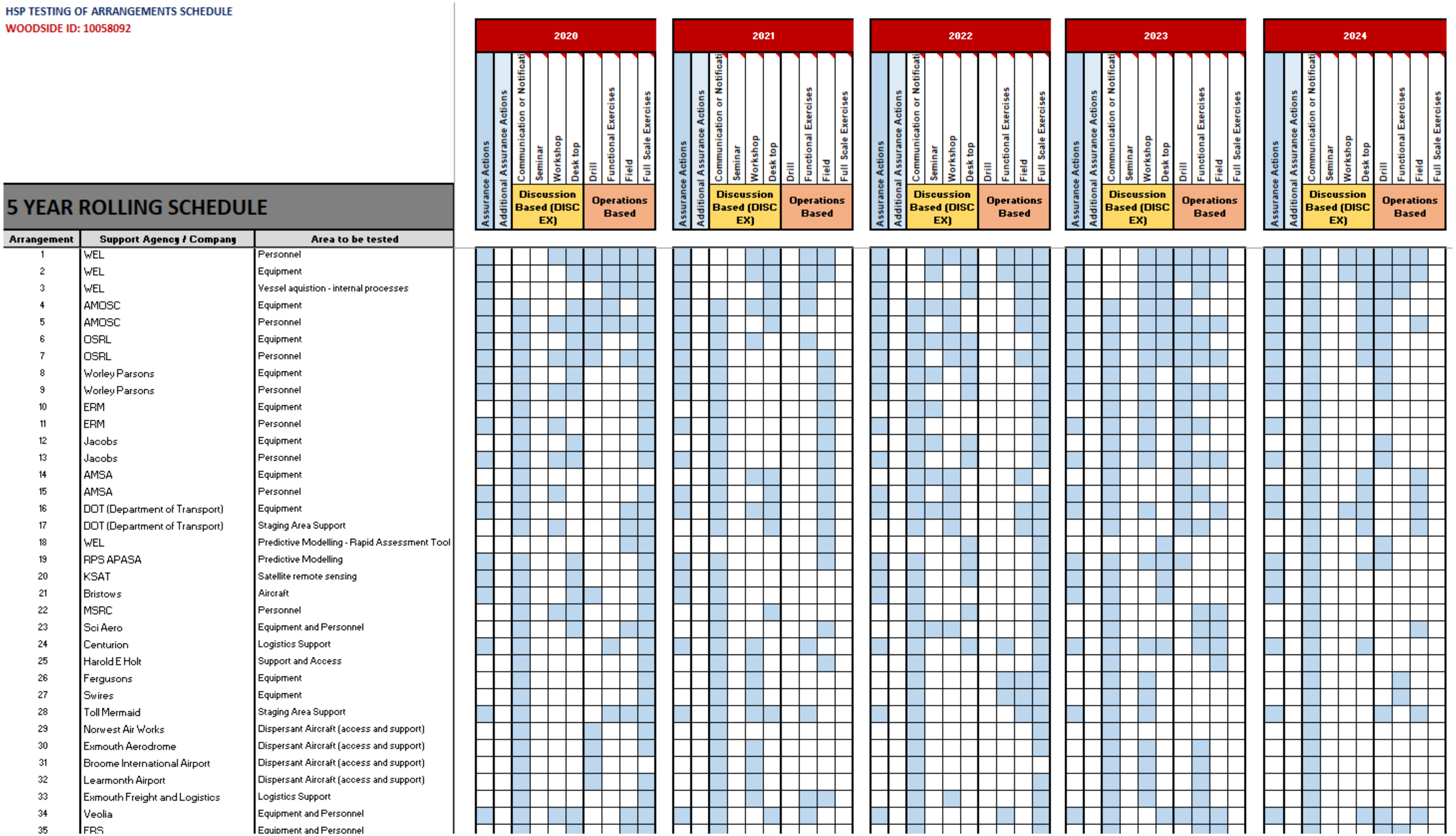
- ensure relevant responders, contractors and key personnel understand and practise their assigned roles and responsibilities
- test response arrangements and actions to validate response plans
- ensure lessons learned are incorporated into Woodside's processes and procedures and improvements are made where required.

If new response arrangements are introduced, or existing arrangements significantly amended, additional testing is undertaken accordingly. Additional activities or activity locations are not anticipated to occur; however, if they do, testing of relevant response arrangements will be undertaken as soon as practicable.

In addition to the testing of response capability described in **Table 7-6**, up to eight formal exercises are planned annually, across Woodside, to specifically test arrangements for responding to a hydrocarbon spill to the marine environment.

7.11.2.1 Testing of Arrangements Schedule

Woodside's Testing of Arrangements Schedule (**Figure 7-1**) aligns with international good practice for spill preparedness and response management; the testing is compatible with the IPIECA Good Practice Guide and the Australian Emergency Management Institute Handbook. If a spill occurs, enacting these arrangements will underpin Woodside's ability to implement a response across its petroleum activities. **Figure 7-1** shows a condensed snapshot of Woodside's 5-year rolling Testing of Arrangements Schedule.



HSP TESTING OF ARRANGEMENTS SCHEDULE
WOODSIDE ID: 10058092

5 YEAR ROLLING SCHEDULE

Arrangement	Support Agency / Company	Area to be tested
1	WEL	Personnel
2	WEL	Equipment
3	WEL	Vessel aquistion - internal processes
4	AMOSC	Equipment
5	AMOSC	Personnel
6	OSRL	Equipment
7	OSRL	Personnel
8	Worley Parsons	Equipment
9	Worley Parsons	Personnel
10	ERM	Equipment
11	ERM	Personnel
12	Jacobs	Equipment
13	Jacobs	Personnel
14	AMSA	Equipment
15	AMSA	Personnel
16	DOT (Department of Transport)	Equipment
17	DOT (Department of Transport)	Staging Area Support
18	WEL	Predictive Modelling - Rapid Assessment Tool
19	RPS APASA	Predictive Modelling
20	KSAT	Satellite remote sensing
21	Bristows	Aircraft
22	MSRC	Personnel
23	Sci Aero	Equipment and Personnel
24	Centurion	Logistics Support
25	Harold E Holt	Support and Access
26	Fergusons	Equipment
27	Swires	Equipment
28	Toll Mermaid	Staging Area Support
29	Norwest Air Works	Dispersant Aircraft (access and support)
30	Exmouth Aerodrome	Dispersant Aircraft (access and support)
31	Broome International Airport	Dispersant Aircraft (access and support)
32	Learmonth Airport	Dispersant Aircraft (access and support)
33	Exmouth Freight and Logistics	Logistics Support
34	Veolia	Equipment and Personnel
35	FBS	Equipment and Personnel

Columns for each year (2020, 2021, 2022, 2023, 2024): Assurance Actions; Additional Assurance Actions; Discussion Based (DISC EX): Communication or Notificati, Seminar, Workshop, Desk top; Operations Based: Drill, Functional Exercises, Field, Full Scale Exercises.

Figure 7-1: Indicative 5-yearly testing of arrangements schedule

(Snapshot of a selection of oil spill response arrangements tested annually; Note: schedule is subject to change, additional detail is included in the live document)

Numbered hydrocarbon spill arrangements listed in the rows of the schedule are taken from the support plans and operational plans described in Section 1.4 of **Appendix D**. Each arrangement has a support agency/company and an area to be tested (e.g. capability, equipment and personnel). For example, an arrangement could be to test Woodside's personnel capability for conducting scientific monitoring, or the ability of the Australian Marine Oil Spill Centre to provide response personnel and equipment. About 75 hydrocarbon spill preparedness arrangements are tested annually across the eight planned exercises, as described above.

The vertical columns under each year in **Figure 7-1** relate to an individual exercise or additional assurance actions that are conducted over the 5-year rolling schedule. The sub-heading for the column describes the standard method of testing (e.g. discussion exercise, desktop exercise), and the blue cells indicate the arrangements that could be tested for each method.

Arrangements in the schedule are tested at least once a year; however, some arrangements may be tested across multiple exercises (e.g. critical arrangements) or via other 'additional assurance' methods outside the formal Testing of Arrangements Schedule that also constitute sufficient evidence of testing of arrangements (e.g. audits, no-notice drills, internal exercises, assurance drills) (refer to the first and second vertical columns for each year in **Figure 7-1**).

7.11.2.2 Exercises, Objectives, and KPIs

Exercises are designed to cumulatively provide assurance for all arrangements within Woodside's Testing of Arrangements Schedule annually across all facilities. Exercise-initiating scenarios are derived from the worst-case credible scenarios as described in the relevant facility's First Strike Plans.

Objectives and KPIs for each exercise are determined by reviewing:

- The Testing of Arrangements Schedule, which identifies which arrangements can be tested for each testing method (**Section 7.11.2**).
- The objectives and KPIs master generic plan, which summarises generic objectives and KPIs that could be tested for specific response strategies, based on industry good practice guidance (i.e. IPIECA) for testing oil spill arrangements.
- The oil spill ALARP commitments register, which summarises all spill response commitments from accepted EPs (e.g. timings, numbers) for different response strategies, and considers priority commitments and worst-cast spill scenarios.
- Actions undertaken from recommendations from previous exercises, where relevant.

The required capabilities, number of personnel, equipment, and timeframes (i.e. arrangements) form specific KPIs during an exercise. Where this is the case, the ALARP commitments register indicates the specific response strategy performance standards to use/test the arrangements against. Where relevant the most stringent performance standard across all in-force EPs is used as the KPI. After each exercise, a report is produced that includes recommendations for improvements, which are then converted to actions and tracked in the Testing of Arrangements Register.

Additional assurance actions are also routinely undertaken outside formal exercises (e.g. response audits, no-notice drills), which support testing of these arrangements. Evidence and outcomes from additional assurance actions are used, where relevant, to support testing individual arrangements, including from external sources (e.g. evidence of suppliers testing their own arrangements).

7.12 Severe Weather Preparation

The activity is scheduled to occur outside of the typical cyclone season (November to April), however cyclones have been known to develop outside of season, between July and October. The seismic vessel contractor must have a Severe Weather Procedure, or equivalent, in place outlining the processes and procedures that would be implemented during a severe weather event.

The seismic vessel will receive daily forecasts. If a severe weather event is forecast, the path and its development will be plotted and monitored using the forecast data. If there is the potential for the severe weather event to affect the Petroleum Activities Program, the Severe Weather Procedure will be actioned.

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9. LIST OF TERMS AND ACRONYMS

Acronym	Description
@	At
~	Approximately
<	Less/fewer than
>	Greater/more than
≤	Less than or equal to
≥	Greater than or equal to
°C	Degrees Celsius
24/7	24 hours a day, seven days a week
3D	Three-dimensional
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
AFMA	Australian Fisheries Management Authority
AHO	Australian Hydrographic Office
AIS	Automated identification system
ALARP	As low as reasonably practicable
AMP	Australian Marine Park
AMSA	Australian Maritime Safety Authority
ANIMAT	Animal Movement And Exposure Modelling
ANSI	American National Standards Institute
APPEA	Australian Petroleum Production and Exploration Association
AS/NZS	Australian Standard/New Zealand Standard
ASMA	Australian Maritime Safety Authority
ATSB	Australian Transport Safety Bureau
AUV	Automated Underwater Vehicle
BIA	Biologically Important Area
BMSL	Below Mean Sea Level
BOEM	Bureau of Ocean Energy Management
BP	Boiling Point
CAES	Catch and Effort System
cm	Centimetre
cm^3	Cubic centimetre
CO_2	Carbon dioxide
CONOPS	Concurrent Operations
CP	Cathodic protection
CS	Cost/Sacrifice
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CV	Company Value
DAWE	Department of Agriculture, Water and the Environment

Acronym	Description
dB re 1 µPa	Decibels relative to one micropascal; the unit used to measure the intensity of an underwater sound
dB re 1 µPa²·s	Decibels relative to one micropascal squared, per second
db 1 µPa^{2}m^{2}s	Decibels relative to one micropascal squared, metres squared, per second
DEH	Department of Environment and Heritage
DEWHA	Former Commonwealth Department of the Environment, Water, Heritage and the Arts (now DoEE)
DFO	Department of Fisheries and Oceans
DIS	Draft International Standard
DNP	Director of National Parks
DoEE	Commonwealth Department of the Environment and Energy
DoIMMS	Department of the Interior, Minerals Management Service
DPIRD	Western Australian Department of Primary Industries and Regional Development
DRIMS	Document Retrieval Integrated Management System
DSEWPaC	Former Commonwealth Department of Sustainability, Environment, Water, Population and Communities (now DoEE)
DWH	Deepwater Horizon
EMBA	Environment that may be affected
ENVID	Environment Identification (study)
EP	Environment Plan
EPBC	Environmental Protection Biodiversity Conservation
EPO	Environmental Performance Outcome
EPS	Environment Performance Standard
ERM	Environmental Resource Management
ESD	Ecologically Sustainable Development
F	Control feasibility
F-Pil	Flatback turtle – Pilbara stock
FRC	Fast Rescue Craft
GNSS	Global Navigation Satellite System
G-NWS	Green turtle – North West Shelf stock
GP	Good Industry Practice
GPS	Global Positioning System
HAZID	Hazard identification (study)
HF	High Frequency
HSE	Health, Safety, and Environment
H-WA	Hawksbill turtle – Western Australia stock
IAGC	International Association of Geophysical Contractors
IAPP	International Air Pollution Prevention
IMCRA	Intergrated Marine and Coastal Regionalisation of Australia
IMO	International Maritime Organisation

Acronym	Description
IMS	Invasive Marine Species
INPEX	International Petroleum Exploration
IOPP	International Oil Pollution Prevention
IPIECA	International Petroleum Industry Environmental Conservation Association
ISO	International Organization for Standardization
ISPP	International Sewage Pollution Prevention
ITOPF	International Tanker Owners Pollution Federation Ltd
IUCN	International Union for the Conservation of Nature
JASCO	Japan American Society of Central Ohio
JASMINE	JASCO Animal Simulation Model Including Noise Exposure
JRCC	Joint Rescue Coordination Centre
JSA	Job Safety Analysis
KEF	Key Ecological Feature
kHz	Kilohertz
km	Kilometre
L	Litre
LCS	Legislation, Codes and Standards
$L_{E,}$24h	Cumulative sound exposure over a 24-hour period
LF	Low Frequency
LH-WA	Loggerhead turtle – Western Australia stock
LNG	Liquefied Natural Gas
LP	Low Pressure
$L_{S,E}$	Per-pulse source SEL
$L_{S,PK}$	Peak Source Pressure
m	Metre
m/s	Metres per second
m^2	Square metre
m^3	Cubic metre
MARPOL	The International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978.
MC	Measurement Criteria
MDO	Marine diesel oil
MEMS	Micro electro mechanical system
MF	Mid Frequency
MNES	Matters of National Environmental Significance
MOD	Maximum-Over-Depth
MOPO	Manual of Permitted Operation
MP	Master Plan
MPA	Marine Protected Area

Acronym	Description
MSIN	Maritime Safety Information Notifications
MSS	Marine Seismic Survey
n.d.	No date
N/A	Not Applicable
NIMS	Non-indigenous Marine Species
NLPG	National Light Pollution Guidelines
Nm	Nautical Mile
NMFS	National Marine Fisheries Service (US)
NNE	North North East
NOAA	National Oceanic and Atmospheric Administration (US)
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NO_X	Oxides of nitrogen
NRC	North Rankin Complex
NSF	National Science Foundation
NTM	Notice to Mariners
NW	North West
NWMR	North-west Marine Region
NWS	North West Shelf
OBN	Ocean Bottom Node
OCNS	Offshore Chemical Notification Scheme
OIW	Oil in water
PAM	Passive Acoustic Monitoring
PENV	Pendoley Environmental
PEIS	Programatic Environmental Impact Statement
PJ	Professional Judgement
PK	Zero-to-peak sound pressure
PK-PK	Peak-to-peak sound pressure
PMI	Potential Mortality Injury
PMST	Protected Matters Search Tool
ppb	Parts per billion
ppm	Parts per million
PS	Performance Standard
PTS	Permanent threshold shift
RBA	Risk-based Analysis
RMS	Root Mean Square
ROV	Remotely operated vehicle
RPS	Rural Planning Services
SEL	Sound Exposure Level
SIMAP	Spill Impact Mapping and Analysis program

Acronym	Description
SMPEP	Spill Monitoring Programme Execution Plan
SNA	Safe Navigation Area
SOLAS	Safety Of Life At Sea
SOPEP	Ship Oil Pollution Emergency Plan
SPL	Sound pressure level
SSE	South South East
SV	Societal Value
SWMR	South-west Marine Region
TAP	Threat Abatement Plan
TGS	Tomlinson Geophysical Services
TSSC	Threatened Species Scientific Committee
TTS	Temporary threshold shift
UK	United Kingdom
US	United States
USBL	Ultra-Short Baseline Acoustic Positioning System
VOC	Volatile Organic Compound
WA	Western Australia
WAFIC	Western Australian Fishing Industry Council
WDCS	Whale and Dolphin Conservation Society
WHP	World Heritage Property
WMS	Woodside Management System
WNW	West North West

APPENDIX A WOODSIDE HEALTH, SAFETY, ENVIRONMENT AND RISK MANAGEMENT POLICIES

WOODSIDE POLICY

Woodside

Health, Safety and Environment Policy

OBJECTIVES

Strong health, safety and environment (HSE) performance is essential for the success and growth of our business. Our aim is to be recognised as an industry leader in HSE through managing our activities in a sustainable manner with respect to our workforce, our communities and the environment.

At Woodside we believe that process and personal safety related incidents, and occupational illnesses, are preventable. We are committed to managing our activities to minimise adverse health, safety or environmental impacts.

PRINCIPLES

Woodside will achieve this by:

- implementing a systematic approach to HSE risk management
- complying with relevant laws and regulations and applying responsible standards where laws do not exist
- setting, measuring and reviewing objectives and targets that will drive continuous improvement in HSE performance
- embedding HSE considerations in our business planning and decision-making processes
- integrating HSE requirements when designing, purchasing, constructing and modifying equipment and facilities
- maintaining a culture in which everybody is aware of their HSE obligations and feels empowered to speak up and intervene on HSE issues
- undertaking and supporting research to improve our understanding of HSE and using science to support impact assessments and evidence-based decision making
- taking a collaborative and pro-active approach with our stakeholders
- requiring contractors to comply with our HSE expectations in a mutually beneficial manner
- publicly reporting on HSE performance

APPLICATION

Responsibility for the application of this Policy rests with all Woodside employees, contractors and joint venturers engaged in activities under Woodside operational control. Woodside managers are also responsible for promotion of this Policy in non-operated joint ventures.

Updated by the Board in April 2021

WOODSIDE POLICY

Risk Management Policy

OBJECTIVES

Woodside recognises that risk is inherent in our business and the effective management of risk is vital to deliver our strategic objectives, continued growth and success. We are committed to managing risks in a proactive and effective manner as a source of competitive advantage.

Our approach protects us against potential negative impacts, enables us to take risk for reward and improves our resilience against emerging risks. The objective of our risk management framework is to provide a single consolidated view of risks across the company to understand our full risk exposure and prioritise risk management and governance.

The success of our approach lies in the responsibility placed on everyone at all levels to proactively identify, assess and treat risks relating to the objectives they are accountable for delivering.

PRINCIPLES

Woodside achieves these objectives by:

- Applying a structured and comprehensive framework for the identification, assessment and treatment of current risks and response to emerging risks;
- Ensuring line of sight of financial and non-financial risks at appropriate levels of the organisation;
- Demonstrating leadership and commitment to integrating risk management into our business activities and governance practices;
- Recognising the value of stakeholder engagement, best available information and proactive identification of potential changes in external and internal context;
- Embedding risk management into our critical business processes and control framework;
- Understanding our exposure to risk and tolerance for uncertainty to inform our decision making and assure that Woodside is operating with due regard to the risk appetite endorsed by the Board; and
- Evaluating and improving the effectiveness and efficiency our approach.

APPLICATION

The Managing Director of Woodside is accountable to the Board of Directors for ensuring this policy is effectively implemented.

Managers are responsible for promoting and applying the Risk Management Policy. Responsibility for the effective application of this policy rests with all Woodside employees, contractors and joint venturers engaged in activities under Woodside operational control.

This policy will be reviewed regularly and updated as required.

Revised by the Woodside Petroleum Ltd Board on 4 December 2020.

APPENDIX B RELEVANT REQUIREMENTS

The below table refers to Commonwealth Legislation related to the project.

Commonwealth Legislation	Legislation Summary
Air Navigation Act 1920 *Air Navigation Regulations 1947* *Air Navigation (Aerodrome Flight Corridors) Regulations 1994* *Air Navigation (Aircraft Engine Emissions) Regulations 1995* *Air Navigation (Aircraft Noise) Regulations 1984* *Air Navigation (Fuel Spillage) Regulations 1999*	This Act relates to the management of air navigation.
Australian Maritime Safety Authority Act 1990	This Act establishes a legal framework for the Australian Maritime Safety Authority (AMSA), which represents the Australian Government and international forums in the development, implementation and enforcement of international standards including those governing ship safety and marine environment protection. AMSA is responsible for administering the Marine Orders in Commonwealth waters.
Australian Radiation Protection and Nuclear Safety Act 1998	This Act relates to the protection of the health and safety of people, and the protection of the environment from the harmful effects of radiation.
Biosecurity Act 2015 *Quarantine Regulations 2000* *Biosecurity Regulation 2016* *Australian Ballast Water Management Requirements 2017*	This Act provides the Commonwealth with powers to take measures of quarantine, and implement related programs as are necessary, to prevent the introduction of any plant, animal, organism or matter that could contain anything that could threaten Australia’s native flora and fauna or natural environment. The Commonwealth’s powers include powers of entry, seizure, detention and disposal. This Act includes mandatory controls on the use of seawater as ballast in ships and the declaration of sea vessels voyaging out of and into Commonwealth waters. The Regulations stipulate that all information regarding the voyage of the vessel and the ballast water is declared correctly to the quarantine officers.
Environment Protection and Biodiversity Conservation Act 1999 *Environment Protection and Biodiversity Conservation Regulations 2000*	This Act protects matters of national environmental significance (NES). It streamlines the national environmental assessment and approvals process, protects Australian biodiversity and integrates management of important natural and culturally significant places. Under this Act, actions that may be likely to have a significant impact on matters of NES must be referred to the Commonwealth Environment Minister.
Environment Protection (Sea Dumping) Act 1981 *Environment Protection (Sea Dumping) Regulations 1983*	This Act provides for the protection of the environment by regulating dumping matter into the sea, incineration of waste at sea and placement of artificial reefs.
Industrial Chemicals (Notification and Assessment Act) 1989 *Industrial Chemicals (Notification and Assessment) Regulations 1990*	This Act creates a national register of industrial chemicals. The Act also provides for restrictions on the use of certain chemicals which could have harmful effects on the environment or health.

Commonwealth Legislation	Legislation Summary
National Environment Protection Measures (Implementation) Act 1998 *National Environment Protection Measures (Implementation) Regulations 1999*	This Act and Regulations provide for the implementation of National Environment Protection Measures (NEPMs) to protect, restore and enhance the quality of the environment in Australia and ensure that the community has access to relevant and meaningful information about pollution. The National Environment Protection Council has made NEPMs relating to ambient air quality, the movement of controlled waste between states and territories, the national pollutant inventory, and used packaging materials.
National Greenhouse and Energy Reporting Act 2007 *National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015*	This Act and associated Rule establishes the legislative framework for the NGER scheme for reporting greenhouse gas emissions and energy consumption and production by corporations in Australia.
Navigation Act 2012 *Marine order 12 – Construction – subdivision and stability, machinery and electrical installations* *Marine order 30 - Prevention of collisions* *Marine order 47 - Mobile offshore drilling units* *Marine order 57 - Helicopter operations* *Marine order 60 - Floating offshore facilities* *Marine order 91 - Marine pollution prevention—oil* *Marine order 93 - Marine pollution prevention—noxious liquid substances* *Marine order 94 - Marine pollution prevention—packaged harmful substances* *Marine order 96 - Marine pollution prevention—sewage* *Marine order 97 - Marine pollution prevention—air pollution*	This Act regulates navigation and shipping including Safety of Life at Sea (SOLAS). The Act will apply to some activities of the MODU and project vessels. This Act is the primary legislation that regulates ship and seafarer safety, shipboard aspects of marine environment protection and pollution prevention.
Offshore Petroleum and Greenhouse Gas Storage Act 2006 *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* *Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011* *Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations 2009*	This Act is the principal Act governing offshore petroleum exploration and production in Commonwealth waters. Specific environmental, resource management and safety obligations are set out in the Regulations listed.
Ozone Protection and Synthetic Greenhouse Gas Management Act 1989 *Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995*	This Act provides for measures to protect ozone in the atmosphere by controlling and ultimately reducing the manufacture, import and export of ozone depleting substances (ODS) and synthetic greenhouse gases, and replacing them with suitable alternatives. The Act will only apply to Woodside if it manufactures, imports or exports ozone depleting substances.
Protection of the Sea (Powers of Intervention) Act 1981	This Act authorises the Commonwealth to take measures for the purpose of protecting the sea from pollution by oil and other noxious substances discharged from ships and provides legal immunity for persons acting under an AMSA direction.

Commonwealth Legislation	Legislation Summary
Protection of the Sea (Prevention of Pollution from Ships) Act 1983 *Protection of the Sea (Prevention of Pollution from Ships) (Orders) Regulations 1994* *Marine order 91 - Marine pollution prevention—oil* *Marine order 93 - Marine pollution prevention—noxious liquid substances* *Marine order 94 - Marine pollution prevention—packaged harmful substances* *Marine order 95 - Marine pollution prevention—garbage* *Marine order 96 - Marine pollution prevention—sewage* *Maritime Legislation Amendment (Prevention of Air Pollution from Ships) Act 2007* MARPOL Convention	This Act relates to the protection of the sea from pollution by oil and other harmful substances discharged from ships. Under this Act, discharge of oil or other harmful substances from ships into the sea is an offence. There is also a requirement to keep records of the ships dealing with such substances. The Act applies to all Australian ships, regardless of their location. It applies to foreign ships operating between 3 nautical miles (nm) off the coast out to the end of the Australian Exclusive Economic Zone (200 nm). It also applies within the 3 nm of the coast where the State/Northern Territory does not have complementary legislation. All the Marine Orders listed, except for Marine Order 95, are enacted under both the *Navigation Act 2012* and the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*. This Act is an amendment to the *Protection of the Sea (Prevention of Pollution from Ships) Act 1983*. This amended Act provides the protection of the sea from pollution by oil and other harmful substances discharged from ships.
Protection of the Sea (Harmful Antifouling Systems) Act 2006 *Marine order 98—(Marine pollution prevention—anti-fouling systems)*	This Act relates to the protection of the sea from the effects of harmful anti-fouling systems. It prohibits the application or reapplication of harmful anti-fouling compounds on Australian ships or foreign ships that are in an Australian shipping facility.

APPENDIX C EPBC ACT PROTECTED MATTERS SEARCH REPORTS

Australian Government

Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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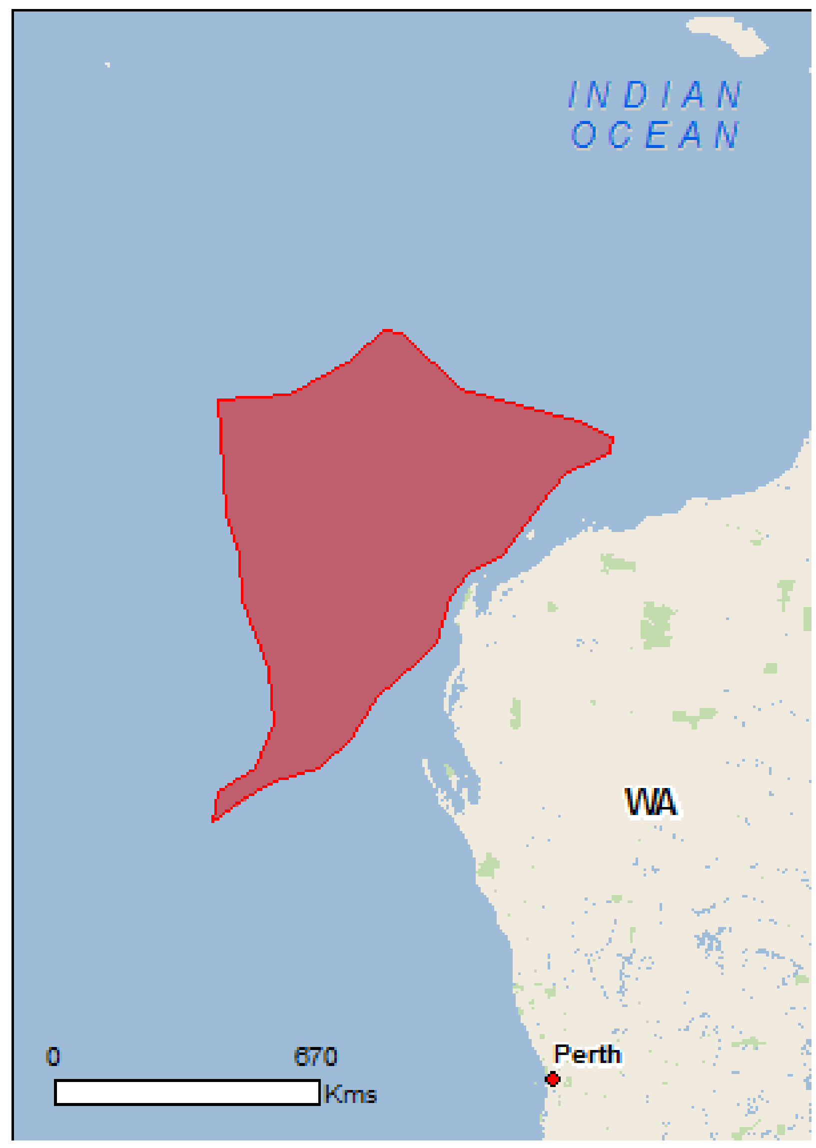

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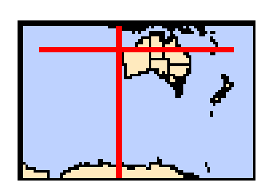

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	31
Listed Migratory Species:	50

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	83
Whales and Other Cetaceans:	32
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	6

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	None
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	6

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea
Extended Continental Shelf

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
North-west
South-west

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Reptiles		
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area
Sharks		

Name	Status	Type of Presence
Carcharias taurus (west coast population) Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Listed Migratory Species

[Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat may occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Sterna dougallii Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat known to occur within area
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat likely to occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Dugong dugon Dugong [28]		Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat may occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely to occur within area
Sterna dougallii Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area
Sterna fuscata Sooty Tern [794]		Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Fish		
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within area
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys latispinosus Muiron Island Pipefish [66196]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Doryrhamphus multiannulatus Many-banded Pipefish [66717]		Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish [66216]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Phoxocampus belcheri Black Rock Pipefish [66719]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Species or species habitat likely to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur

Name	Threatened	Type of Presence
		within area
[Aipysurus duboisii](#) Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Aipysurus tenuis Brown-lined Seasnake [1121]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake [1125]		Species or species habitat may occur within area
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Hydrophis czeblukovi Fine-spined Seasnake [59233]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis mcdowelli null [25926]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area

Name	Threatened	Type of Presence
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans		[Resource Information]
Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Indopacetus pacificus Longman's Beaked Whale [72]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within

Name	Status	Type of Presence
		area
Mesoplodon ginkgodens Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale [59564]		Species or species habitat may occur within area
Mesoplodon grayi Gray's Beaked Whale, Scamperdown Whale [75]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat may occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat may occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks

[Resource Information]

Name	Label
Abrolhos	Habitat Protection Zone (IUCN IV)
Carnarvon Canyon	Habitat Protection Zone (IUCN IV)
Gascoyne	Habitat Protection Zone (IUCN IV)
Gascoyne	Multiple Use Zone (IUCN VI)

Name	Label
Gascoyne	National Park Zone (IUCN II)
Montebello	Multiple Use Zone (IUCN VI)

Extra Information

Key Ecological Features (Marine) [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Ancient coastline at 125 m depth contour	North-west
Canyons linking the Cuvier Abyssal Plain and the	North-west
Continental Slope Demersal Fish Communities	North-west
Exmouth Plateau	North-west
Wallaby Saddle	North-west
Western demersal slope and associated fish	South-west

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-17.8329 108.2184,-19.4397 108.3199,-20.353 108.4098,-21.1643 108.6918,-22.1724 108.7438,-23.6072 109.346,-24.7401 109.4788,-25.678 109.0383,-26.1799 108.2016,-26.7799 108.0874,-25.9252 109.4634,-25.6414 110.524,-25.0456 111.2586,-24.1557 111.8923,-23.4208 112.7645,-23.0784 113.2122,-22.0904 113.5383,-21.5972 113.9791,-21.2323 114.6948,-20.7077 115.0846,-19.8 115.8321,-19.4201 116.2138,-19.1793 116.8237,-19.0082 117.1705,-18.6672 117.2461,-18.2927 116.4595,-17.6175 113.7464,-16.3747 112.4046,-16.3146 111.9894,-16.9964 111.2705,-17.7321 109.8735,-17.8329 108.2184

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- -Office of Environment and Heritage, New South Wales
- -Department of Environment and Primary Industries, Victoria
- -Department of Primary Industries, Parks, Water and Environment, Tasmania
- -Department of Environment, Water and Natural Resources, South Australia
- -Department of Land and Resource Management, Northern Territory
- -Department of Environmental and Heritage Protection, Queensland
- -Department of Parks and Wildlife, Western Australia
- -Environment and Planning Directorate, ACT
- -Birdlife Australia
- -Australian Bird and Bat Banding Scheme
- -Australian National Wildlife Collection
- -Natural history museums of Australia
- -Museum Victoria
- -Australian Museum
- -South Australian Museum
- -Queensland Museum
- -Online Zoological Collections of Australian Museums
- -Queensland Herbarium
- -National Herbarium of NSW
- -Royal Botanic Gardens and National Herbarium of Victoria
- -Tasmanian Herbarium
- -State Herbarium of South Australia
- -Northern Territory Herbarium
- -Western Australian Herbarium
- -Australian National Herbarium, Canberra
- -University of New England
- -Ocean Biogeographic Information System
- -Australian Government, Department of Defence
- Forestry Corporation, NSW
- -Geoscience Australia
- -CSIRO
- -Australian Tropical Herbarium, Cairns
- -eBird Australia
- -Australian Government – Australian Antarctic Data Centre
- -Museum and Art Gallery of the Northern Territory
- -Australian Government National Environmental Science Program
- -Australian Institute of Marine Science
- -Reef Life Survey Australia
- -American Museum of Natural History
- -Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
- -Tasmanian Museum and Art Gallery, Hobart, Tasmania
- -Other groups and individuals

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Department of Agriculture Water and the Environment
GPO Box 858
Canberra City ACT 2601 Australia
+61 2 6274 1111

Australian Government
Department of Agriculture, Water and the Environment

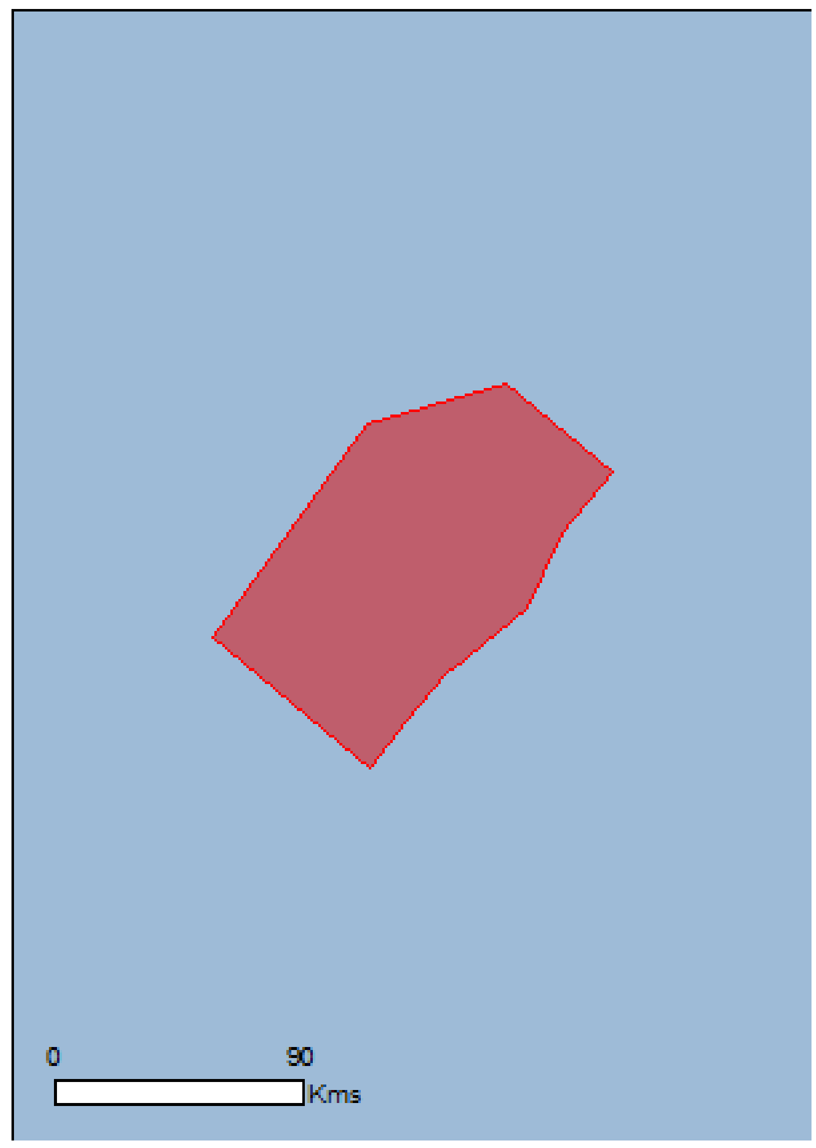
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 08/04/21 13:22:47



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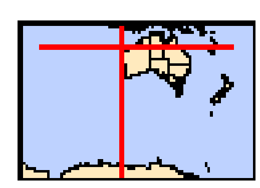

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	12
Listed Migratory Species:	25

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	15
Whales and Other Cetaceans:	25
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	None
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	1

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
North-west

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus		
Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Macronectes giganteus		
Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Mammals		
Balaenoptera borealis		
Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus		
Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area
Megaptera novaeangliae		
Humpback Whale [38]	Vulnerable	Species or species habitat may occur within area
Reptiles		
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat likely to occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Migratory Marine Species		
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species

[Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Reptiles		
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat likely to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area

Name	Status	Type of Presence
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Extra Information

Key Ecological Features (Marine) [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Exmouth Plateau	North-west

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-20.1088 113.3704,-20.1008 113.3864,-19.9117 113.6278,-19.6807 113.7458,-19.4949 113.9089,-19.2237 113.5637,-19.3443 113.1115,-19.9994 112.6022,-20.4005 113.1125,-20.1088 113.3704

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
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GPO Box 858
Canberra City ACT 2601 Australia
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APPENDIX D OIL SPILL PREPAREDNESS AND RESPONSE STRATEGY SELECTION AND EVALUATION

Oil Spill Preparedness and Response Mitigation Assessment for the Scarborough 4D Baseline 1 (B1) Marine Seismic Survey (MSS)

Security and Emergency Management
Hydrocarbon Spill Preparedness

August 2021
Revision 0

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

EXECUTIVE SUMMARY

Woodside Energy Ltd (Woodside) has developed its oil spill preparedness and response position for the Scarborough 4D Baseline 1 (B1) Marine Seismic Survey (MSS), hereafter known as the Petroleum Activities Program (PAP).

This document demonstrates that the risks and impacts from an unplanned hydrocarbon release, and the associated response operations, are controlled to As Low as Reasonably Practicable (ALARP) and Acceptable levels. It achieves this by evaluating response options to address the potential environmental impacts resulting from an unplanned loss of hydrocarbon containment associated with the PAP described in the Environment Plan (EP). This document then outlines Woodside's decisions and techniques for responding to a hydrocarbon release event and the process for determining its level of hydrocarbon spill preparedness.

A summary of the key facts and references to additional detail within this document are presented below.

Table 0-1: Summary of the key details for assessment

<table>
<tr><th>Key details of assessment</th><th colspan="2">Summary</th><th>Reference to additional detail</th></tr>
<tr><td>Worst Case Credible Scenario</td><td colspan="2">Hydrocarbon release caused by vessel collision
Instantaneous surface release of 1062 m^3 of marine diesel.</td><td>Section 2.2</td></tr>
<tr><td>Hydrocarbon Properties</td><td colspan="2">Under constant 5 kn wind conditions approximately 45% of the oil is predicted to evaporate within 24 hours. The majority of remaining oil on the water surface will weather at a slower rate due to being comprised of the longer-chain compounds with higher boiling points. Evaporation of the residual compounds will slow significantly, and they will then be subject to more gradual decay through biological and photochemical processes.
Under variable wind conditions where winds are of a greater strength, more entrainment of oil into the water column is predicted (about 45% after 24 hours). A further 35% is forecast to evaporate, leaving only a small proportion of the oil floating on the water surface (<1%).
It is predicted only 53.1 m^3 of product would remain after weathering from the marine diesel scenario and there is no predicted shoreline contact or accumulation.</td><td>Section 6.7.1.1 of the EP
Appendix A of the First Strike Plan</td></tr>
<tr><td rowspan="4">Modelling Results</td><td colspan="2">A quantitative, stochastic assessment has been undertaken for the credible worst case spill scenario to help assess the environmental risk of a hydrocarbon spill.
A total of 100 replicate simulations were completed for the scenarios to test for trends and variations in the trajectory and weathering of the spilled oil, with an even number of replicates completed using samples of metocean data that commenced within each calendar quarter.
The stochastic modelling did not predict the threshold concentrations required to trigger deterministic modelling. Deterministic modelling was therefore not undertaken and stochastic modelling has been used to scale the response.</td><td rowspan="4">Section 2.3</td></tr>
<tr><td>Minimum time to shoreline contact (above 100 g/m^2)</td><td>No contact at threshold</td></tr>
<tr><td>Largest volume ashore at any single Response Priority Area (RPA) (above 100g/m^2)</td><td>No contact at threshold</td></tr>
<tr><td>Largest total shoreline accumulation</td><td>No contact at threshold</td></tr>
</table>

Key details of assessment	Summary		Reference to additional detail
	(above 100g/m^2) all shorelines		
Net Environmental Benefit Analysis	Monitor and evaluate, source control via vessel SOPEP and oiled wildlife response, are all identified as potentially having a net environmental benefit (dependent on the actual spill scenario) and carried forward for further assessment.		**Section 4**
ALARP evaluation of selected response techniques	The evaluation of the selected response techniques shows the proposed controls reduced the risk to an ALARP and Acceptable level for the risk presented in **Section 2**, without the implementation of considered additional, alternative or improved control measures.		**Section 6**

1 INTRODUCTION

1.1 Overview

Woodside Energy Ltd (Woodside) has developed its oil spill preparedness and response position for the Scarborough 4D B1 MSS, hereafter known as the PAP. This document outlines Woodside's decisions and techniques for responding to a hydrocarbon loss of containment event and the process for determining its level of hydrocarbon spill preparedness.

1.2 Purpose

This document, together with the documents listed below, meet the requirements of the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Environment Regulations) relating to hydrocarbon spill response arrangements.

- The Scarborough 4D B1 MSS Environment Plan (EP)
- Oil Pollution Emergency Arrangements (OPEA) (Australia)
- The Scarborough 4D B1 MSS Oil Pollution Emergency Plan (OPEP) including
    - First Strike Response Plan (FSP)
    - Relevant Operations Plans
    - Relevant Tactical Response Plans (TRPs)
    - Relevant Supporting Plans
    - Data Directory.

The purpose of this document is to demonstrate that the risks and impacts from an unplanned hydrocarbon release and the associated response operations are controlled to As Low as Reasonably Practicable (ALARP) and Acceptable levels.

1.3 Scope

This document demonstrates that the risks and impacts from an unplanned hydrocarbon release, and the associated response operations, are controlled to ALARP and Acceptable levels. It achieves this by evaluating response options to address the potential environmental risks and impacts resulting from an unplanned loss of hydrocarbon containment associated with the PAP described in the EP. This document then outlines Woodside's decisions and techniques for responding to a hydrocarbon release event and the process for determining its level of hydrocarbon spill preparedness. It should be read in conjunction with the documents listed in **Table 1-1**. The location of the PAP is shown in Figure 3-1 of the EP.

1.4 Oil spill response document overview

The documents outlined in **Table 1-1** and **Figure 1-1** are collectively used to manage the preparedness and response for a hydrocarbon release.

The Oil Pollution First Strike Response Plan (FSP) (Woodside ID: 1401752711) contains a pre-operational Net Environmental Benefit Analysis (NEBA) summary, outlining the selected response techniques for this PAP. Relevant Operational Plans to be initiated for associated response techniques are identified in the FSP and relevant forms to initiate a response are appended to the FSP.

The process to develop an Incident Action Plan (IAP) begins once the Oil Pollution FSP is underway. The IAP includes inputs from the Monitor and Evaluate (ME) operations and the operational NEBA (**Section 4**). Planning, coordination and resource management are initiated by the Incident

Management Team (IMT). In some instances, technical specialists may be utilised to provide expert advice. The planning may also involve liaison officers from supporting government agencies.

During each operational period, field reports are continually reviewed to evaluate the effectiveness of response operations. In addition, the operational NEBA is continually reviewed and updated to ensure the response techniques implemented continue to result in a net environmental benefit (**Section 4**).

The response will continue as described in **Section 5** until the response termination criteria have been met.

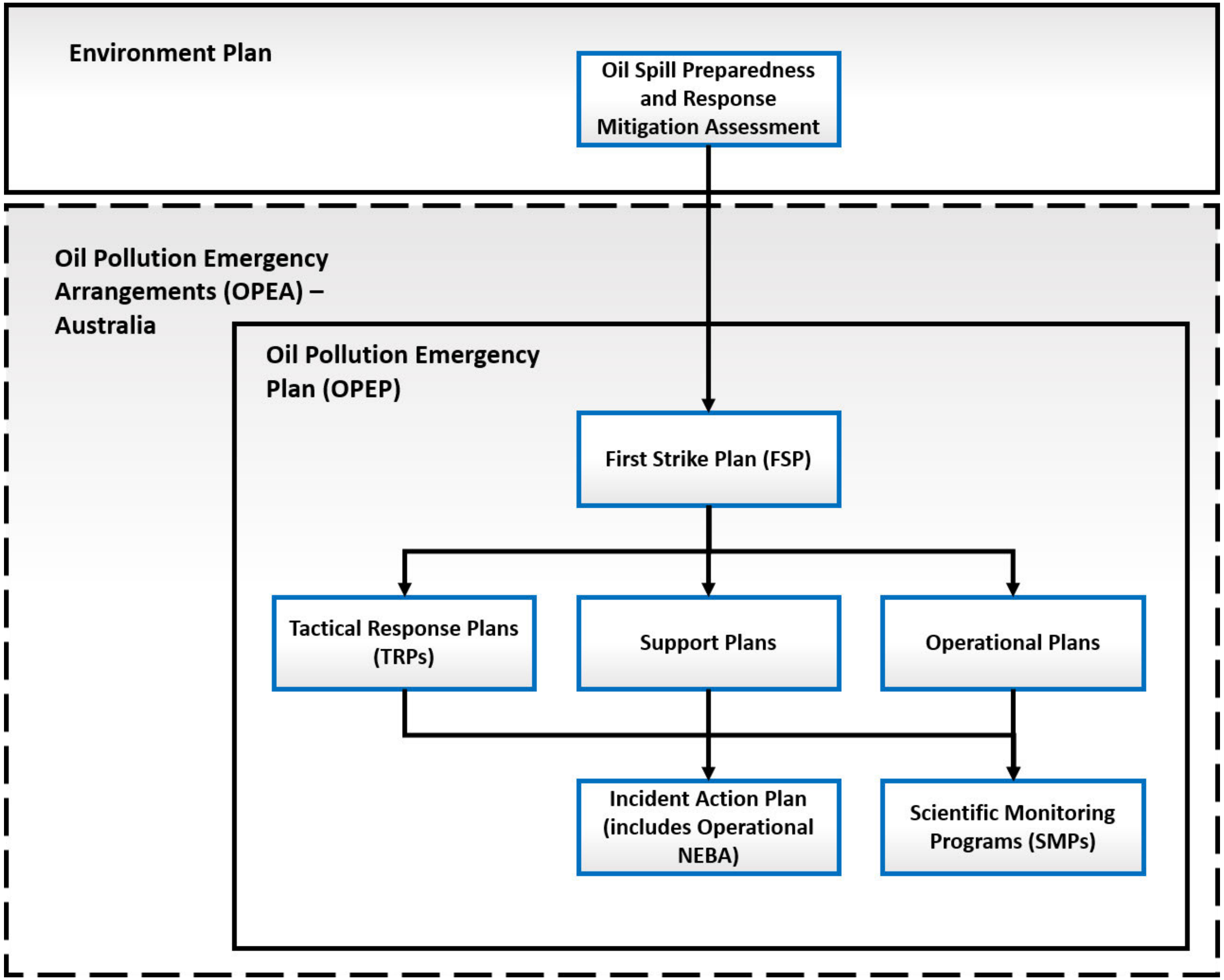


Figure 1-1: Woodside hydrocarbon spill document structure

Table 1-1: Hydrocarbon spill preparedness and response – document references

Document	Document overview	Stakeholders	Relevant information	Document name/reference
Scarborough 4D B1 MSS EP	Demonstrates that potential adverse impacts on the environment associated with the Scarborough 4D B1 MSS (during both routine and non-routine operations) are mitigated and managed to ALARP and will be of an acceptable level.	NOPSEMA Woodside internal	EP Section 6 (Identification and evaluation of environmental risks and impacts, including credible spill scenarios) EP Section 7 (Implementation strategy – including emergency preparedness and response) EP Section 7 (Reporting and compliance) EP Section 6 (Performance outcomes, standards and measurement criteria)	
Oil Pollution Emergency Arrangements (OPEA) Australia	Describes the arrangements and processes adopted by Woodside when responding to a hydrocarbon spill from a petroleum activity.	Regulatory agencies Woodside internal	All	
Oil Spill Preparedness and Response Mitigation Assessment for the Scarborough 4D B1 MSS (this document)	Evaluates response options to address the potential environmental impacts resulting from an unplanned loss of hydrocarbon containment associated with the PAP described in the EP.	Regulatory agencies Corporate Incident Control Centre (CICC): Control function in an ongoing spill response for activity-specific response information.	All Performance outcomes, standards and measurement criteria related to hydrocarbon spill preparedness and response are included in this document.	
Scarborough 4D B1 MSS Oil Pollution First Strike Response Plan	Facility specific document providing details and tasks required to mobilise a first strike response. Primarily applied to the first 24 hours of a response until a full IAP specific to the event is developed. Oil Pollution First Strike Response Plans are intended to be the first document used to provide immediate guidance to the	Site-based IMT for initial response, activation and notification. CICC for initial response, activation and notification. CICC: Control function in an ongoing spill response for activity-specific response information.	Initial notifications and reporting required within the first 24 hours of a spill event. Relevant spill response options that could be initiated for mobilisation in the event of a spill. Recommended pre-planned tactics. Details and forms for use in immediate response. Activation process for oil spill	

Document	Document overview	Stakeholders	Relevant information	Document name/reference
	responding Incident Management Team (IMT).		trajectory modelling, aerial surveillance and oil spill tracking buoy details.	
Operational Plans	Lists the actions required to activate, mobilise and deploy personnel and resources to commence response operations. Includes details on access to equipment and personnel (available immediately) and steps to mobilise additional resources depending on the nature and scale of a release. Relevant operational plans will be initially selected based on the Oil Pollution First Strike Plan; additional operational plans will be activated depending on the nature and scale of the release.	CICC: Operations and Logistics functions for first strike activities. CICC: Planning Function to help inform the IAP on resources available.	Locations from where resources may be mobilised. How resources will be mobilised. Details of where resources may be mobilised to and what facilities are required once the resources arrive. Details on how to implement resources to undertake a response.	Operational Monitoring Plan Vessel Shipboard Oil Pollution Emergency Plan (SOPEP) Oiled Wildlife
Tactical Response Plans	Provides options for response techniques in selected RPAs. Provides site, access and deployment information to support a response at the location.	CICC: Planning Function to help develop IAPs, and Logistics Function to assist with determining resources required.	Indicative response techniques. Access requirements and/or permissions. Relevant information for undertaking a response at that site. Where applicable, may include equipment deployment locations and site layouts.	For full list of relevant Tactical Plans for the Scarborough 4D B1 MSS oil spill response, refer to ANNEX E: Tactical Response Plans.
Support Plans	Support Plans detail Woodside's approach to resourcing and the provision of services during a hydrocarbon spill response.	CICC: Operations, Logistics and Planning functions.	Technique for mobilising and managing additional resources outside of Woodside's immediate preparedness arrangements.	Marine Logistics People & Global Capability Surge Labour Requirement Plan Health & Safety Aviation IT Response Plan

Document	Document overview	Stakeholders	Relevant information	Document name/reference
				Communications Response Plan Stakeholder Engagement Accommodation & Catering Waste Management Guidance for Oil Spill Claims Management Security Support Plan Hydrocarbon Spill Responder Health Monitoring Guideline

2 RESPONSE PLANNING PROCESS

This document details Woodside's process for identifying potential response options for the hydrocarbon release scenarios, identified in the EP. **Figure 2-1** outlines the interaction between Woodside's response, planning/preparedness and selection process.

This structure has been used because it shows how the planning and preparedness activities inform a response and provides indicative guidance on what activities would be undertaken, in sequential order, if a real event were to occur. The process also evaluates alternative, additional and/or improved control measures specific to the PAP.

The Scarborough 4D B1 MSS First Strike Response Plan then summarises the outcome of the response planning process and provides initial response guidance and a summary of ongoing response activities, if an incident were to occur.

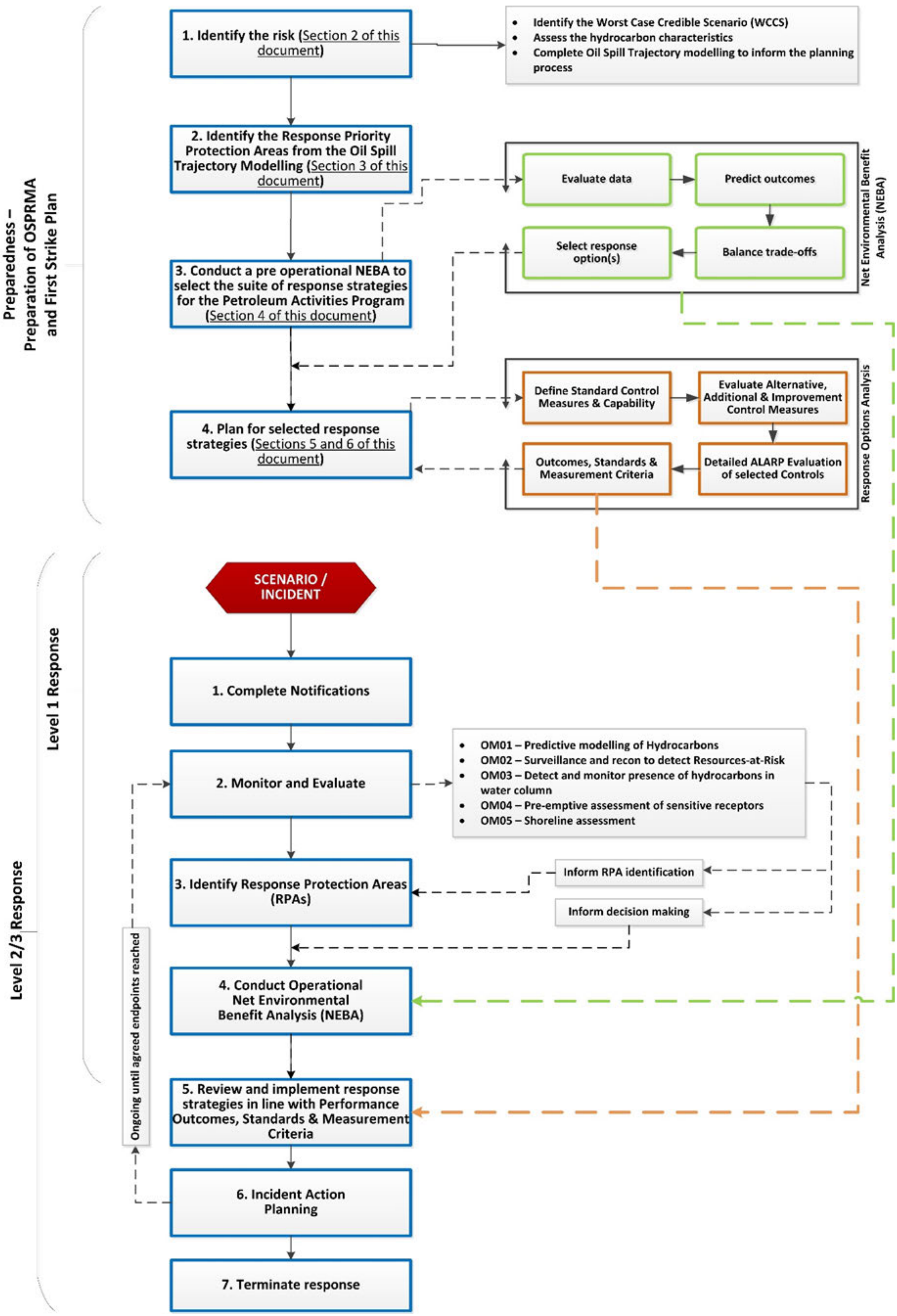


Figure 2-1: Response planning and selection process

2.1 Response planning process outline

This document is expanded below to provide additional context on the key steps in determining capability, evaluating ALARP and hydrocarbon spill response requirements.

Section 1. INTRODUCTION

Section 2. RESPONSE PLANNING PROCESS

- identification of worst-case credible scenario(s) (WCCS)
- spill modelling for WCCS.

Section 3. IDENTIFY RESPONSE PROTECTION AREAS (RPAs)

- areas predicted to be contacted at concentration >100g/m^2.

Section 4. NET ENVIRONMENTAL BENEFIT ANALYSIS (NEBA)

- pre-operational NEBA (during planning/ALARP evaluation): this must be reviewed during the initial response to an incident to ensure its accuracy
- selected response techniques prioritised and carried forward for ALARP assessment.

Section 5. HYDROCARBON SPILL ALARP PROCESS

- determines the response need based on predicted consequence parameters.
- details the environmental performance of the selected response options based on need.
- sets the environmental performance outcomes, environmental performance standards and measurement criteria.

Section 6. ALARP EVALUATION

- evaluates alternative, additional, and improved options for each response technique to demonstrate the risk has been reduced to ALARP.
- provides a detailed ALARP assessment of selected control measure options against:
  - predicted cost associated with implementing the option
  - predicted change to environmental benefit
  - predicted effectiveness / feasibility of the control measure.

Section 7. ENVIRONMENTAL RISK ASSESSMENT OF SELECTED RESPONSE TECHNIQUES

- evaluation of impacts and risks from implementing selected response options.

Section 8. ALARP CONCLUSION

Section 9. ACCEPTABILITY CONCLUSION

2.1.1 Response Planning Assumptions

For the purpose of defining terms related to response planning and timing, the following definitions have been developed.

IMT Call-out/ Notification	Contract Activation	Response Option Mobilisation	Response Option Deployment	Response Option Effectiveness
This is the time taken from call-out to mobilise the IMT to the designated Incident Control Centre	This is the time taken once the IMT has been mobilised to activate specific contracts for resources (SFRT, FWADC, AMOSC, AMSA, OSRL, etc)	This is the time taken to mobilise resources from home location to laydown/staging area (expected to be airport or sea port) close to response area	This is the time taken to deploy resources from laydown/staging area (expected to be airport or sea port) to response area/field	This relates to the performance of equipment/response option as well as required personnel resourcing (Specialists/Supervisors + support personnel)
Approx 2-4 hours	Approx 2-4 hours	Response Technique specific	Field/Location specific	Response Strategy specific

Figure 2-2: Response Planning Assumption - Timing, Resourcing and Effectiveness

2.2 Environment plan risk assessment (credible spill scenarios)

Potential hydrocarbon release scenarios from the PAP have been identified during the risk assessment process (Section 6 of the EP). Further descriptions of risk, impacts and mitigation measures (which are not related to hydrocarbon preparedness and response) are provided in Section 6 of the EP. Three unplanned events or credible spill scenarios for the PAP have been selected as representative across types, sources and incident/response levels, up to and including the WCCS.

Table 2-1 presents the credible scenarios for the PAP. The WCCS for the activity is then used for response planning purposes, as all other scenarios are of a lesser scale and extent. By demonstrating capability to manage the response to the WCCS, Woodside assumes other scenarios that are smaller in nature and scale can also be managed by the same capability. Response performance measures have been defined based on a response to the WCCS.

The surface release of marine diesel caused by vessel collision (Credible Scenario-01; CS-01) has been modelled and considered for response planning purposes. Credible Scenario-02 (CS-02) and Credible Scenario-03 (CS-03) have significantly smaller marine diesel release volumes and are considered to be within the risk profile and spill response capability requirements of CS-01.

CS-01 is therefore selected for response planning purposes.

Table 2-1: Petroleum Activities Program credible spill scenarios

Credible Spill Scenarios	Scenario selected for planning purposes	Scenario description	Maximum credible volume released (liquid m^3)[1]	Incident Level	Hydrocarbon (HC) type	Residual proportion	Residual volume (liquid m^3)
Credible Scenario-01 (Worst Case)	Yes	Hydrocarbon release due to vessel collision	Instantaneous release of 1062 m^3 marine diesel[1]	2	Marine diesel	5%	53.1 m^3
Credible Scenario-02	No	Hydrocarbon release due to vessel collision	Instantaneous release of 250 m^3 marine diesel	2	Marine diesel	5%	12.5 m^3
Credible Scenario-03	No	Marine Fuel Loss during bunkering	Instantaneous release of 8 m^3 marine diesel	1	Marine diesel	5%	0.4 m^3

[1] *Please note that modelling of a 2000 m^3 surface release of marine diesel from Woodside's Scarborough Project, conducted in 2019, was available and used for the analysis within this document. The release location used for the spill modelling is at the FPU location (19° 53' 54.72" S, 113° 14' 19.56" E). The modelled spill volume of 2000 m^3 is greater than the worst-case credible release volume of 1062 m^3 for this EP. However, the results of the modelling can be used to demonstrate that a much larger marine diesel spill in the vicinity of the Operational Area has an Environment that May Be Affect (EMBA) that is not predicted to include any surface slicks above threshold volumes entering WA state waters, or any shoreline contact or accumulation. Basing the impact assessment for a vessel collision scenario on this modelling is considered highly conservative and consequently, the EMBA for a 1062 m^3 surface release of marine diesel within the Operational Area would be considerably smaller than the EMBA described in this EP.*

2.2.1 Hydrocarbon characteristics

Hydrocarbon characteristics, including modelled weathering data and ecotoxicity, are included in Section 6 of the EP.

Marine Diesel

Marine Diesel Oil is typically classed as an International Tanker Owners Federation (ITOPF) Group I/II oil.

Marine diesel is a mixture of volatile and persistent hydrocarbons with low proportions of highly volatile and residual components. Under constant 5 kn wind conditions, approximately 45% of the oil is predicted to evaporate within 24 hours. Under these calm conditions the majority of the remaining oil on the water surface will weather at a slower rate due to being comprised of the longer-chain compounds with higher boiling points. Evaporation of the residual compounds will slow significantly, and they will then be subject to more gradual decay through biological and photochemical processes. Under variable wind conditions where winds are of a greater strength, more entrainment of oil into the water column is predicted (about 45% after 24 hours). A further 35% is forecast to evaporate, leaving only a small proportion of the oil floating on the water surface (<1%).

The heavier (low volatility) components of the oil have a tendency to entrain into the upper water column due to wind-generated waves but can subsequently resurface if wind-waves abate. Therefore, the heavier components of this oil can remain entrained or on the sea surface for an extended period, with associated potential for dissolution of the soluble aromatic fraction. It is predicted only 53.1 m^3 of product would remain after weathering from the marine diesel scenario and there is no predicted shoreline contact or accumulation.

2.3 Hydrocarbon spill modelling

Oil spill trajectory modelling tools are used for environmental impact assessment and during response planning to understand spatial scale and timeframes for response operations. Woodside recognises that there is a degree of uncertainty related to the use of modelling data and has subsequently utilised conservative approaches to volumes, weathering, spatial areas, timing and response effectiveness to scale capability to need.

The Oil Spill Model and Response System (OILMAP) and Integrated Oil Spill Impact Model System (SIMAP) models are used for stochastic modelling. They have been developed over three decades of planning, exercises, actual responses, several peer reviews, and validation studies. OILMAP was originally derived from the United States Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Type A model (French et al. 1996), for assessing marine transport, biological impact and economic impact that was also used under the United States Oil Pollution Act 1990 Natural Resource Damage Assessment (NRDA) regulations. Notable spills where the model has been used and validated against actual field observations include, Exxon Valdez (French McCay 2004), North Cape Oil Spill (French McCay 2003), along with an assessment of 20 other spills (French McCay and Rowe, 2004). In addition, test spills designed to verify fate, weathering and movement algorithms have been conducted regularly and in a range of climate conditions (French and Rines 1997; French et al. 1997; Payne et al. 2007s, 2007b; French McCay et al. 2007).

Further to this, the algorithms have been updated using the latest findings from the Macondo/Deepwater Horizon well blowout in the Gulf of Mexico and validated according to the Deepwater Horizon (DWH) oil spill in support of the Natural Resource Damage Assessment (NRDA) (Spaulding et al. 2015; French McCay et al. 2015, 2016). Finally, the OILMAP and SIMAP models have been used extensively in Australia to prosecute pollution offences, predict discharge locations and likely spill volumes based on weathering and surveillance observations, and has been used as expert witness evidence in Australian court proceedings, aiding the prosecution to determine spill quantum estimates.

2.3.1 Stochastic modelling

Stochastic modelling of a 2000 m^3 surface release of marine diesel was available for Woodside's Scarborough Project, conducted in 2019 for the scenario outlined in **Table 2-1**. The release location used for the spill modelling is within the Operational Area (19° 53' 54.72" S, 113° 14' 19.56" E). The modelled spill volume of 2000 m^3 is greater than the worst-case credible release volume of 1062 m^3 for this EP. However, the results of the modelling can be used to demonstrate that a much larger marine diesel spill in the vicinity of the Operational Area has an Environment that May Be Affect (EMBA) that is not predicted to include any surface slicks above threshold volumes entering WA state waters, or any shoreline contact or accumulation. Basing the impact assessment for a vessel collision scenario on this modelling is considered highly conservative and consequently, the EMBA for a 1062 m^3 surface release of marine diesel within the Operational Area would be considerably smaller than the EMBA described in this EP.

A quantitative, stochastic assessment has been undertaken for the credible spill scenario to help assess the environmental consequences of a hydrocarbon spill.

A total of 100 replicate simulations were completed for the scenario to test for trends and variations in the trajectory and weathering of the spilled oil over an annual period, with an even number of replicates completed using samples of metocean data that commenced within each month. Further details relating to the assessments for the scenario can be found in Section 6 of the EP.

2.3.1.1 Environmental impact thresholds – EMBA and hydrocarbon exposure

The outputs of the stochastic spill modelling are used to assess the potential environmental impact from the credible scenarios. The stochastic modelling results are used to delineate areas of the marine and shoreline environment that could be exposed to hydrocarbon levels exceeding environmental impact threshold concentrations. The summary of all the locations where hydrocarbon thresholds could be exceeded by any of the simulations modelled is defined as Environment that May Be Affected (EMBA) and is discussed further in Section 4 of the EP. As the weathering of different fates of hydrocarbons (surface, entrained and dissolved) differs due to the influence of the metocean mechanism of transportation, a different EMBA is presented for each fate within the EP.

A conservative approach – adopting accepted contact thresholds for impacts on the marine environment – is used to define the EMBA. These hydrocarbon thresholds are presented in **Table 2-2** below and described in Section 6 of the EP.

Table 2-2: Summary of thresholds applied to the stochastic hydrocarbon spill modelling of marine diesel to determine the EMBA and environmental impacts

Threshold (marine diesel)	Description
10 g / m^2	Surface hydrocarbon
100 ppb	Entrained hydrocarbon (ppb)
50 ppb	Dissolved aromatic hydrocarbon (ppb)
100 g / m^2	Shoreline accumulation

2.3.2 Deterministic Modelling

Deterministic modelling is undertaken where initial stochastic modelling has indicated that floating oil is present at an impact threshold of 50 g/m^2 and/or where there is shoreline accumulations at an impact threshold of 100 g/m^2. The deterministic modelling outputs are then used to scale the required capability for the offshore (containment and recovery and dispersant) and/or shoreline responses.

The selected stochastic modelling used as a representative of the WCCS for this PAP did not predict the threshold concentrations required to trigger the undertaking of deterministic modelling. Deterministic modelling was therefore not undertaken for CS-01 and stochastic modelling has been used to scale the response.

2.3.3 Response Planning Thresholds for Surface and Shoreline Hydrocarbon Exposure

Thresholds to determine the EMBA are used to predict and assess environmental impacts and inform the SMP, however they do not appropriately represent the thresholds at which an effective response can be implemented. Additional response thresholds are used for response planning and to determine areas where response techniques would be most effective. The spill modelling results are then used to assess the nature and scale of a response.

In the event of an actual response, existing modelling would be reviewed for suitability and additional modelling would be conducted using real-time data and field information to inform Incident Management Team decisions.

The spill modelling outputs are presented at response planning thresholds for surface hydrocarbons for the WCCS. Surface spill concentrations are expressed as grams per square metre (g/m^2) (**Section 2.2**). The thresholds used are derived from oil spill response planning literature and industry guidance and are summarised below.

2.3.4 Surface Hydrocarbon Concentrations

Table 2-3: Surface hydrocarbon thresholds for response planning

Surface hydrocarbon concentration (g/m²)	Description	Bonn Agreement Oil Appearance Code (BAOAC)	Mass per area (g/m²)
>10	Predicted minimum threshold for commencing operational monitoring [2]	Code 3 – Dull metallic colours	5 - 50
50	Predicted minimum floating oil threshold for containment and recovery and surface dispersant application [3]	Code 4 – Discontinuous true oil colour	50 - 200
100	Predicted optimum floating oil threshold for containment and recovery and surface dispersant application	Code 5 – Continuous true oil colour	>200
Shoreline hydrocarbon concentration (g/m²)	**Description**	**National Plan Guidance on Oil Contaminated Foreshores**	**Mass per area (g/m²)**
100	Predicted minimum shoreline accumulation threshold for shoreline assessment operations	Stain	>100
250	Predicted minimum threshold for commencing shoreline clean-up operations	Level 3 - Thin Coating	200 - 1000

The surface thickness of oil at which dispersants are typically effective is approximately 100 g/m^2. However, substantial variations occur in the thickness of the oil within the slick. Additionally, the recommended rate of application for surface dispersant is typically 1-part dispersant to 20 or 25 parts of spilled oil. These figures assume a 0.1 mm slick thickness, averaged over the thickest part of the spill, to calculate a litres/hectare application rate from vessels and aircraft. In practice, this can be difficult to achieve as it is not possible to accurately assess the thickness of the floating oil.

Some degree of localised over-dosage and under-dosage is inevitable in dispersant response. An average oil layer thickness of 0.1 mm is often assumed, although the actual thickness can vary over a wide range (from less than 0.0001 mm to more than 1 mm) over short distances (International Petroleum Industry Environment Conservation Association [IPIECA] 2015).

Guidance from AMSA (AMSA, 2015) indicates that spreading of spills of Group II or III products will rapidly decrease slick thickness over the first 24 hours of a spill resulting in the potential requirement of up to a ten (10) fold increase in capability on day 2 to achieve the same level of performance.

Further guidance from the European Maritime Safety Authority (EMSA) states that spraying the 'metallic' looking area of an oil slick (Bonn Agreement Oil Appearance Code [BAOAC] 3, approx. 5 – 50 μm) with dispersant from spraying gear designed to treat an oil layer 0.1 mm (100 μm) thick, will inevitably cause dispersant over-treatment by a factor of 2 to 20 times (EMSA 2012).

Therefore, dispersant application should be concentrated on the thickest areas of an oil slick and Woodside intends on applying surface dispersants to only BAOAC 4 and 5. Spraying areas of oil

[2] Operational monitoring will be undertaken from the outset of a spill whether or not this threshold has been reached. Monitoring is needed throughout the response to assess the nature of the spill, track its location and inform the need for any additional monitoring and/or response techniques. It also informs when the spill has entered State Waters and control of the incident passes to Western Australia Department of Transport (WA DoT).

[3] At 50g/m^2, containment and recovery and surface dispersant application operations are not expected to be particularly effective. This threshold represents a conservative approach to planning response capability and containing the spread of surface oil.

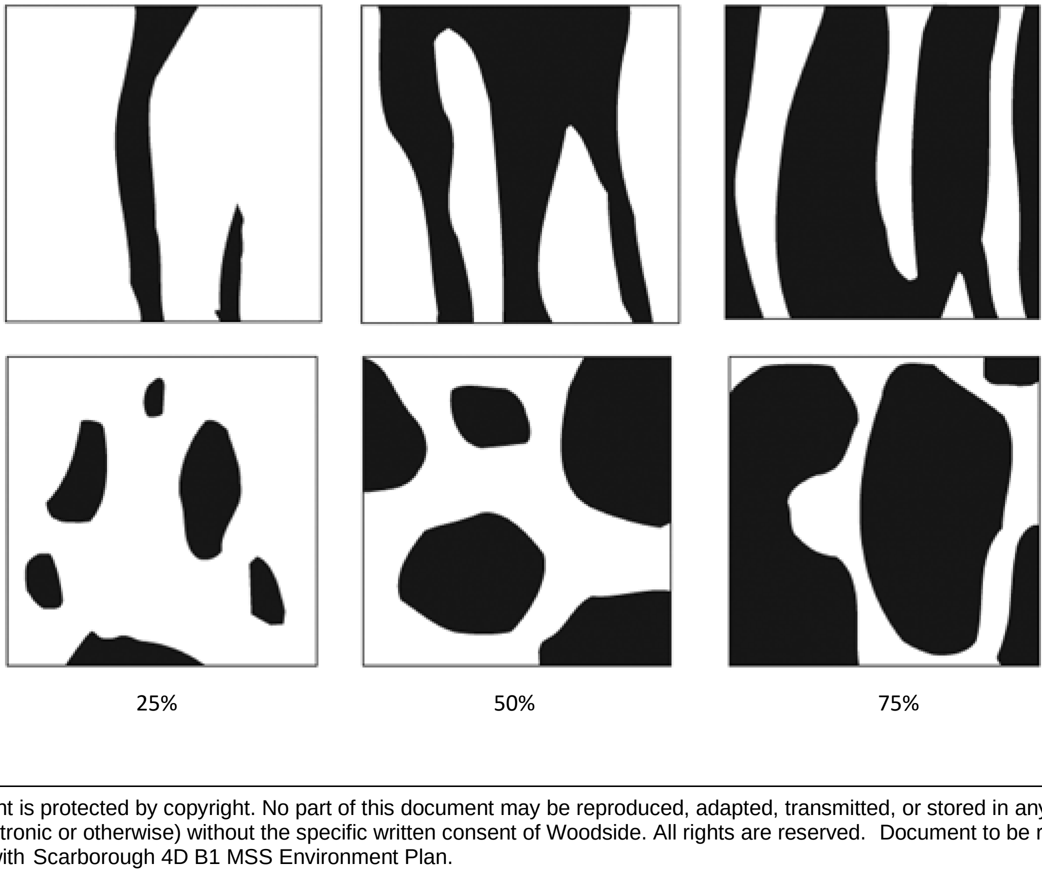
designated as BAOAC Code 4 (Discontinuous true oil colour) with dispersant will, on average, deliver approximately the recommended treatment rate of dispersant.

Spraying areas of oil designated as BAOAC Code 5 with dispersant (Continuous true oil colour and more than 0.2 mm thick) will, on average, deliver approximately half the recommended treatment rate of dispersant. Repeated application of these areas of thicker oil, or increased dosage ratios, will be required to achieve the recommended treatment rate of dispersant (EMSA 2012).

Guidance from the National Oceanic and Atmospheric Administration (NOAA) in the United States is found in the document: *Characteristics of Response Techniques: A Guide for Spill Response Planning in Marine Environments 2013 (NOAA 2013).* This guide outlines advice for response planning across all common techniques, including surface dispersant spraying and containment and recovery. It states that oil thickness can vary by orders of magnitude within distinct areas of a slick, thus the actual slick thickness and oil distribution of target areas are crucial for determining response method feasibility. Further to this, ITOPF also states that in terms of oil spill response, sheen can be disregarded as it represents a negligible quantity of oil, cannot be recovered or otherwise dealt with to a significant degree by existing response techniques, and is likely to dissipate readily and naturally (ITOPF, 2014).

Figure 2-3 below from AMSA's Identification of Oil on Water – Aerial Observation and Identification Guide (AMSA, 2014) shows expected percent coverage of surface hydrocarbons as a proportion of total surface area. Wind-rows, heavy oil patches and tar balls, for example, must be considered, as they influence oil encounter rates, chemical dosages and ignition potential. Each method has different thickness thresholds for effective response.

From this information and other relevant sources (Allen and Dale, 1996, EMSA, 2012, Spence, 2018) the surface threshold of 50g/m^2 was chosen as an average / equilibrium thickness (50g/m^2 is an average is 50% coverage of 0.1mm Bonn Agreement Code 4 - discontinuous true oil colour, or 25% coverage of 0.2mm Bonn Agreement Code 5 – continuous true oil colour which would represent small patches of thick oil or wind-rows).



25% 50% 75%

Figure 2-3: Proportion of total area coverage (AMSA, 2014)

Figure 2-4 illustrates the general relationships between on-water response techniques and slick thickness. Wind-rows, heavy oil patches and tar balls, for example, must be considered, as they influence oil encounter rates, chemical dosages and ignition potential. Each method has different thickness thresholds for effective response.

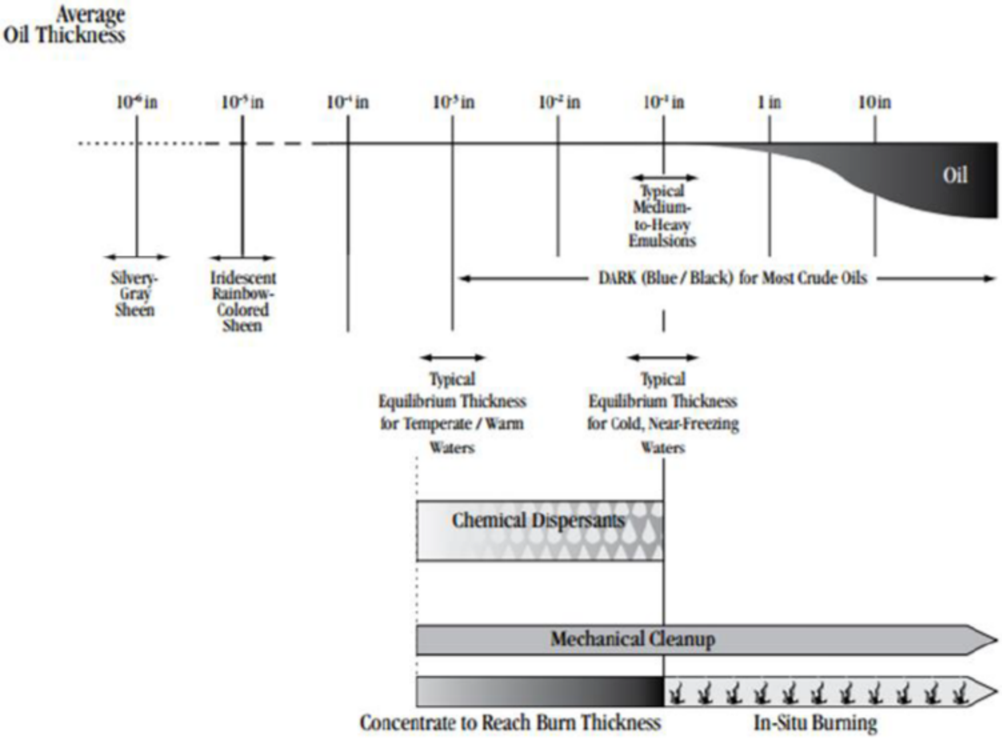


Figure 2-4: Oil thickness versus potential response options (from Allen and Dale 1996)

Wind and waves influence the feasibility of mechanical clean-up operations, dropping the effectiveness significantly because of entrainment and/or splash-over as short period waves develop beyond two to three feet (0.6–0.9m) in height. Waves and wind can also be limiting factors for the safe operation of vessels and aircraft. There is also potential secondary contamination of unimpacted areas and waste issues associated with mechanical dispersion of slicks (**Table 4-2 and Section 4.2.3.3**).

2.3.5 Surface Hydrocarbon Viscosity

Table 2-4: Surface hydrocarbon viscosity thresholds

Surface viscosity (cSt)	Description	European Maritime Safety Authority (EMSA)	Viscosity at sea temperature (cSt)
5,000	Predicted optimum viscosity for surface dispersant operations	Generally possible to disperse	500-5000
10,000	Predicted maximum viscosity for effective surface dispersant operations	Sometimes possible to disperse	5,000-10,000

Further to the required thickness for surface dispersant application and containment and recovery to be deployed effectively as outlined above, changes to viscosity will also limit the treatment of offshore response techniques. As outlined in the EMSA Manual on the Applicability of Oil Spill Dispersants (EMSA, 2012), guidance around changes to viscosity and likely effectiveness of surface dispersant application is provided.

This includes the following statements: "It has been known for many years that it is more difficult to disperse a high viscosity oil than a low or medium viscosity oil. Laboratory testing had shown that the effectiveness of dispersants is related to oil viscosity, being highest for modern "Concentrate, UK Type 2/3" dispersants at an oil viscosity of about 1,000 or 2,000 mPa.s (1,000 – 2,000 cSt) and then declining to a low level with an oil viscosity of 10,000 mPa.s (10,000 cSt). It was considered that some generally applicable viscosity limit, such as 2,000 or 5,000 mPa.s (2,000 – 5,000 cSt), could be applied to all oils."

However, modern oil spill dispersants are generally effective up to an oil viscosity of 5,000 mPa.s (5,000 cSt) or more, and their performance gradually decreases with increasing viscosity; oils with a viscosity of more than 10,000 are, in most cases, no longer dispersible. Guidance from CEDRE (EMSA, 2012) also indicates that products with a range of 500 – 5,000 cSt at sea temperature are generally possible to disperse, while 5,000 – 10,000 cSt at sea temperature above pour point are sometimes possible to disperse, with products beyond 10,000 cSt at sea temperature below pour point are generally impossible to disperse. The potential use of dispersants is evaluated in **Table 4-2**.

To support decision making and response planning, a threshold of 10,000 cSt at sea temperature was chosen as a conservative estimate of maximum viscosity for surface dispersant spraying operations.

The thresholds described above are compared with the modelling results for the WCCS (**Table 2-5**).

2.3.6 Spill modelling results

Details of the scenario and modelling inputs are included along with results in **Table 2-5.**

The selected results used to represent the WCCS are based on response thresholds:

- Minimum time to commencement of hydrocarbon accumulation at any shoreline receptor (at a threshold of 100 g/m^2).
- Minimum time to floating hydrocarbon contact with the offshore edge(s) of any shoreline receptor polygon (at a threshold of 10 g/m^2).
- Maximum cumulative hydrocarbon volume accumulated at any individual shoreline receptor.
- Maximum cumulative hydrocarbon volume accumulated across all shoreline receptors contacted by accumulated hydrocarbons (including those contacted at <100 g/m^2 accumulation concentration).
- Minimum time to entrained/dissolved hydrocarbon contact with the offshore edges of any receptor polygon (at a threshold of 100 ppb/50 ppb).

The volumes as presented in **Table 2-5** are the worst case volumes resulting from the selected stochastic modelling and have been used to determine appropriate level of response.

As noted, the modelled volume selected (2000 m^3) is nearly double the volume of the Scarborough project marine diesel scenario volume (1062 m^3) and thus it is concluded that thresholds would be unlikely to be met for the actual scenario for this PAP.

Table 2-5: Worst case credible scenario modelling results

Response parameter	Modelled result: Marine diesel release caused by vessel collision
Maximum instantaneous liquid hydrocarbon release rate and duration	Modelled instantaneous surface release of 2000 m^3 marine diesel.
Maximum residual surface hydrocarbon after weathering	53.1 m^3
Modelling results	
Minimum time to commencement of hydrocarbon accumulation at any shoreline receptor (at a threshold of 100 g/m^2)	No contact at threshold
Minimum time to floating hydrocarbon contact with the offshore edge(s) of any shoreline receptor polygon (at a threshold of 10 g/m^2)	64 hours at Gascoyne AMP
Maximum cumulative hydrocarbon volume accumulated at any individual shoreline receptor	No contact at threshold
Maximum cumulative hydrocarbon volume accumulated across all shoreline receptors contacted by accumulated hydrocarbons (including those contacted at <100 g/m^2 accumulation concentration)	No contact at threshold
Minimum time to entrained/dissolved hydrocarbon contact with the offshore edges of any receptor polygon (at a threshold of 100 ppb/50 ppb)	61 hours at Gascoyne AMP

The stochastic modelling results for the WCCS have been used as the basis for response planning and are included in **Section 4.2.**

The stochastic modelling results for Credible Scenario-01 are summarized as follows:

- Surface hydrocarbon concentrations greater than 10 g/m^2 may occur up to 113 km from the release location.
- Floating oil at the 10 g/m^2 threshold is predicted to arrive at the surface waters of the Gascoyne AMP receptor with a probability of 1% after 64 hours.
- No shoreline receptors are predicted to be contacted by floating oil concentrations at any of the assessed thresholds.
- No accumulation of oil on shorelines is predicted.
- The Gascoyne AMP is predicted to receive entrained oil concentrations at the 100 ppb threshold with a probability of 10% after 61 hours.
- Spreading and weathering of the surface oil occurs rapidly due to the loss of light, volatile components and the spreading. Dispersant application and containment and recovery are not appropriate for use on spills of marine diesel due to these weathering characteristics.

3 IDENTIFY RESPONSE PROTECTION AREAS (RPAs)

In a response, operational monitoring programs – including trajectory modelling and vessel/aerial observations – would be used to predict RPAs that may be impacted. For the purposes of planning and appropriately scaling a response, modelling has been used to identify RPAs as outlined below in **Figure 3-1**.

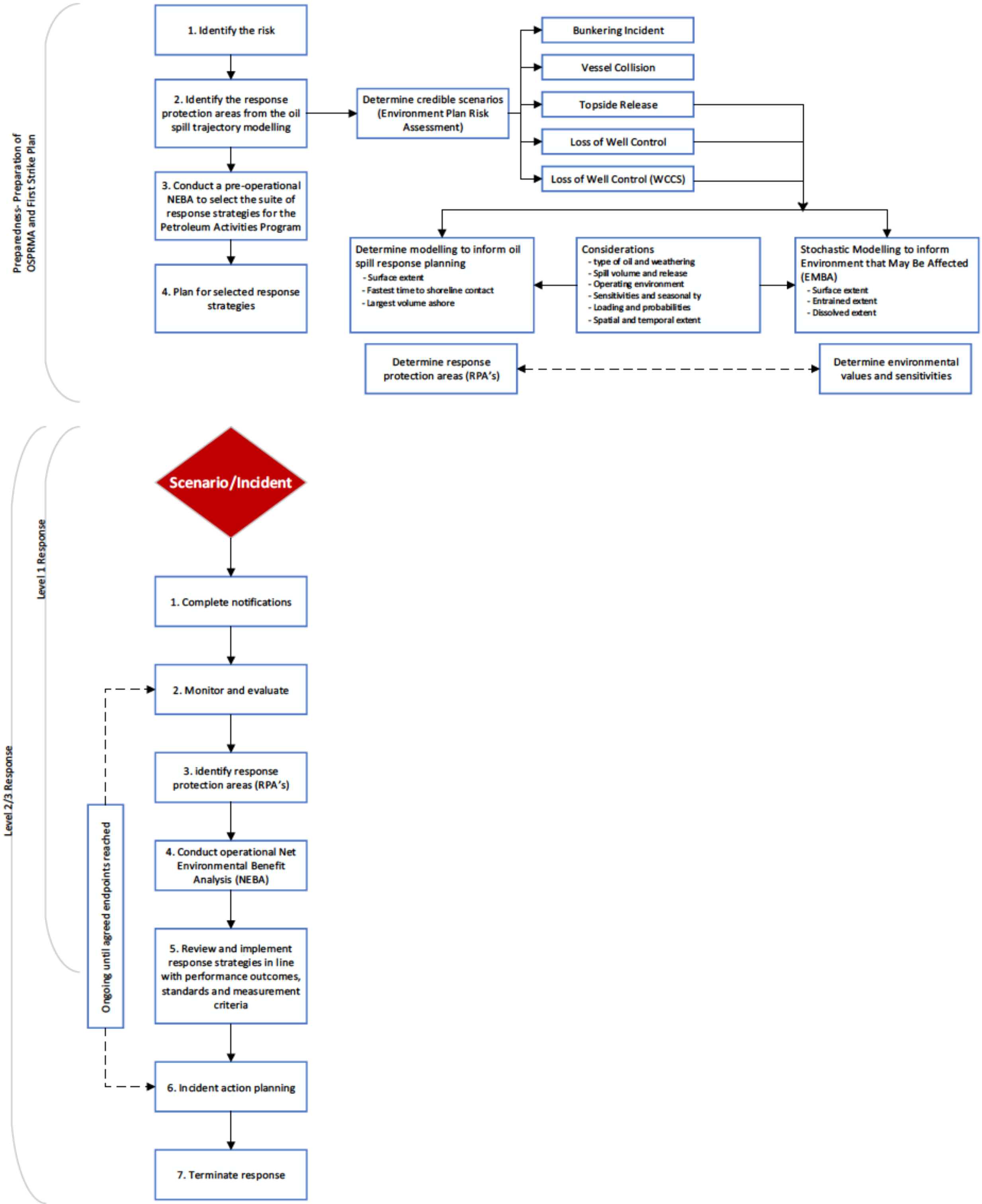


Figure 3-1: Identify Response Protection Areas (RPAs) flowchart

3.1 Identified sensitive receptor locations

Section 6 of the EP includes the list of sensitive receptor locations that have been identified by stochastic modelling as meeting the requirements outlined below:

- receptors with the potential to incur surface, entrained or shoreline accumulation contact above environmental impact thresholds
- receptors within the EMBA which meet the following:
    - a number of priority protection criteria/categories
    - International Union of Conservation of Nature IUCN marine protected area categories
    - high conservation value habitat and species
    - important socio-economic/heritage value.

3.2 Identify Response Protection Areas (RPAs)

From the identified sensitive receptors described in Section 6 of the EP, only those which a shoreline response could feasibly be conducted (accumulation > 100g/m^2 for shoreline assessment and/or contact with surface slicks >10 g/m^2 for operational monitoring[4]) have been selected for response planning purposes.

3.2.1 Response Protection Areas (RPAs)

RPAs are selected on the basis of their environmental ecological, social, economic, cultural and heritage values and sensitivities and the ability to conduct a response based on the minimum response thresholds (**Section 2.3.3**). The Gascoyne AMP is the only RPA identified as the WCCS is predicted by modelling to be limited to offshore open waters. Contact from floating hydrocarbons above 10 g/m^2 is predicted to arrive at the surface waters of the Gascoyne AMP with a probability of 1% after 64 hours based on the stochastic modelling selected for this PAP. The Gascoyne AMP is predicted to receive entrained oil concentrations at the 100 ppb threshold with a probability of 10% after 61 hours. The maximum entrained oil concentration is forecast as 7.2 ppm within the Gascoyne AMP.

No shoreline receptors are predicted to be contacted by floating oil concentrations at any of the assessed thresholds. Additionally, modelling shows there is no accumulation of oil on shorelines is predicted.

During a spill event, operational monitoring techniques (OM01, OM02, OM03, OM04 and OM05) would be deployed from the outset of the spill to track the spill trajectory and deduce if any RPAs are at risk of impact. TRPs will be drafted in advance for any RPAs with a contact time of <14 days.

Any additional sensitive receptors are presented in the existing environment description (Section 4 of the EP) and impact assessment section (Section 6 of the EP) for the spill scenario. The pre-operational NEBA (**Section 4**) considers the results from the stochastic modelling to ensure all feasible response techniques are considered in the planning phase, therefore additional receptors are also included in the pre-operational NEBA.

[4] Operational monitoring will be undertaken from the outset of a spill whether or not this threshold has been reached. Monitoring is needed throughout the response to assess the nature of the spill, track its location and inform the need for any additional monitoring and/or response techniques. It also informs when the spill has entered State Waters and/or control of the incident passes to statutory authorities e.g. WA DoT or AMSA.

4 NET ENVIRONMENTAL BENEFIT ANALYSIS (NEBA)

A Net Environmental Benefit Analysis (NEBA) is a structured process to consider which response techniques are likely to provide the greatest net environmental benefit.

The NEBA process typically involves four key steps outlined in **Figure 4-1:** evaluate data, predict outcomes, balance trade-offs, and select response options. These steps are followed in the planning/preparedness process and would also be followed in a response.

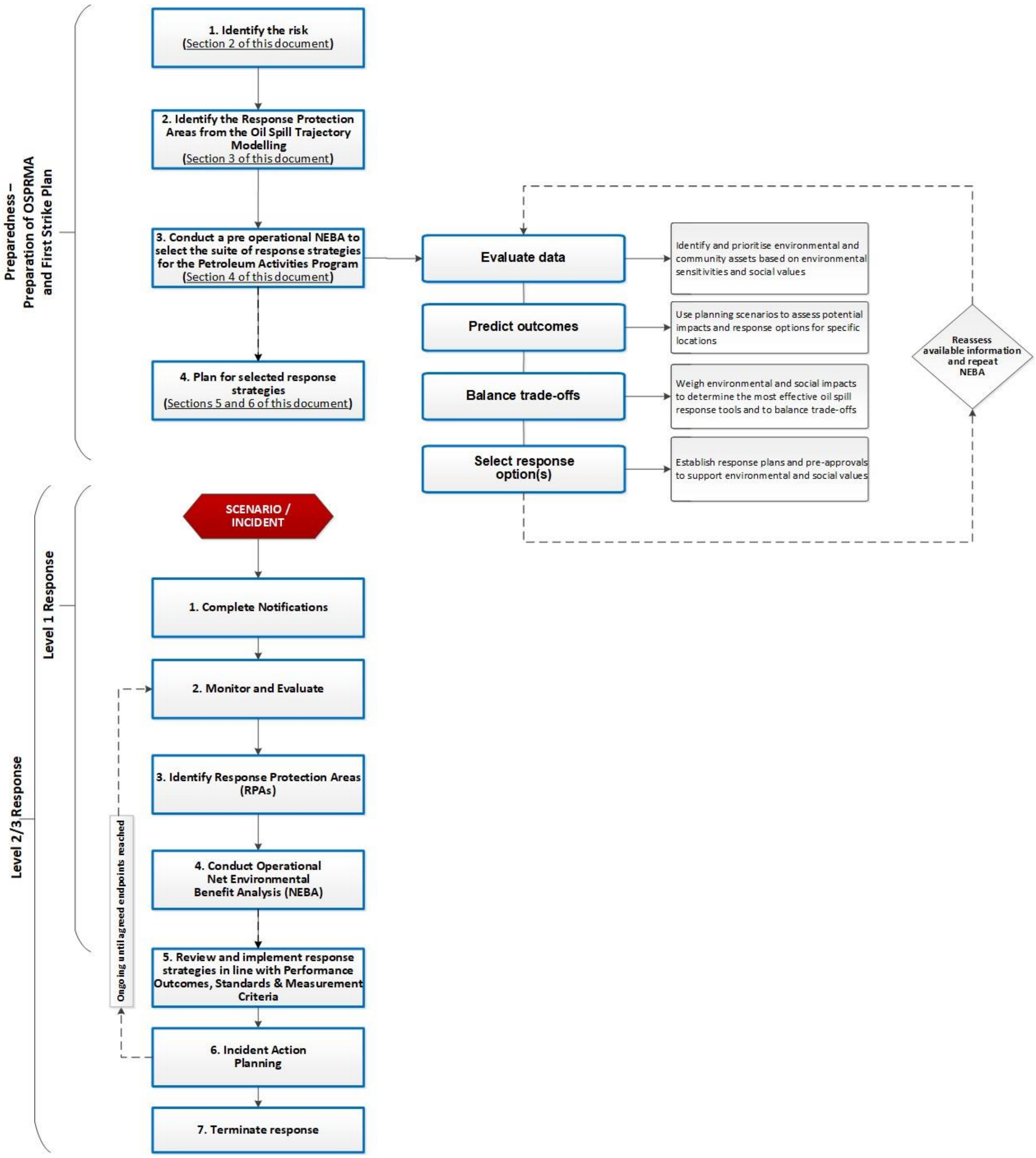


Figure 4-1: Net Environmental Benefit Analysis (NEBA) flowchart

4.1 Pre-operational / Strategic NEBA

The pre-operational NEBA identifies positive and negative impacts to sensitive receptors from implementing the response techniques. Feasibility is considered by assessing the receptors potentially impacted above response thresholds (**Section 2.3.1.1**) and the surface concentrations from the modelling.

Completing a pre-operational NEBA is a key response planning control that reduces the environmental risks and impacts of implementing the selected response techniques. Comprehensive details of the pre-operational NEBA for this PAP are contained in **ANNEX A**: Net Environmental Benefit Analysis detailed outcomes.

4.2 Stage 1: Evaluate data

Woodside identifies and prioritises environmental and community assets based on environmental sensitivities and social values, informed through the use of trajectory modelling. Interpretation of stochastic oil spill modelling determines the EMBA for the release, which defines the spatial area that may be potentially impacted by the PAP activities.

4.2.1 Define the scenario(s)

Woodside uses scenarios identified from the risk assessment in the EP to assess potential impacts and response options for specific locations. Modelling of the WCCS is then used for this pre-operational NEBA. Outlier locations with potential environmental impacts, selected from the stochastic modelling may also be included for assessment. Response thresholds and modelling results are then used to assess the feasibility/effectiveness and scale of the response.

Table 4-1: Scenario summary information (WCCS)

Scenario summary information (WCCS– Credible scenario-01)	
Scenario	Hydrocarbon release caused by marine vessel collision
Location	19° 53' 54.72" S, 113° 14' 19.56" E
Oil Type	Marine diesel
Volume and duration of release	Instantaneous release of 1062 m^3

4.2.1.1 Hydrocarbon characteristics

Marine Diesel

Marine Diesel is typically classed as an International Tanker Owners Pollution Federation (ITOPF) Group I/II oil.

Marine diesel is a mixture of volatile and persistent hydrocarbons with low proportions of highly volatile and residual components. Under constant 5 kn wind conditions, about 6% of the oil mass is predicted to evaporate within the first 12 hours (BP < 180 °C); a further 35% should evaporate within the first 24 hours (180 °C < BP < 265 °C); and a further 54% should evaporate over several days (265 °C < BP < 380 °C). Approximately 5% of the oil is shown to be persistent. The aromatic content of the oil is approximately 3%. Under variable wind conditions where winds are of a greater strength, more entrainment of oil into the water column is predicted (about 45% after 24 hours). A further 35% is forecast to evaporate, leaving only a small proportion of the oil floating on the water surface (<1%).

The heavier (low volatility) components of the oil have a tendency to entrain into the upper water column due to wind-generated waves but can subsequently resurface if wind-waves abate. Therefore, the heavier components of this oil can remain entrained or on the sea surface for an extended period, with associated potential for dissolution of the soluble aromatic fraction.

Stochastic modelling results for WCCS Credible Scenario-01	
Minimum time to shoreline contact (above 100 g/m²)	No contact at threshold
Largest volume ashore at any single RPA (above 100 g/m²)	No contact at threshold
Largest total shoreline accumulation (above 100g/m²)	No contact at threshold

4.2.2 Determining potential response options

The available response techniques based on current technology can be summarised under the following headings:

- Monitor and evaluate (including operational monitoring)
- Source control
  - vessel source control
  - remotely operated vehicle (ROV) intervention
  - debris clearance and/or removal
  - capping stack
  - containment dome
  - relief well drilling
- Surface dispersant application:
  - aerial dispersant application
  - vessel dispersant application
- Containment and recovery
- Mechanical dispersion
- In-situ burning
- Shoreline protection and deflection
- Shoreline clean-up:
  - Phase 1 – Mechanical clean-up
  - Phase 2 – Manual clean-up
  - Phase 3 – Final polishing
- Oiled wildlife response (including hazing)
- Waste management
- Post spill monitoring/scientific monitoring

An assessment of which response options are feasible for the scenarios is included below in **Table 4-2.** These options are evaluated against each scenario's parameters including oil type, volume and characteristics, prevailing weather conditions, logistical support, and resource availability to determine their deployment feasibility.

A shortlist of the feasible response options is then carried forward for the ALARP assessment with a justification for the exclusion of other response techniques included in **Section 4.2.3**. This assessment will typically result in a range of available options, that are deployed at different areas (at-source, offshore, nearshore and onshore) and times through the response. The NEBA process assists in prioritising which options to use where and when and timings throughout the response.

Table 4-2: Response technique evaluation – Surface Release

Response Technique	Effectiveness	Feasibility	Decision	Rationale for the decision
Hydrocarbon: Marine Diesel				
Monitor and Evaluate	Will be effective in tracking the location of the spill, predicting potential impacts and triggering further monitoring and response techniques as required. Monitoring techniques include: • OM01 Predictive modelling of hydrocarbons – used throughout spill. 'Ground-truthed' using the outputs of all other monitoring techniques. • OM02 Surveillance and reconnaissance to detect hydrocarbons and resources at risk – from outset of spill. • OM03 Monitoring of hydrocarbon presence, properties, behaviour and weathering in water – from outset of spill. • OM04 Pre-emptive assessment of sensitive receptors at risk – triggered once OM01, OM02 and OM03 inform likely RPAs at risk. • OM05 Shoreline assessment – once OM02, OM03 and OM04 inform which RPAs have been impacted.	Monitoring of a Marine Diesel spill is a feasible response technique and outputs will be used to guide decision making on the use of other monitoring/response techniques and providing information to regulatory agencies including AMSA and WA DoT.	Yes	Monitoring the spill will be necessary to: • Validate trajectory and weathering models • Determine the behaviour of the oil in water • Determine the location and weathering condition of the slick • Provide forecasts of spill trajectory • Determine appropriate response techniques • Determine effectiveness of response techniques • Confirm impact pathways to receptors
Source Control (vessel)	Controlling the spill of diesel at source would be the most effective way to limit the quantity of hydrocarbon entering the marine environment.	A spill of diesel from a vessel collision will be instantaneous and source control will be limited to what the vessel can achieve whilst responding to the incident.	Yes	Ability to stop the spill at source will be dependent upon the specific spill circumstances and whether or not it is safe for response personnel to access/isolate the source of the spill.
Surface Dispersant Application	Dispersants are not considered effective when applied on thin surface films such as marine diesel as the dispersant droplets tend to pass through the surface films without binding to the hydrocarbon.	Marine diesel is prone to rapid spreading and evaporation thus the use of dispersant would be deemed an unnecessary response technique.	No	The application of dispersant to marine diesel is unnecessary as the diesel will rapidly evaporate and would thus unnecessarily introduce additional chemical substances to the marine environment. The additional entrainment would also increase exposure of subsea species and habitats to hydrocarbons.
Containment and Recovery	Containment and recovery has an effective recovery rate of 5-10% when a hydrocarbon encounter rate of 25-50% is achieved at BAOAC 4 and 5. Containment and recovery requires a spill to be BAOAC 4 or 5 with a 50-100% coverage of 100 g/m^2 to 200 g/m^2.	Marine diesel is prone to rapid spreading and evaporation thus reducing the feasibility of containment and recovery as a response technique.	No	Containment and recovery would be an inappropriate response technique as the coverage requirements would not be achieved by a marine diesel spill. In addition, most of the spilled diesel would have been subject to rapid evaporation and entrainment prior to the commencement of containment and recovery operations.
Mechanical dispersion	Mechanical dispersion involves the use of a vessel's prop wash and/or fire hose to target surface hydrocarbons to achieve dispersion into the water column. However, this technique is of limited benefit in an open ocean environment where wind and wave action are likely to deliver similar advantages.	Although the technique is feasible, highly volatile hydrocarbons are likely to weather, spread and evaporate quickly. The volatile nature of the oil is also likely to lead to unsafe conditions in the vicinity of fresh hydrocarbon. Additionally, any vessel used for mechanical dispersion activities would be contaminated by the hydrocarbon and could potentially cause secondary contamination of unimpacted areas when exiting the spill area. The decontamination of a vessel used for mechanical dispersion activities would result in additional quantities of oily waste requiring appropriate handling and treatment.	No	Given the limited benefit of mechanical dispersion over natural wind and wave action, secondary contamination and waste issues, and the associated safety risk of implementing the response for this activity, this strategy is deemed unsuitable.
In-situ Burning	In-situ burning is only effective where minimum slick thickness can be achieved.	Use of in-situ burning as a response technique for marine diesel is unfeasible as the minimum slick thickness cannot be attained due to rapid spreading. In addition, there is a limited window of opportunity in which this technique can be applied (prior to evaporation of the volatiles) which is unlikely to be achieved. Furthermore, entering a volatile environment to undertake this technique would be unsafe for response personnel.	No	Diesel characteristics are not appropriate for the use of in-situ burning as the minimum thickness will not be attained due to rapid spreading. Furthermore, it would unnecessarily cause an increase in the release of atmospheric pollutants.
Shoreline Protection and Deflection	Shoreline protection and deflection can be effective at preventing contamination of at-risk areas.	Use of shoreline protection and deflection for a spill of marine diesel is unlikely to provide any significant environmental benefit as the diesel will be subject to rapid spreading and evaporation prior to contact with any sensitive areas. The modelling undertaken predicts no shoreline receptors are to be contacted by floating oil concentrations at any of	No	The modelling undertaken predicts that no shorelines will be impacted thus it is unlikely that this technique would be required.

		the assessed thresholds and no accumulation of oil on shorelines, therefore shoreline protection and deflection does not require consideration.		
Shoreline Clean up	Shoreline clean-up is an effective means of hydrocarbon removal from contaminated shorelines where coverage is at an optimum level of 250 g/m^2.	A marine diesel spill would be prone to rapid spreading and evaporation prior to impacting any sensitive receptors. Operational monitoring will, however, be deployed from the outset of a spill to track the spill location and fate in real-time. The modelling undertaken predicts no shoreline receptors are to be contacted by floating oil concentrations at any of the assessed thresholds and no accumulation of oil on shorelines, therefore shoreline protection and deflection does not require consideration.	**No**	The modelling undertaken predicts that no shorelines will be impacted thus it is unlikely that this technique would be required.
Oiled Wildlife	Oiled wildlife response is an effective response technique for reducing the overall impact of a spill on wildlife.- This is mostly achieved through hazing to prevent additional wildlife from being contaminated and through rehabilitation of those already subject to contamination.	Due to the likely volatile atmospheric conditions surrounding a diesel spill, response options would be limited to hazing to ensure the safety of response personnel. -In addition, any rehabilitation could only be undertaken by trained specialists.	**Potentially**	The modelling undertaken predicts that no sensitive areas will be impacted thus it is unlikely that this technique would be required. However, in the event that wildlife are at risk of contamination, oiled wildlife response will be undertaken as and where required.

4.2.3 Exclusion of response techniques

Response techniques that are not feasible for the worst case scenario (Credible Scenario-01) for the Scarborough 4D B1 MSS are detailed in the subsections below and are excluded from further assessment within this document.

4.2.3.1 Surface Dispersant Application

Marine diesel is prone to rapid spreading and evaporation thus the use of dispersant would be deemed an unnecessary response technique. The application of dispersant to marine diesel is unnecessary as the diesel will rapidly evaporate and would thus unnecessarily introduce additional chemical substances to the marine environment. The additional entrainment would also increase exposure of subsea species and habitats to hydrocarbons.

4.2.3.2 Containment and Recovery

Marine diesel is prone to rapid spreading and evaporation thus reducing the feasibility of containment and recovery as a response technique. Furthermore, entering a volatile environment to undertake this technique would be unsafe for response personnel. Although this scenario results in surface oil of BAOAC 4, this only occurs within the first few hours during which time volatile levels would be very high and unsafe for response personnel.

4.2.3.3 Mechanical Dispersion

Mechanical dispersion involves the use of a vessel’s prop wash and/or fire hose to target surface hydrocarbons to achieve dispersion into the water column. However, this technique is of limited benefit in an open ocean environment where wind and wave action are likely to deliver similar advantages. The volatile nature of the oil is likely to lead to unsafe conditions in the vicinity of fresh hydrocarbon. There are also secondary contamination and waste issues to consider.

4.2.3.4 In-situ Burning

This technique requires calm sea state conditions as is required for containment and recovery operations, which limits its feasibility in the offshore waters of the Operational Area. Optimum weather conditions are <20 knot wind speed and waves <1 to 1.5 m with oil collected to a minimum 3mm thick layer. Due to the conditions in Operational Area it is expected that the ability to contain oil may be limited as the sea state may exceed the optimum conditions. It is preferable that oil is fresh and does not emulsify to maximise burn efficiency and reduce residue thickness.

There are health and safety risks for response personnel associated with the containment and subsequent burning of hydrocarbons. It is also suggested that the residue from attempts to burn would sink, thereby posing a risk to the environment. The longer-term effects of burn residues on the marine environment are not fully understood and therefore, no assessment of the potential environmental impact can be determined. Furthermore, it is unlikely that MDO would achieve the required thickness for in-situ burning, rendering this an unsuitable method.

Until further operational and environmental information becomes available, Woodside will not consider this option.

4.2.3.5 Shoreline Protection and Deflection and Clean Up

No shoreline surface contact is predicted (above thresholds), according to the modelling of a hydrocarbon spill conducted for this PAP. Therefore, shoreline protection and deflection is not considered feasible.

4.3 Stage 2: Predict Outcomes

Woodside uses planning scenarios to assess potential impacts and response options for specific locations. Locations with potential environmental impacts, selected from the stochastic modelling are included for assessment. Response thresholds and modelling results are then used to assess the feasibility/effectiveness of a response.

4.4 Stage 3: Balance trade-offs

Woodside considers environmental impacts and response effectiveness/feasibility to determine the most effective oil spill response tools and balance trade-offs, using an automated NEBA tool. The tool considers potential benefits and impacts associated with a response at sensitive receptors and then considers the effectiveness/feasibility of the response to select the response techniques carried forward to the ALARP assessment. The NEBA can be found in **ANNEX A**: Net Environmental Benefit Analysis detailed outcomes.

4.5 Stage 4: Select Best Response Options

To select the response technique, all the other stages in the NEBA process are considered and used to establish response plans and any pre-approvals to support protection of identified environmental and social values.

The response techniques implemented may vary according to a particular spill. The hydrocarbon type released and the sensitivities of the receptors (both ecological and socio-economic) may influence the response. The pre-operational NEBA broadly evaluates each response technique and supports decisions on whether they are feasible and of net environmental benefit. Response techniques that are not feasible or beneficial are rejected at this stage and not progressed to planning.

Further risks and impacts from implementing these selected response options are outlined in **Section 7.**

Table 4-3: Selection and prioritisation of response techniques

Response planning scenario	Key characteristics for response planning (times are minimum times to contact for first receptor and/or shoreline contacted above response threshold)	Feasibility of response techniques									
		Monitor and evaluate	Source control (vessel)	Surface dispersant application	Containment and recovery	Mechanical dispersion	In situ burning	Shoreline protection and deflection	Shoreline clean-up	Oiled wildlife response	Outline response technique
Credible Scenario-01: Release of up to 1062 m^3 marine diesel from a vessel collision	No shoreline contact predicted. The Gascoyne AMP is predicted to receive entrained oil concentrations at the 100 ppb threshold with a probability of 10%, and surface oil at the 10 g/m^2 threshold with a probability of 1%.	Yes	Yes	No	No	No	No	No	No	Yes	Monitor and evaluate. Initiate vessel source control if feasible. Plan for oiled wildlife response and implement if oiled wildlife is observed.

From the NEBA undertaken on the WCCS identified the primary response techniques are;

- Monitor and evaluate
- Source control on the vessel
- Oiled wildlife response

Support techniques may include:

- Waste management
- Scientific monitoring

5 HYDROCARBON SPILL ALARP PROCESS

Woodside's hydrocarbon spill ALARP process is aligned with guidance provided by NOPSEMA in *Oil Spill Risk Management Guidance Note N-04750-GN1488* (2021) and is set out in the 'Woodside Hydrocarbon Spill Oil Spill Preparedness and Response Mitigation Assessment (OSPRMA) Development Guidelines'.

From the identified response planning need and pre-operational NEBA/SIMA, Woodside conducts a structured, semi-quantitative hydrocarbon spill process which has the following steps:

1. considers the Response Planning Need identified in terms of surface area (km^2) and available surface hydrocarbon volumes (m^3) against existing Woodside capability
2. considers alternative, additional, and improved options for each response technique/control measure by providing an initial and, if required, detailed evaluation of:
   - predicted cost associated with adopting the control measure
   - predicted change/environmental benefit
   - predicted effectiveness/feasibility of the control measure.
3. evaluates the risks and impacts of implementing the proposed response techniques, and any further control measures with associated environmental performance to manage these additional risks and impacts.

Woodside considers the risks and impacts from a hydrocarbon spill to have been reduced to ALARP when:

1. a structured process for identifying and considering alternative, additional, and improved options has been completed for each selected response technique
2. the analysis of alternate, additional, and improved control measures meets one of the following criteria:
   - all identified, reasonably practicable control measures have been adopted; or
   - no identified reasonably practicable additional, alternative and/or improved control measures would provide further overall increased proportionate environmental benefit; or
   - no reasonably practical additional, alternative, and/or improved control measures have been identified.
3. where an alternative, additional and/or improved control measure is adopted, a measurable level of environmental performance has been assigned
4. higher order impacts/ risks have received more comprehensive alternative, additional, and improved control measure evaluations and do not just compare the cost of the adopted control measures to the costs of an extreme or clearly unreasonable control measure
5. cumulative effects have been analysed when considered in combination across the whole activity.

The response technique selection is based on the risk assessment conducted in the EP. The risk assessment identifies the type of oil, volume of release, duration of release, predicted fate, weathering and the EMBA (along with other requirements such as time to impact and predicted volumes ashore). Modelling is then used to inform the NEBA and the prioritisation of suitable response options. The scale of the response techniques selected in the pre-operational NEBA is informed through the assessment of results from modelling.

For the purpose of the ALARP assessment, the following terms and definitions have been used:

- Response techniques are considered the control measures that reduce consequences from hydrocarbon spill events. The terms ‘response technique’ and ‘control measure’ are used interchangeably.
- Cost is defined as the time, effort and/or trouble taken in financial, safety, design/storage/installation, capital/lease, and/or operations/maintenance terms to adopt a control measure.
- Where the predicted change to environmental impact is compared against standard environmental values and sensitivities impacts using positive or negative criteria from the NEBA Impact Ranking Classification Guidance in Annex A.

5.1 Monitor and Evaluate (including operational monitoring)

Monitor and evaluate includes the gathering and evaluation of data to inform the oil spill response planning and operations. It includes fate and trajectory modelling, spill tracking, weather updates and field observations. This response option is deployed in some capacity for every event.

Table 5-1 below provides the operations monitoring plans that support the successful execution of this response technique.

Table 5-1: Description of supporting operational monitoring plans

ID	Title
OM01	Predictive modelling of hydrocarbons to assess resources at risk
OM02	Surveillance and reconnaissance to detect hydrocarbons and resources at risk
OM03	Monitoring of hydrocarbon presence, properties, behaviour and weathering in water
OM04	Pre-emptive assessment of sensitive receptors at risk
OM05	Shoreline assessment

Woodside maintains an *Operational Monitoring Operational Plan*. If shoreline contact is predicted, RPAs will be identified and assessed before contact. If shorelines are contacted, a shoreline assessment survey will be completed to guide effective shoreline clean-up operations. This plan includes the process for the IMT to mobilise resources depending on the nature and scale of the spill.

The proximity of Exmouth, Onslow and Karratha to the spill event location means that multiple logistical options are available to monitor the spill in relatively short timeframes. The primary mobilisation base for initial monitoring activities would be Exmouth. However, in the unlikely event of an extended spill with potential to impact receptors further afield, monitoring activities may also be mobilised from Onslow and Karratha.

5.1.1 Response need based on predicted consequence parameters

The following statements identify the key parameters upon which a response need can be based:

- Modelling of floating oil indicates that concentrations equal to or greater than the 10 g/m^2, 50 g/m^2 and 100 g/m^2 thresholds could potentially be found, in the form of slicks, up to 113 km, 60 km and 58 km from the spill site, respectively.
- No shoreline receptors are predicted to be contacted by floating oil concentrations at any of the assessed thresholds.
- No accumulation of oil on shorelines is predicted.
- The time to contact for oil at concentrations of entrained hydrocarbons greater than 100 ppb at shoreline receptors is 61 hours at the Gascoyne AMP.
- Arrangements for support organisations who provide specialist services or resources should be tested regularly.
- Plans, procedures and support documents need to be in place for Operational and Support functions. These should be reviewed and updated regularly.

5.1.2 Environmental performance based on need

Table 5-2: Environmental Performance – Monitor and Evaluate

<table>
<tr><th colspan="2">Environmental Performance Outcome</th><th colspan="3">To gather information from multiple sources to establish an accurate common operating picture as soon as possible and predict the fate and behaviour of the spill to validate planning assumptions and adjust response plans as appropriate to the scenario.</th></tr>
<tr><th colspan="2">Control measure</th><th colspan="2">Performance Standard</th><th>Measurement Criteria</th></tr>
<tr><td rowspan="3">1</td><td rowspan="3">Oil spill trajectory modelling</td><td>1.1</td><td>Initial modelling available within 6 hours using the Rapid Assessment Tool</td><td rowspan="3">1, 3B, 3C, 4</td></tr>
<tr><td>1.2</td><td>Detailed modelling available within 4 hours of RPS receiving information from Woodside</td></tr>
<tr><td>1.3</td><td>Detailed modelling service available for the duration of the incident upon contract activation</td></tr>
<tr><td rowspan="4">2</td><td rowspan="4">Tracking buoy</td><td>2.1</td><td>Tracking buoy located on facility/vessel and ready for deployment 24/7</td><td>1, 3A, 3C, 4</td></tr>
<tr><td>2.2</td><td>Deploy tracking buoy from facility within 2 hours as per the First Strike Plan.</td><td>1, 3A, 3B, 4</td></tr>
<tr><td>2.3</td><td>Contract in place with service provider to allow data from tracking buoy to be received 24/7 and processed.</td><td>1, 3B, 3C, 4</td></tr>
<tr><td>2.4</td><td>Data received to be uploaded into Woodside COP daily to improve the accuracy of other monitor and evaluate techniques.</td><td>1, 3B, 4</td></tr>
<tr><td rowspan="6">3</td><td rowspan="6">Satellite imagery</td><td>3.1</td><td>Contract in place with 3rd party provider to enable access and analysis of satellite imagery. Imagery source/type requested on activation of service.</td><td>1, 3C, 4</td></tr>
<tr><td>3.2</td><td>3rd party provider will confirm availability of an initial acquisition within 2 hours.</td><td>1, 3B, 3C, 4</td></tr>
<tr><td>3.3</td><td>First image received with 24 hours of Woodside confirming to 3rd party provider its acceptance of the proposed acquisition plan.</td><td>1</td></tr>
<tr><td>3.4</td><td>3rd party provider to submit report to Woodside per image. Report is to include a polygon of any possible or identified slick(s) with metadata.</td><td>1</td></tr>
<tr><td>3.5</td><td>Data received to be uploaded into Woodside COP daily to improve accuracy of other monitor and evaluate techniques.</td><td>1, 3B, 4</td></tr>
<tr><td>3.6</td><td>Satellite Imagery services available and employed during response.</td><td>1, 3C, 4</td></tr>
<tr><td rowspan="4">4</td><td rowspan="4">Aerial surveillance</td><td>4.1</td><td>At least 2 trained aerial observers available to be deployed by day 1 from resource pool.</td><td>1, 2, 3B, 3C, 4</td></tr>
<tr><td>4.2</td><td>1 aircraft available for two sorties per day, available for the duration of the response from day 1</td><td>1, 3C, 4</td></tr>
<tr><td>4.3</td><td>Observer to compile report during flight as per first strike plan. Observers report available to the IMT within 2 hours of landing after each sortie.</td><td>1, 2, 3B, 4</td></tr>
<tr><td>4.4</td><td>Unmanned Aerial Vehicles/Systems (UAV/UASs) to support pre-emptive assessments as contingency if required.</td><td>1, 2</td></tr>
<tr><td rowspan="3">5</td><td rowspan="3">Hydrocarbon detections in water</td><td>5.1</td><td>Activate 3rd party service provider as per first strike plan. Deploy resources within 3 days:
• 3 specialists in water quality monitoring
• 2 monitoring systems and ancillaries
• 1 vessel for deploying the monitoring systems with a dedicated winch, A-frame or Hiab and ancillaries to deploy the equipment.</td><td>1, 2, 3C, 3D, 4</td></tr>
<tr><td>5.2</td><td>Water monitoring services available and employed during response.</td><td rowspan="2">1, 3C, 4</td></tr>
<tr><td>5.3</td><td>Preliminary results of water sample as per contractor's implementation plan within 7 days of receipt of samples at the accredited lab.</td></tr>
</table>

		5.4	Daily fluorometry reports as per service provider's implementation plan will be provided to IMT to validate modelling and monitor presence/absence of entrained hydrocarbons.	
		5.5	Use of Autonomous Underwater Vehicles (AUVs) for hydrocarbon presence and detection may be used as a contingency if the operational NEBA confirms conventional methods are unsafe or not possible.	1, 2, 3C, 4
6	Pre-emptive assessment of sensitive receptors	6.1	10 days prior to any predicted impact, in agreement with WA DoT (for Level 2/3 incidents), deployment of 2 specialists from resource pool in establishing the status of sensitive receptors.	1, 2, 3B, 3C, 4
		6.2	Daily reports provided to IMT on the status of the receptors to prioritise Response Protection Areas (RPAs) and maximise effective utilisation of resources.	1, 3B, 4
7	Management of environmental impact of the response risks	7.1	If vessels are required for access, anchoring locations will be selected to minimise disturbance to benthic habitats. Where existing fixed anchoring points are not available, locations will be selected to minimise impact to nearshore benthic environments with a preference for areas of sandy seabed where they can be identified.	1

The control measures and capability of Woodside and its third-party service providers are shown to support Monitor and Evaluate activities up to and including the identified WCCS. This is demonstrated by the following:

- Woodside has a documented, structured and tested capability for Monitor and Evaluate operations including internal trajectory modelling capabilities, tracking buoys located offshore and contracted aerial observation platforms with access to trained observers.
- Woodside and its third-party service providers ensure there is sufficient capability for the duration of the response.
- Woodside has assessed the existing capability available and considered potential alternative, additional and improved control measures. Where control measures have been selected and implemented, they are included in **Section 6.1.**
- The health and safety, financial, capital and operations/maintenance costs of implementing the alternative, additional or improved control measures identified and not carried forward are considered grossly disproportionate to the environmental benefit gained and/or not reasonably practicable for this PAP.
- The Monitor and Evaluate capability outlined in this section is part of the response developed to manage potential risks and impacts associated with the scenarios to ALARP, and there are no further additional, alternative and improved control measures other than those implemented that would provide further benefit.

5.2 Source Control via Vessel SOPEP

Vessel source control will be conducted, where feasible and in accordance with MARPOL 73/78 Annex I, by the Vessel Master under the Shipboard Oil Pollution Emergency Plan (SOPEP) triggered by any loss of containment from the PAP vessels.

The SOPEP provides guidance to the Master and Officers on board the vessel with respect to the extra steps to be taken when an unexpected pollution incident has occurred or is likely to occur. The SOPEP contains all information and operational instructions required by IMO Resolution MEPC.54 (32) adopted on 6 March 1992, as amended by resolution MEPC.86 (44) adopted on 13 March 2000.

Its purpose is to set in motion the necessary actions to stop or minimise oil discharge and mitigate its effects and outlines responsibilities, pollution reporting requirements, procedures and resources needed in the event of a hydrocarbon spill from vessel activities.

In the event of a potential vessel collision, the vessel master may engage precautionary marine manoeuvres to avoid collision or commence pumping operations to transfer marine diesel and thus minimise the release.

5.2.1 Environmental performance based on need

Woodside has established control measures, environmental performance outcomes, performance standards and measurement criteria to be used for vessel-source oil spill response during the PAP which are detailed in Section 6.7 of the EP. The vessel master's roles and responsibilities are described in EP Section 7.3**.**

Performance standards for each contracted PAP vessel are detailed in the vessel's specific SOPEP.

These standards ensure that sufficient resources are available and are adequately tested to ensure implementation of the SOPEP in the event of a hydrocarbon spill.

5.3 Oiled wildlife response (including hazing)

Woodside would implement a response in accordance with the Western Australian *Oiled Wildlife Operational Plan* (WA OWRP) (W0000AH9756292). This plan includes the process for the IMT to mobilise resources depending on the nature and scale of the spill. Oiled wildlife operations would be implemented with advice and assistance from the Oiled Wildlife Advisor from the DBCA.

Oiled wildlife response is undertaken in accordance with the Western Australian Oiled Wildlife Response Plan to ensure it is conducted in accordance with legislative requirements under the Animal Welfare Act 2002.

If there is a net environmental benefit, oiled wildlife operations will be conducted 24 hours per day to reduce the time for rehabilitation and release of oiled wildlife. Hazing and pre-emptive capture techniques to keep non-oiled animals away from contaminated habitat in instances where it is deemed appropriate will be conducted in accordance with the Western Australian Oiled Wildlife Response Plan, specifically vessels used in hazing/pre-emptive capture will approach fauna at slow speeds to ensure animals are not directed towards the oil and deterrence/hazing and pre-emptive capture will only be conducted if Woodside has licensed authority from DBCA and approval from the Incident Controller.

Shoreline access will be considered as part of the operational NEBA. Vehicular access would be restricted on dunes, turtle nesting beaches and in mangroves. Woodside retains specialist personnel to support and manage oiled wildlife operations, including trained and competent responders in Exmouth and Onslow. Additional personnel would be sourced through Woodside's arrangements to support an oiled wildlife response as required.

5.3.1 Response need based on predicted consequence parameters

The following statements identify the key parameters upon which a response need can be based:

- No shoreline contact is predicted.
- Surface hydrocarbon concentrations greater than 10 g/m^2 may travel up to a maximum of 113 km.
- The offshore location of the release site is expected to result in low numbers of at-risk or impacted wildlife.

Table 5-3: Key at-risk species potentially in Priority Protection Areas and open ocean

Species	Open ocean	Gascoyne AMP
Marine turtles (including foraging and inter-nesting areas and significant nesting beaches)	√	√
Whale sharks (migration to and from waters at Ningaloo)	√	√
Seabirds and/or migratory shorebirds	√	√
Cetaceans – migratory whales	√	√
Cetaceans – dolphins and porpoises	√	√
Sea snakes	√	√

The oiled wildlife response technique targets key wildlife populations at risk within Commonwealth open waters and the nearshore waters. Responding to oiled wildlife consists of eight key stages, as described in **Table 5-4** below.

Table 5-4: Oiled wildlife response stages

Stage	Description
Stage 1: Wildlife first strike response	Gather situational awareness including potential wildlife assets at risk.
Stage 2: Mobilisation of wildlife resources	Resources include personnel, equipment and facilities.
Stage 3: Wildlife reconnaissance	Reconnaissance to identify potentially affected animals.
Stage 4: IAP wildlife sub-plan development	The IAP includes the appropriate response options for oiled wildlife, including wildlife priorities for protection from oiling; deterrence measures (see below); and recovery and treatment of oiled wildlife; resourcing of equipment and personnel. It includes consideration of deterrence practices such as 'hazing' to prevent fauna from entering areas potentially contaminated by spilled hydrocarbons, as well as dispersing, displacing or relocating fauna to minimise/prevent contact and provide time for clean-up.
Stage 5: Wildlife rescue and staging	This includes the different roles of finding oiled wildlife, capturing wildlife, and holding and/or transportation of wildlife to oiled wildlife facilities.
Stage 6: Establishment of an oiled wildlife facility	Treatment facilities would be required for the first-aid, cleaning and rehabilitation of affected animals. A vessel-based 'on-water' facility would likely need to be established to enable stabilisation of oiled wildlife before transport to a suitable treatment facility. Suitable staging sites in Exmouth and Onslow have been identified in the draft Regional OWROP, should a land-based site be required.
Stage 7: Wildlife rehabilitation	Considerations include a suitable rehabilitation centre and personnel, wildlife housing, record keeping and success tracking.
Stage 8: Oiled wildlife response termination	Once a decision has been made to terminate operations, the Incident Controller will stand down individual participating and supporting agencies.

Reconnaissance and primary response would be done during operational monitoring and surveillance activities. Where marine fauna are observed on water or transiting near or within the spill area, observations would be recorded through surveillance records.

Staging sites may be established as forward bases for vessel-based field teams. Once recovered to a staging site, wildlife would be transported to the designated oiled wildlife facility or a temporary holding centre (before being transported to the oiled wildlife facility). Temporary holding centres are required when there is significant distance between a staging site and the oiled wildlife facility, to enable stabilisation of oiled animals. The oiled wildlife facility is the primary location where animals would be housed and treated. Sites proposed for staging a regional oiled wildlife response in Exmouth and Onslow have been identified.

To deploy a response that is appropriate to the nature and scale of the event, as well as scalable over time, Woodside would implement an oiled wildlife response in consultation with DBCA and use the capability outlined in the WA OWRP, with additional capability if required (e.g. volunteers) accessible through Woodside's *People and Global Capability Surge Labour Requirement Plan*.

The WA OWRP provides indicative oiled wildlife response levels (**Table 5-5**) and the resources likely to be needed at each increasing level of response.

Table 5-5: Indicative oiled wildlife response level (adapted from the WA OWRP, 2014)

OWR Level	Indicative personnel numbers	Indicative duration	Indicative number of birds (non-threatened species)	Indicative number of birds (threatened species)	Turtles (hatchlings, juveniles, adults)	Cetaceans
Level 1	6	< 3 days	1–2/day < 5 total	None	None	None
Level 2	26	> 4–14 days	1–5/day < 20 total	None	< 20 hatchlings No juv/adults	None
Level 3	59	> 4–14 days	5–10/day	1–5/day < 10 total	< 5 juv/adults < 50 hatchlings	None
Level 4	77	> 4–14 days	5–10/day < 200 total	5–10/day	< 20 juv/adults < 500 hatchlings	< 5, or known habitats affected
Level 5	116	> 4–14 days	10–100/ day > 200 total	10–50/day	> 20 juv/adults > 500 hatchlings	< 5 dolphins
Level 6	122	> 4–14 days	> 100/day	10–50/day	> 20 juv/adults > 500 hatchlings	> 5 dolphins

5.3.2 Environmental performance based on need

Table 5-6: Environmental Performance – Oiled Wildlife Response

Environmental Performance Outcome		Oiled Wildlife Response is conducted in accordance with WA OWRP to ensure it is conducted in accordance with legislative requirements to house, release or euthanise fauna under the Animal Welfare Act 2002.		
Control Measure		**Performance Standard**		**Measurement Criteria**
8	Wildlife response equipment	8.1	Contracted capability to treat 100 individual fauna for immediate mobilisation to Response Priority Areas (RPAs)	1, 3A, 3B, 3C, 4
		8.2	Contracted capability to treat up to an additional 250 individual fauna within a five-day period.	
		8.3	National plan access to additional resources under the guidance of the DoT (up to a Level 5 oiled wildlife response as specified in the WA OWRP), with the ability to treat about 600 individual fauna.	1, 3C, 4
		8.4	Vessels used in hazing/pre-emptive capture will approach fauna at slow speeds to ensure animals are not directed towards the hydrocarbons.	1, 3A, 3B, 4
		8.5	Facilities for the rehabilitation of oiled wildlife are operational 24/7 as per WA OWRP.	1, 3A, 4
9	Wildlife responders	9.1	2 wildlife divisional commanders to lead the oiled wildlife operations who have completed an Oiled Wildlife Response Management course	1, 2, 3B
		9.2	Wildlife responders to be accessed through resource pool and additional agreements with specialist providers	1, 2, 3A, 3B, 3C, 4
		9.3	Oiled wildlife operations (including hazing) would be implemented with advice and assistance from the Oiled Wildlife Advisor from the DBCA.	1
		9.4	Open communication line to be maintained between IMT and infield operations to ensure awareness of progress against plan(s)	1, 3A, 3B

The resulting wildlife response capability has been assessed against the WCCS.

Under optimal conditions, during the surface release the capability available meets the need identified. It indicates that, the wildlife response capability has the following expected performance:

- Mobilisation and deployment of approximately two wildlife collection teams within the first 5 days of the incident (if required) which may provide an oiled wildlife response in offshore waters.
- Mobilisation and deployment of two central wildlife treatment and rehabilitation locations at Exmouth and Onslow in accordance with WA OWRP.

No additional capability will be required for this activity, given the oiled wildlife response will be limited to open water.

Recovered wildlife from open water would be transported to a central treatment location at Exmouth or Onslow.

5.4 Waste Management

Waste management is considered a support technique to oiled wildlife response, containment and recovery and shoreline clean-up. For the purposes of this OSPRMA, waste management may be required to support wildlife response. Waste generated and collected during the response that will require handling, management and disposal may consist of:

- Liquids (hydrocarbons and contaminated liquids) collected during wildlife response, and/or
- Solids/semi-solids (oily solids, garbage, contaminated materials) and debris collected during wildlife response.

Expected waste volumes during an event are likely to vary depending on oil type, volume released, response techniques employed and extent of weathering of hydrocarbons. Waste management, handling and capacity should be scalable to ensure continuous response operations can be maintained.

All waste management activities will follow the Environment Protection (Controlled Waste) Regulations 2004 and the waste will be managed to minimise final disposal volumes. Waste treatment techniques will consider contaminated solids treatment to allow disposal to landfill and solids with high concentrations of hydrocarbon will be treated and recycled where possible or used in clean fill if suitable.

The waste products would be transported from response locations to the nearest suitable staging area/waste transfer station for treatment, disposal or recycling. Waste will be transferred with appropriately licensed vehicles. Containers will be available for temporary waste storage and will be:

- labelled with the waste type
- provided with appropriate lids to prevent waste being blown overboard
- bunded if storing liquid wastes.
- processes will be in place for transfers of bulk liquid wastes and include:
  - inspection of transfer hose undertaken prior to transfer
  - watchman equipped with radio visually monitors loading hose during transfer
  - tank gauges monitored throughout operation to prevent overflow

The *Oil Spill Preparedness Waste Management Support Plan* (Woodside doc. W0000AH9675798) details the procedures, capability and capacity in place between Woodside and its primary waste services contractor (Veolia Waste Management) to manage waste volumes generated from response activities.

5.4.1 Response Need Based on Predicted Consequence Parameters

Table 5-7: Response Planning Assumptions – Waste Management

Response planning assumptions: Waste management	
Waste loading per m^3 oil recovered (multiplier)	Oiled wildlife response – approx. $1m^3$ of oily liquid waste generated for each wildlife unit cleaned

5.4.2 Environmental Performance Based on Need

Table 5-8: Environmental Performance – Waste Management

Environmental Performance Outcome		To minimise further impacts, waste will be managed, tracked and disposed of in accordance with laws and regulations.		
Control Measure		**Performance Standard**		**Measurement Criteria**
10	Waste Management	10.1	Contract with waste management services for transport, removal, treatment and disposal of waste.	1, 3A, 3B, 3C, 4
		10.2	Access to at least 50 m^3 of solid and liquid waste storage available within 1 week upon activation of 3rd party contract.	
		10.3	Recovered hydrocarbons and wastes will be transferred to licensed treatment facility for reprocessing or disposal.	
		10.4	Teams will segregate liquid and solid wastes at the earliest opportunity.	
		10.5	Waste management provider support staff available year-round to assist in the event of an incident with waste management as detailed in contract.	
		10.6	Open communication line to be maintained between IMT and waste management services to ensure the reliable flow of accurate information between parties.	1, 3A, 3B
		10.7	Waste management to be conducted in accordance with Australian laws and regulations.	1, 3A, 3B, 3C, 4
		10.8	Waste management services available and employed during response.	
11	Management of environmental impact of the response risks	11.1	All oiled wildlife response sites zoned and marked before operations commence to prevent secondary contamination and minimise the mixing of clean and oiled waste.	

The resulting waste management capability has been assessed against the WCCS. The range of techniques provide an ongoing approach to waste management from oiled wildlife response.

It indicates that the waste management capability has the following expected performance:

- Woodside has assessed the existing capability available and considered potential alternative, additional and improved control measures.
- The waste management requirements of all credible spill scenarios are well within Woodside's and its service providers existing capacity.
- No further control measures that may result in an increased environmental benefit that involve moderate to significant cost and/or dedication of resources have been adopted as the requirements of this technique does not justify the excessive costs of identified alternate, improved or additional controls.

5.5 Scientific monitoring

A scientific monitoring program (SMP) would be activated following a Level 2 or 3 unplanned hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors. This would consider receptors at risk (ecological and socio-economic) for the entire predicted Environment that Maybe Affected (EMBA) and in particular, any identified Pre-emptive Baseline Areas (PBAs) for the credible spill scenario(s) or other identified unplanned hydrocarbon releases associated with the activity (refer to Table 2 1 Activity credible spill scenarios).

The outputs of the stochastic hydrocarbon spill modelling were used to assess the environmental risk of the hydrocarbon affected area as delineated by the ecological impact EMBA and social-cultural EMBA based on exceedance of environmental and social-cultural hydrocarbon threshold concentrations (refer to Table 2 2, Section 2.3.1.1 and see Section 4 and 6 of the EP for further information on applicable thresholds and the EMBAs). The Petroleum Activities Program vessel collision marine diesel spill (CS-01) has been modelled and considered to determine the WCCS for the SMP planning purposes and is the basis of the SMP approach presented in this section.

It should be noted that the resulting SMP receptor locations may differ from the Response Protection Areas (RPAs) presented and as discussed in Section 3 of this document due to the applicability of different hydrocarbon threshold levels. The SMP would be informed by the data collected via the operational monitoring program (OMP) studies, however, it differs from the OMP in being a long-term program independent of, and not directing, the operational oil spill response or monitoring of impacts from response activities (refer to Section 5.1 Monitor and Evaluate) for the operational monitoring overview.

Key objectives of the Woodside oil spill scientific monitoring program are:

- Assess the extent, severity and persistence of the environmental impacts from the spill event.
- Monitor subsequent recovery of impacted key species, habitats and ecosystems.

The SMP comprises ten targeted environmental monitoring programs to assess the condition of a range of physical-chemical (water and sediment) and biological (species and habitats) receptors including Environment Protection and Biodiversity Conservation Act (EPBC Act 1999) listed species, environmental values associated with protected areas and socio-economic values, such as fisheries. The ten SMPs are as follows:

- SM01 – Assessment of the presence, quantity and character of hydrocarbons in marine waters (linked to OM01 to OM03)
- SM02 – Assessment of the presence, quantity and character of hydrocarbons in marine sediments (linked to OM01 and OM05)
- SM03– Assessment of impacts and recovery of subtidal and intertidal benthos
- SM04 – Assessment of impacts and recovery of mangroves/saltmarsh habitat
- SM05 – Assessment of impacts and recovery of seabird and shorebird populations
- SM06 – Assessment of impacts and recovery of nesting marine turtle populations
- SM07 – Assessment of impacts to pinniped colonies including haul-out site populations
- SM08 – Desktop assessment of impacts to other non-avian marine megafauna
- SM09 – Assessment of impacts and recovery of marine fish (linked to SM03)

- SM10 – Assessment of physiological impacts to important fish and shellfish species (fish health and seafood quality/safety) and recovery.

These SMPs have been designed to cover all key tropical and temperate habitats and species within Australian waters and broader, if required. A planning area for scientific monitoring is also identified to acknowledge potential hydrocarbon contact below the environmental threshold concentrations and beyond the EMBA. This planning area has been set with reference to the entrained low exposure value of 10 ppb detailed in NOPSEMA Bulletin #1 Oil Spill Modelling (2019), as shown in Figure 5-1. Please note that Figure 5-1 represents the overall combined extent of the oil spill model outputs based on a total of 100 replicate simulations over an annual period for the WCCS (CS-01) and therefore represents the largest spatial boundaries of all 100 CS-01 hydrocarbon release combinations, and not the spatial extent of a single CS-01 spill.

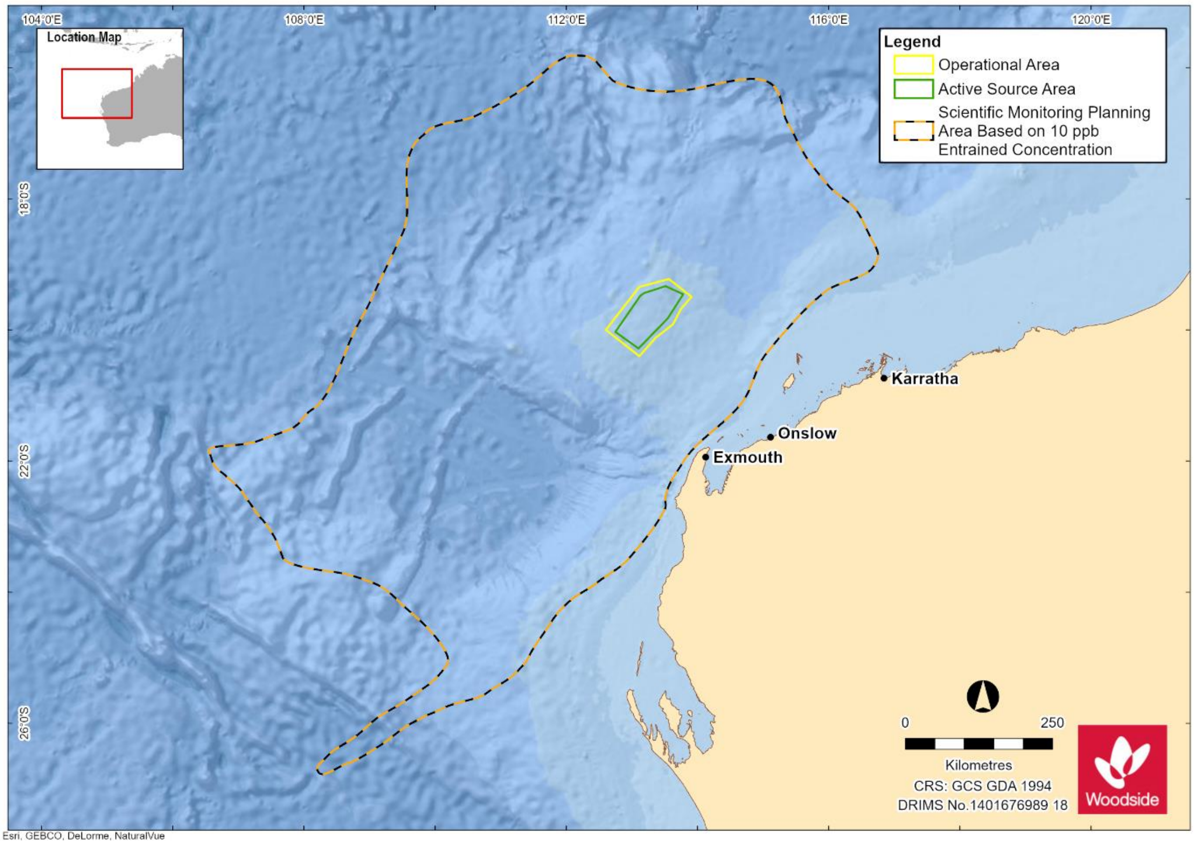


Figure 5-1: The planning area for scientific monitoring based on the area potentially contacted by the low (below ecological impact) entrained hydrocarbon threshold of 10 ppb in the event of the credible spill scenario (CS-01).

NOTE: Figure 5-1 represents the overall combined extent of the oil spill model outputs based on a total of 100 replicate simulations over an annual period for CS-01 and therefore represents the largest spatial boundaries of 100 CS-01 oil spill combinations, and not the spatial extent of a single CS-01 spill.

5.5.1 Scientific Monitoring Deployment Considerations

Scientific Monitoring Deployment Considerations	
Existing baseline studies for sensitive receptor locations predicted to be affected by a spill	Pre-emptive Baseline Areas (PBAs) of the following two categories: • PBAs within the predicted < 10-day hydrocarbon contact time prediction: As part of this assessment, the approach was to conduct a desktop review of available and appropriate baseline data for key receptors for locations (if any) that are potentially impacted within ten days of a spill (based on the EMBA). Then investigate the need to conduct baseline data collection to address data gaps and demonstrate spill response preparedness (refer to Annex D). In the scenario, that baseline data needs are identified, planning for baseline data acquisition is typically commenced pre-PAP and execution of studies undertaken with consideration of weather, receptor type, seasonality and temporal assessment requirements. • PBAs predicted > 10 days' time to predicted hydrocarbon contact in the event of an unplanned hydrocarbon release (for the worse case spill scenario). As part of this assessment, a desktop review is conducted of available and appropriate baseline data for key receptors for locations (if any) that are potentially impacted >10 days' time of a hydrocarbon spill event and documented (refer to Section 5.5.2). In the event of a spill, the SMP activation (as per the Scarborough 4D Marine Seismic Survey First Strike Plan) directs the SMP team to follow the steps outlined in the SMP Operational Plan. The steps include: checking the availability and type of existing baseline data, with particular reference to any Pre-emptive Baseline Areas (PBAs) identified as >10 days to hydrocarbon contact. Such information is used to identify response phase PBAs and plan for the activation of SMPs for pre-emptive (i.e. pre-hydrocarbon contact) baseline assessment.
Pre-emptive Baseline in the event of a spill	Activation of SMPs in order to collect baseline data at sensitive receptor locations with predicted hydrocarbon contact time > 10 days (refer to Section 5.5.2) and the process (as documented in **Error! Reference source not found.**).
Survey platform suitability and availability	In the event of the SMP activation, suitable survey platforms are available and can support the range of equipment and data collection methodologies to be implemented in nearshore and offshore marine environments.
Trained personnel to implement SMPs suitable and available	Access to trained personnel and the sampling equipment contracted for scientific monitoring via a dedicated scientific monitoring program standby contract.
Met-ocean conditions	The following met-ocean conditions have been identified as the field operational limits for implementing SMPs: • waves < 1 m for nearshore systems • waves < 1.5 m for offshore systems • winds < 20 knots • daylight operations only. SMP implementation will be planned and managed according to HSE risk reviews and the met-ocean conditions on a day to day basis by SMP operations.

5.5.2 Response planning assumptions

Response Planning Assumptions	
Pre-emptive Baseline Areas (PBAs)	Pre-emptive Baseline Areas (PBAs) identified through the application of defined hydrocarbon impact thresholds during the Quantitative Spill Risk Assessment process and a consideration of the minimum time to contact at receptor locations fall into two categories: • PBAs for which baseline data exist or are planned for and data collection may commence pre-PAP (≤ 10 days minimum time to contact). • PBAs (> 10 days minimum time to contact) for which baseline data may be collected in the event of an unplanned hydrocarbon release. In the event of a spill, response phase PBAs are prioritised for SMP activities based on vulnerability (i.e. time to contact and

	environmental sensitivity) to potential impacts from hydrocarbon contact and as well as the identified need to acquire baseline data. Time to hydrocarbon contact of >10 days has been identified as a minimum timeframe within which it is feasible to plan and mobilise applicable SMPs and commence collection of baseline (pre-hydrocarbon contact) data, in the event of an unplanned hydrocarbon release from the Scarborough 4D Marine Seismic Survey operations. 1. Pre-emptive Baseline Areas for the Scarborough 4D Marine Seismic Survey operations.are identified and listed in ANNEX D, Table D-1. The PBAs together with the situational awareness (from the operational monitoring) are the basis for the response phase SMP planning and implementation.
Pre-Spill	Scarborough 4D Marine Seismic Survey operations.: A review of existing baseline data for receptor locations (refer to Annex D) with potential to be contacted entrained hydrocarbons at environmental thresholds within ≤10 days, relating to the credible hydrocarbon release for Scarborough 4D Marine Seismic Survey operations identified the following: • Gascoyne AMP • Carnarvon Canyon AMP *Note: Both are offshore deepwater marine parks and entrained hydrocarbons above the 100 ppb ecological threshold is predicted for the upper layers of the water column but there is no contact with the seabed.*
In the Event of a Spill	Receptor locations with >10 days to hydrocarbon contact, as well as the wider area, will be investigated and identified by the SMP team (in the Environment Unit of the ICC) as the spill event unfolds and as the situational awareness provided by the OMPs permits delineation of the spill affected area (for example, updates to the spill trajectory tracking). The full list is presented in Annex D, based on the PAP credible spill scenario (Table 2-1). To address the initial focus in a response phase SMP planning situation, receptor locations predicted to be contacted between >10 days have been identified as follows: • Abrolhos AMP (see note above for Gascoyne and Carnarvon Canyons AMPs, same applicable). In addition, the following AMPs are listed as a precaution as entrained hydrocarbons above 10 ppb are predicted to be present in the water column. • Ningaloo Coast AMP and World Heritage Area (including the Muiron Islands) • Montebello AMP The unfolding spill affected area predictions and confirmation of appropriate baseline data will determine the selection of receptor locations and SMPs to be activated in order to gather pre-emptive (pre-hydrocarbon contact) data. Refer to ANNEX C for further details on scientific monitoring plan implementation and delivery). The timing of SMP activation and mobilisation of the individual SMPs to undertake data collection will be decided and documented by the Woodside SMP team following the process outlined in the SMP Operational Plan. In the event key receptors within geographic locations that are potentially impacted after 10 days following a spill event or commencement of the spill and where adequate and appropriate baseline data are not available, there will be a response phase effort to collect baseline data for the following purposes: i. Priority will be given to the collection of baseline data for receptors predicted to be within the spill affected area prior to hydrocarbon contact. The process is initiated with the investigation of available baseline and time to hydrocarbon contact (>10 days which is sufficient time to mobilise SMP teams and acquire data before hydrocarbon contact). No receptor locations have been identified at this time for the Scarborough 4D MSS operations. ii. Collect baseline data for receptors predicted to be outside the spill affected area so reference datasets for comparative analysis with impacted receptor types can be assessed post-spill.

Baseline Data	A summary of the spill affected area and receptor locations as defined by the EMBA for the activity WCCS CS-01 are presented Section **Error! Reference source not found.**. The key receptors at risk by location and corresponding SMPs based on the EMBA for the PAP are presented in ANNEX D, as per credible spill event scenario(s). This matrix maps the receptors at risk with their location and the applicable SMPs that may be triggered in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors. Receptor locations and applicable SMPs are colour coded to highlight possible time to contact based on receptor types and locations. The status of baseline studies relevant to the PAP are tracked by Woodside through the maintenance of a Corporate Environment Environmental Baseline Database (managed by the Woodside Environmental Science team), as well as accessing external databases such as the Department of Water and Environmental Regulation (WA) Index of Marine Surveys for Assessment (IMSA)[[1]] (refer to ANNEX C: Oil Spill Scientific Monitoring Program).

5.5.3 Summary – scientific monitoring

The resulting scientific monitoring capability has been assessed against the PAP credible spill scenario. The range of techniques provide an ongoing approach to monitoring operations to assess and evaluate the scale and extent of impacts. All known reasonably practicable control measures have been adopted with the cost and organisational complexity of these options determined to be moderate and the overall delivery effectiveness determined to be medium. The SMP's main objectives can be met, with no additional, alternative or improved control measures providing further benefit.

5.5.4 Response planning: need, capability and gap – scientific monitoring

The receptor locations identified in Annex D provide the basis of the SMPs likely to be selected and activated. Once the Woodside SMP Delivery team and the SMP standby contractor have been stood up and the exact nature and scale of the spill becomes known, the SMPs to be activated will be confirmed as per the process set out in the SMP Operational Plan.

<u>Scope of SMP Operations in the event of a hydrocarbon spill:</u>

Receptor locations of interest for the SMP during the response phase are:

- Gascoyne AMP
- Carnarvon Canyons AMP
- Ningaloo Coast WHA and AMP

Documented baseline studies are available for certain receptor locations including the Ningaloo Coast (Annex D, Table D-2). The SMP technique; however, would be to deploy SMP teams to maximise the opportunity to collect pre-emptive data such water quality in the upper water layers of the Gascoyne and Carnarvon Canyons AMPs as well as along the Ningaloo Coast. SM01 would be mobilised as a priority to be able to detect hydrocarbons and track the leading edge of the spill to verify where hydrocarbon contact occurs which will assist with where SMP resources are a priority need to obtain pre-emptive baseline data.

The ALARP assessment for the SMP (Section 6.5) considers alternate, additional, and/or improved control measures on each selected response technique.

[1] https://biocollect.ala.org.au/imsa#max%3D20%26sort%3DdateCreatedSort

5.5.5 Environmental performance based on need

Table 5-9: Scientific monitoring

Environmental Performance Outcome		Woodside can demonstrate preparedness to stand up the SMP to quantitatively assess and report on the extent, severity, persistence and recovery of sensitive receptors impacted from the spill event		
Control measure		**Performance Standard**		**Measurement Criteria**
12	• Woodside has an established and dedicated SMP team comprising the Environmental Science Team and additional Environment Advisers within the HSE Function.	12.1	SMP team comprises a pool of competent Environment Advisers (stand up personnel) who receive training regarding the SMP, SMP activation and implementation of the SMP on an annual basis	• Training materials • Training attendance registers • Process that maps minimum qualification and experience with key SMP role competency and a tracker to manage availability of competent people for the SMP team including redundancy and rostering
13	• Woodside has contracted SMP service provider to provide scientific personnel to resource a base capability of one team per SMP (SM01-SM10, see ANNEX C Table C-2) as detailed in Woodside's SMP standby contractor Implementation Plan, to implement the oil spill scientific monitoring programs. The availability of relevant personnel is reported to Woodside on a monthly basis via a simple report on the base-loading availability of people for each of the SMPs comprising field work for data collection (SMP resourcing report register). • In the event of a spill and the SMP is activated, the base-loading availability of scientific personnel will be provided by SMP standby contractor for the individual SMPs and where gaps in resources are identified, SMP standby contractor/Woodside will seek additional personnel (if needed) from other sources including Woodside's Environmental Services Panel.	13.1	Woodside maintains the capability to mobilise personnel required to conduct scientific monitoring programs SM01 – SM10 (except desktop based SM08): • Personnel are sourced through the existing standby contract with SMP standby contractor. as detailed within the SMP Implementation Plan. • Scientific Monitoring Program Implementation Plan describes the process for standing up and implementing the scientific monitoring programs. • SMP team stand up personnel receive training regarding the stand up, activation and implementation of the SMP on an annual basis	• OSPU Internal Control Environment tracks the quarterly review of the Oil Spill Contracts Master. • SMP resource report of personnel availability provided by SMP contractor on monthly basis (SMP resourcing report register). • Training materials • Training attendance registers • Competency criteria for SMP roles • SMP annual arrangement testing and reporting
14	• Roles and responsibilities for SMP implementation are captured in Table C-1 (ANNEX C) and the SMP team (as per the organisational structure of the ICC) is outlined in SMP Operational Plan. Woodside has a defined Crisis and Incident Management structure including Source Control, Operations, Planning and Logistics functions to manage a loss of well containment response. • SMP Team structure, interface with SMP standby contractor and linkage to the ICC is presented in Figure C-1, ANNEX C. • Woodside has a defined Command, Control and Coordination structure for Incident and Emergency Management that is based on the AIIMS framework utilised in Australia. • Woodside utilises an online Incident Management System (IMS) to coordinate and track key incident management functions. This includes specialist modelling programs, geographic information systems (GIS), as well as communication flows within the Command, Control and Coordination structure. • SMP activated via the FSP. • Step by step process to activation of individual SMPs provided in the SMP Operational Plan. • All decisions made regarding SMP logged in the online IMS (SMP team members trained in using Woodside's online Incident Management System). • SMP component input to the ICC IAP as per the identified ICC timed sessions and the SMP IAP logged on the online IMS. • Woodside Environmental Science Team provides awareness training on the activation and stand-up of the Scientific Monitoring Programme (SMP) for the Environment Advisers in Woodside who are listed on the SMP team on an annual basis. • Woodside Environmental Science Team provides awareness training on the activation and stand-up of the Scientific Monitoring Program (SMP) for the SMP Standby provider. • Woodside Environmental Science Team co-ordinates an annual SMP arrangement testing exercise performed by the SMP standby contractor. SMP standby contractor and the SMP arrangements (people and equipment availability) tested annually since 2016.	14.1	• Woodside have established an SMP organisational structure and processes to stand up and deliver the SMP.	• SMP Oil Spill Scientific Monitoring Operational Plan • SMP Implementation Plan • SMP annual arrangement testing and reporting

15	• Chartered and mutual aid vessels. • Suitable vessels would be secured from the Woodside support vessels, regional fleet of vessels operated by Woodside and other operators and the regional charter market. • Vessel suitability will be guided by the need to be equipped to operate grab samplers, drop camera systems and water sampling equipment (the individual vessel requirements are outlined in the relevant SMP methodologies (refer to Table C-2, ANNEX C). • Nearshore mainland waters could use the same approach as for open water. Smaller vessels may be used where available and appropriate. Suitable vehicles and machinery for onshore access to nearshore SMP locations would be provided by Woodside's transport services contract and sourced from the wider market. • Dedicated survey equipment requirements for scientific monitoring range from remote towed video and drop camera systems to capture seabed images of benthic communities to intertidal/onshore surveying tools such as quadrats, theodolites and spades/trowels, cameras and binoculars (specific survey equipment requirements are outlined in the relevant SMP methodologies (refer to Table C-2, ANNEX C)). Equipment would be sourced through the existing SMP standby contract with Standby SMP contractor for SMP resources and if additional surge capacity is required this would be available through the other Woodside Environmental Services Panel Contractors and specialist contractors. Standby SMP contractor can also address equipment redundancy through either individual or multiple suppliers. MoUs are in place with marine sampling equipment suppliers and analytical laboratories (SMP resourcing report register). • Availability of SMP equipment for offshore/onshore scientific monitoring team mobilisation is within one week to ten days of the commencement of a hydrocarbon release. This meets the SMP mobilisation lead time that will support meeting the response objective of 'acquire, where practicable, the environmental baseline data prior to hydrocarbon contact required to support the post-response SMP.	15.1	Woodside maintains standby SMP capability to mobilise equipment required to conduct scientific monitoring programs SM01 – SM10 (except desktop based SM08): • Equipment are sourced through the existing standby contract with SMP standby contractor as detailed within the SMP Implementation Plan.	• Hydrocarbon Spill Preparedness Team Internal Control Environment tracks the quarterly review of the Oil Spill Contracts Master. • SMP standby monthly resource reports of equipment availability provided by SMP contractor (SMP resourcing report register). • SMP annual arrangement testing and reporting.
16	Woodside's SMP approach addresses the pre-PAP acquisition of baseline data for Pre-emptive Baseline Areas (PBAs) with ≤10 days if required following a baseline gap analysis process. Woodside maintains knowledge of Environmental Baseline data through: • Documentation annual reviews of the Woodside Baseline Environmental Studies Database, and specific activity baseline gap analyses. • Accessing external databases such as the Department of Water and Environmental Regulation (WA) Index of Marine Surveys for Assessment (IMSA) (refer to ANNEX C: Oil Spill Scientific Monitoring Program).	16.1	• Annual reviews of environmental baseline data • PAP specific Pre-emptive Baseline Area baseline gap analysis	• Annual review/update of Woodside Baseline Environmental Studies Database. • Desktop review to assess the environmental baseline study gaps completed prior to EP submission. • Accessing baseline knowledge via the SMP annual arrangement testing.

Environmental Performance Outcome		SMP plan to acquire response phase monitoring targeting pre-emptive baseline data achieved		
Control measure		**Performance Standard**		**Measurement Criteria**
17	Woodside's SMP approach addresses: • Scientific data acquisition for PBAs >10 days to hydrocarbon contact and activated in the response phase and • Transition into post-response SMP monitoring.	17.1	**Pre-emptive Baseline Area (PBA) baseline data acquisition in the response phase** If baseline data gaps are identified for PBAs predicted to have hydrocarbon contact in >10 days, there will be a response phase effort to collect baseline data. Priority in implementing SMPs will be given to receptors where pre-emptive baseline data can be acquired or improved. SMP team (within the Environment Unit of the ICC) contribute SMP component of the ICC Planning Function in development of the IAP.	• Response SMP plan • Woodside's online Incident Management System Records • SMP component of the Incident Action Plan (IAPs).
		17.2	**Post Spill contact** For the receptors contacted by the spill in where baseline data are available, SMPs programs to assess and monitor receptor condition will be implemented post spill (i.e. after the response phase).	• SMP planning document • SMP Decision Log • Incident Action Plans (IAPs) •

Environmental Performance Outcome		Implementation of the SMP (response and post-response phases)		
Control measure		**Performance Standard**		**Measurement Criteria**
18	• Scientific monitoring will address quantitative assessment of environmental impacts of a level two or three spill or any release event with the potential to contact sensitive environmental receptors. The SMP comprises ten targeted environmental monitoring programs. • SMP supporting documentation: (1) Oil Spill Scientific Monitoring Operational Plan; (2) SMP Implementation Plan and (3) SMP Process and Methodologies Guideline. • The Oil Spill Scientific Monitoring Operational Plan details the process of SMP selection, input to the Incident Action Plan (IAP) to trigger operational logistic support services. Methodology documents for each of the ten SMPs	18.1	**Implementation of SM01** SM01 will be implemented to assess the presence, quantity and character of hydrocarbons in marine waters during the spill event in nearshore areas	Evidence SM01 has been triggered: • Documentation as per requirements of the SMP Operational Plan • Woodside's online Incident Management System Records. • SMP component of the IAP • SMP data records from field

	are accessible detailing equipment, data collection techniques and the specifications required for the survey platform support. • The SMP standby contractor holds a Woodside SMP implementation plan detailing activation processes, linkage with the Woodside SMP team and the general principles for the planning and mobilisation of SMPs to deliver the individual SMPs activated. Monthly resourcing report are issued by the SMP standby contractor (SMP resourcing report register). All SMP documents and their status are tracked via SMP document register.	18.2	**Implementation of SM02-SM10** SM02-SM10 will be implemented in accordance with the objectives and activation triggers as per Table C-2 of Annex C.	Evidence SMPs have been triggered: • Documentation as per requirements of the SMP Operational Plan • Woodside's online Incident Management System Records. • SMP component of the IAP • SMP Data records from field
		18.3	**Termination of SMP plans** The Scientific Monitoring Program will be terminated in accordance with termination triggers for the SMP's detailed in Table C-2 of Annex C, and the Termination Criteria Decision-tree for Oil Spill Environmental Monitoring (Figure C-3 of Annex C):	Evidence of Termination Criteria triggered: • Documentation and approval by relevant stakeholders to end SMPs for specific receptor types.

5.6 Incident Management System

The Incident Management System (IMS) is both a control measure and a measurement criteria. As a control measure the IMS function is to prompt, facilitate and record the completion of three key response planning processes detailed below. As a measurement criteria, the IMS records the evidence of the timeliness of all response actions included in the environmental performance standards and the plans used of the PAP.

As the IMS does not directly remove hydrocarbons spilt into the marine environment there is no direct relationship to the response planning need.

5.6.1 Incident action planning

The ICC will be required to collect and interpret information from the scene of the incident to determine support requirements to the site-based IMT, develop an incident action plan (IAP) and assist the IMT with the execution of that plan. The site-based IC may request the ICC to complete notifications internally within Woodside, to stakeholders and government agencies as required. Depending on the type and scale of the incident either the ICC DM or IC will be responsible for ensuring the development of the IAP. Incident Action Planning is an ongoing process that involves continual review to ensure techniques to control the incident are appropriate to the situation at the time.

5.6.2 Operational NEBA process

In the event of a response Woodside will confirm that the response techniques adopted at the time of Environment Plan/Oil Pollution Emergency Plan (EP/OPEP) acceptance remain appropriate to reduce the consequences of the spill. This process verifies that there is a continuing net environmental benefit associated with continuing the response technique through the operational NEBA process. This process manages the environmental risks and impacts of response techniques during the spill response, an operational NEBA will be undertaken throughout the response, for each operational period.

The operational NEBA will consider the risks and benefits of conducting and response activity. For example, if vessels are required for access to nearshore or onshore areas, anchoring locations will be selected to minimise disturbance to benthic habitats. Vessel cleanliness would be commensurate with the receiving environment. The operational NEBA will consider the risks and benefits of conducting other response techniques.

The operational NEBA process is also used to terminate a response. Using data from operational and scientific monitoring activities the response to a hydrocarbon spill will be terminated in accordance with the termination process outlined in the Oil Pollution Emergency Arrangements (Australia). In effect the operational NEBA will determine whether there is net environmental benefit to continue response operations.

5.6.3 Stakeholder engagement process

Woodside will ensure stakeholders are engaged during the spill response in accordance with internal standards as outlined in **Table 5-10**. This process requires that Woodside will:

- Undertake all required notifications (including government notifications) for stakeholders in the region (identified in the First-Strike Response Plan). This includes notification to mariners to communicate navigational hazards introduced through response equipment and personnel.
- In the event of a response, identify and engage with relevant stakeholders and continually assess and review.

5.6.4 Environmental performance based on need

Table 5-10: Environmental Performance – Incident Management System

Environmental Performance Outcome		To support the effectiveness of all other control measures and monitor/record the performance levels achieved.		
Control measure		**Performance Standard**		**Measurement Criteria**
19	Operational NEBA	19.1	Confirm that the response techniques adopted at the time of acceptance remain appropriate to reduce the consequences of the spill within 24 hours.	1, 3A
		19.2	Record the evidence and justification for any deviation from the planned response activities.	
		19.3	Record the information and data from operational and scientific monitoring activities used to inform the NEBA.	
20	Stakeholder engagement	20.1	Prompt and record all notifications (including government notifications) for stakeholders in the region are made	
		20.2	In the event of a response, identification of relevant stakeholders will be re-assessed throughout the response period.	
		20.3	Undertake communications in accordance with: • Woodside Crisis Management Functional Support Team Guideline – Reputation • External Communication and Continuous Disclosure Procedure • External Stakeholder Engagement Procedure	
21	Personnel required to support any response	21.1	Action planning is an ongoing process that involves continual review to ensure techniques to control the incident are appropriate to the situation at the time.	1, 3B
		21.2	A duty roster of trained and competent people will be maintained to ensure that minimum manning requirements are met all year round.	3C
		21.3	Immediately activate the IMT with personnel filling one or more of the following roles: • Operations Duty Manager • D&C Duty Manager • Operations Coordinator • Deputy Operations Coordinator • Planning Coordinator • Logistics (materials, aviation, marine and support positions) • Management Support • Health and Safety Advisor • Environment duty Manager • People Coordinator • Public Information Coordinator • Intelligence Coordinator • Finance Coordinator.	1, 2, 3B, 3C, 4
		21.4	Collect and interpret information from the scene of the incident to determine support requirements to the site-based IMT, develop an Incident Action Plan (IAP) and assist with the execution of that plan.	
		21.5	S&EM advisors will be integrated into ICC to monitor performance of all functional roles.	
		21.6	Continually communicate the status of the spill and support Woodside to determine the most appropriate response by delivering on the responsibilities of their role.	
		21.7	Follow the OPEA, Operational Plans, FSPs, support plans and the IAPs developed.	1, 2, 3A, 4
		21.8	Contribute to Woodside's response in accordance with the aims and objectives set by the Duty Manager.	1, 2, 3B, 3C, 4

5.7 Measurement criteria for all response techniques

Woodside ensures compliance with environmental performance outcomes and standards through four primary mechanisms. The aforementioned performance tables identify which of these four mechanisms monitors the readiness and records the effectiveness and performance of the control measures adopted.

1. The Incident Management System

The Incident Management System (IMS) supports the implementation of the Emergency and Crisis Management Procedure. The IMS provides a near real-time, single source of information for monitoring and recording an incident and measuring the performance of those control measures.

The Emergency and Crisis Management Procedure defines the management framework, including roles and responsibilities, to be applied to any size incident (including hydrocarbon spills). The organisational structure required to manage an incident is developed in a modular fashion and is based on the specific requirements of each incident. The structure can be scaled up or down.

The Incident Action Plan (IAP) process formally documents and communicated the:

- Incident objectives
- Status of assets
- Operational period objectives
- Response techniques (defined during response planning)
- The effectiveness of response techniques.

The information captured in the IMS (including information from personal logs and assigned tasks/close outs) confirms the response techniques implemented remain appropriate to reduce the consequences of the spill. The system also records all information and data that can be used to support the site-based IMT, development and the execution of the IAP.

2. The S&EM Competency Dashboard

The S&EM competency dashboard records the number of trained and competent responders that are available across Woodside, and some external providers, to participate in a response.

This number varies dependent on expiry of competency certificates, staff attrition, internal rotations, leave and other absences. As such the Dashboard is designed to identify the minimum manning requirements and to identify sufficient redundancy to cater for the variances listed above.

Figure 5-2 shows the minimum manning numbers for the different hydrocarbon spill response roles and the number of qualified persons against those roles.

Woodside's pool of trained responders is composed of but not limited to personnel from the following organisations:

- Woodside internal
- Australian Marine Oil Spill Centre (AMOSC) core group
- AMOSC
- Oil Spill Response Limited (OSRL)
- Marine Spill Response Corporation (MSRC)
- AMSA
- Woodside contracted workforce

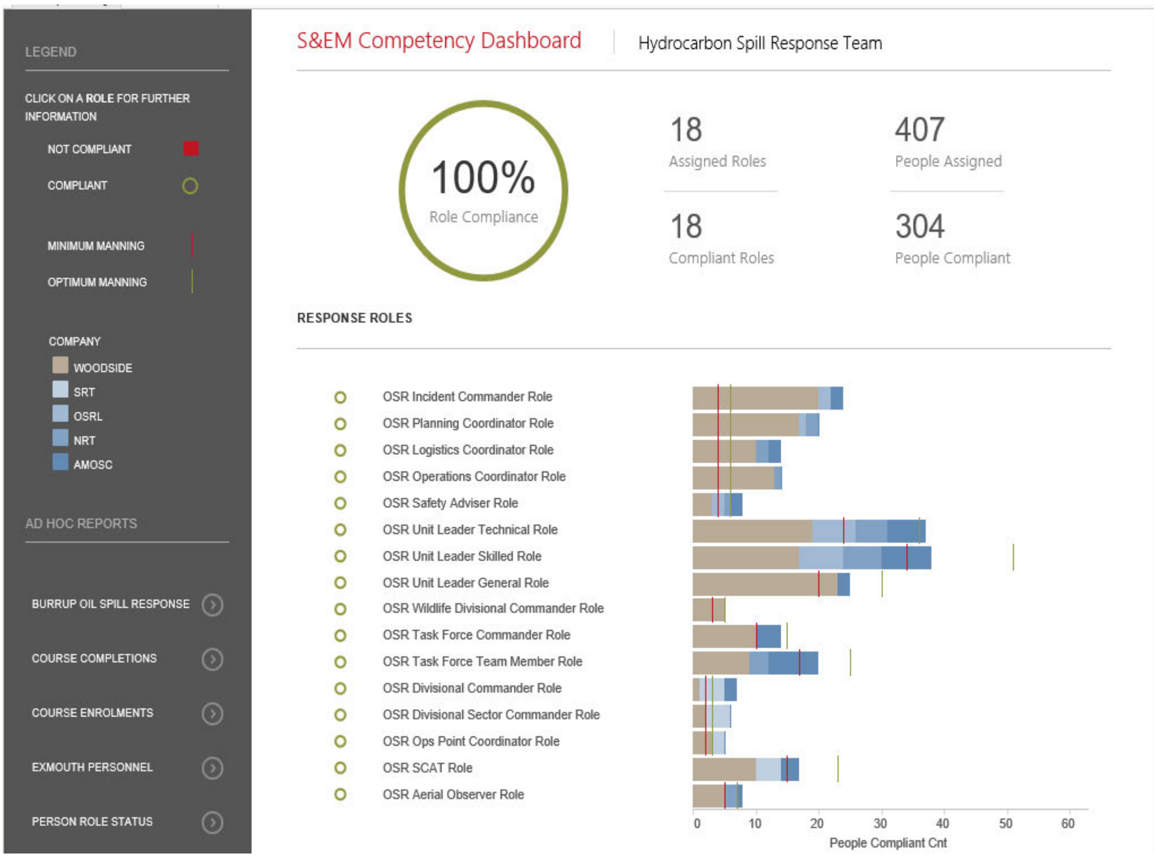
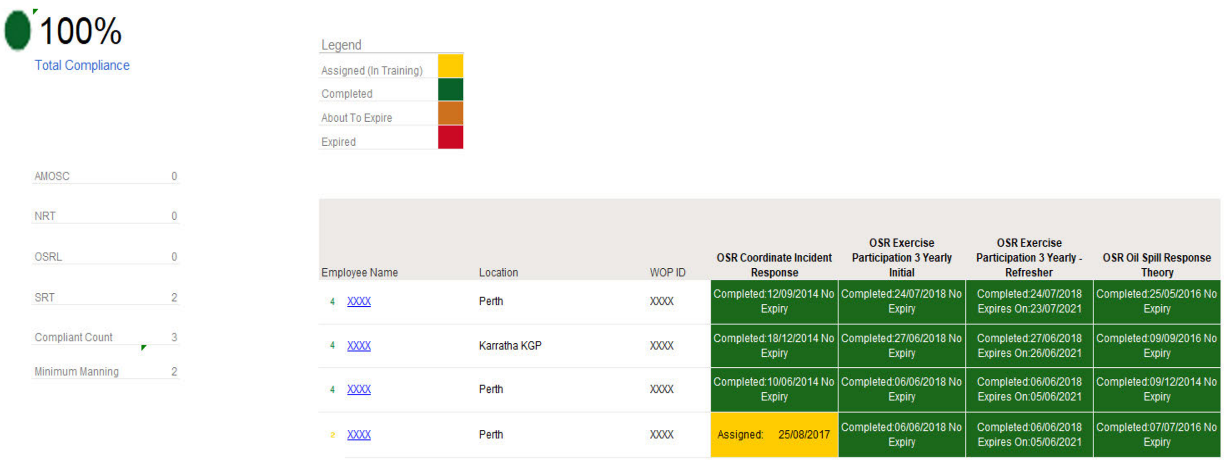


Figure 5-2: Example screen shot of the HSP competency dashboard

The Dashboard is one of Woodside's key means of monitoring its readiness to respond. It also shows that Woodside can meet the requirements of the environmental performance standard that relate to filling certain response roles.

Figure 5-3 shows deeper dive into the Ops Point Coordinator role and the training modules required to show competence.



Employee Name	Location	WOP ID	OSR Coordinate Incident Response	OSR Exercise Participation 3 Yearly Initial	OSR Exercise Participation 3 Yearly - Refresher	OSR Oil Spill Response Theory
4 XXXX	Perth	XXXX	Completed:12/09/2014 No Expiry	Completed:24/07/2018 No Expiry	Completed:24/07/2018 Expires On:23/07/2021	Completed:25/05/2016 No Expiry
4 XXXX	Karratha KGP	XXXX	Completed:18/12/2014 No Expiry	Completed:27/06/2018 No Expiry	Completed:27/06/2018 Expires On:26/06/2021	Completed:09/09/2016 No Expiry
4 XXXX	Perth	XXXX	Completed:10/06/2014 No Expiry	Completed:06/06/2018 No Expiry	Completed:06/06/2018 Expires On:05/06/2021	Completed:09/12/2014 No Expiry
2 XXXX	Perth	XXXX	Assigned: 25/08/2017	Completed:06/06/2018 No Expiry	Completed:06/06/2018 Expires On:05/06/2021	Completed:07/07/2016 No Expiry

Figure 5-3: Example screen shot for the Ops Point Coordinator role

3. The Hydrocarbon Spill Preparedness ICE Assurance Process

The Hydrocarbon Spill Response Team has developed a Hydrocarbon Spill Preparedness and Response Internal Control Environment (ICE) process to align and feed into the Woodside Management System Assurance process for hydrocarbon spill. The process tracks compliance over four key control areas:

a) **Plans** – Ensures all plans (including: Oil Pollution Emergency Arrangements, first strike response plans, operational plans, support plans and tactical response plans) are current and in line with regulatory and internal requirements.

b) **Competency –** Ensures the competency dashboard is up to date and there are the minimum competency numbers across ICC, CMT and hydrocarbon spill response roles. The hydrocarbon spill training plan and exercise schedule, including testing of arrangements is also tracked. The Testing of Arrangements (TOA) register tracks the testing of all hydrocarbon spill response arrangements, key contracts and agreements in place with internal and external parties to ensure compliance.

c) **Capability** – Tracks and monitors capability that could be required in a hydrocarbon incident, including but not limited to: integrated fleet[5] vessel schedule, dispersant availability, rig/vessels monitoring, equipment stockpiles, tracking buoy locations and the CICC duty roster.

d) **Compliance and Assurance –** Ensures all regulator inspection outcomes are actioned and closed out, the global legislation register is up to date and that the key assurance components are tracked and managed. Assurance activities (including Audits) conducted on memberships with key Oil Spill Response Organisations (OSROs) including AMOSC and OSRL are also tracked and recorded in the ICE.

The ICE assurance process records how each commitment listed in the performance tables above is managed to ensure ongoing compliance monitoring. The level of compliance can be reviewed in real time and is reported on a monthly basis through the S&EM Function.

The completion of the assurance checks (over and above the ICE process) is also applied via the Woodside Integrated Risk and Compliance System (WiRCs) and subject to the requirements of Woodside's Provide Assurance Procedure.

4. The Hydrocarbon Spill Preparedness and Response Procedure

This procedure sets out how to plan and prepare for a liquid hydrocarbon spill to the marine environment. (Note, this procedure does not apply to scenarios relating to gas releases in the marine environment).

This procedure details the:

- Requirement for an Oil Pollution Emergency Plan (OPEP) to be developed, maintained, reviewed, and approved by appropriate regulators (where applicable) including:
  - Defining how spill scenarios are developed on an activity specific basis
  - Developing and maintaining all hydrocarbon spill related plans
  - Ensuring the ongoing maintenance of training and competency for personnel
  - Developing the testing of spill response arrangements
  - Maintaining access to identified equipment and personnel.
- Planning for hydrocarbon spill response preparedness
- Accountabilities for hydrocarbon spill response preparedness
- Spill training requirements
- Requirements for spill exercising / testing of spill response arrangements

[5] The Integrated fleet consists of vessels from multiple operators that have been contracted to Woodside to undertake a number of duties including hydrocarbon spill response.

- Spill equipment and services requirements.

The procedure also details the roles and responsibilities of the dedicated Woodside Hydrocarbon Spill Preparedness team. This team is responsible for:

- Assuring that Woodside hydrocarbon spill responders meet competency requirements.
- Establishing the competency requirements, annual training schedule and a training register of trained personnel.
- Establishing and maintaining the total numbers of trained personnel required to provide an effective response to any hydrocarbon spill incident.
- Ensuring equipment and services contracts are maintained
- Establishing OPEPs
- Establishing OPEAs
- Priority response receptor determination
- ALARP determination
- Ensuring compliance and assurance is undertaken in accordance with external and internal requirements.

6 ALARP EVALUATION

This section should be read in conjunction with Section 5 which is the capability planned for this activity.

6.1 Monitor and evaluate – ALARP assessment

Alternative, Additional and Improved options have been identified and assessed against the base capability described in Section 5 with those that have been selected for implementation highlighted in green. Items highlighted in red have been considered and rejected on the basis that they are not feasible, the costs are clearly disproportionate to the environmental benefit, and/or the option is not reasonably practical. Control measures where there is not a clear justification for their inclusion or exclusion may be subject to a detailed ALARP assessment.

6.1.1 Monitor and evaluate – control measure options analysis

Woodside's existing level of capability is based on internal and third-party resources that are available 24 hours, 7 days per week. The capability presented below is displayed as ranges to incorporate operational factors such as weather, crew/vessel/aircraft/vehicle location and duties, survey or classification society inspection requirements, overflight/port/quarantine permits and inspections, crew/pilot duty and fatigue hours, re-fuelling/re-stocking provisions, and other similar logistic and operational limitation that are beyond Woodside's direct control.

6.1.1.1 Alternative control measures

Alternative Control Measures considered *Alternative, including potentially more effective and/or novel control measures are evaluated as replacements for an adopted control*					
Option considered	**Environmental consideration**	**Feasibility**	**Approx. Cost**	**Assessment conclusions**	**Implemented**
Aerostat (or similar inflatable observation platform) for localised aerial surveillance.	Lead time to Aerostat surveillance is disproportionate to the environmental benefit. The system also provides a very limited field of visibility around the vessel it is deployed from.	Long lead time to access (>10 days). Each system would require an operator to interpret data and direct vessels accordingly.	Purchase cost per system approx. A$300,000.	This option is not adopted as the minimal environmental benefit gained is disproportionate to the cost and complexity of its implementation.	No
Alternate analysis technologies and methods such as gravimetric, colorimetric, infra-red and UV absorption for OM03.	Due to time, limitations on sampling, equipment, methodology and analysis, the technique does not provide an environmental benefit compared to alternative available technologies.	• Gravimetric (Involves lab analysis so cannot be done on location, maybe completed with field samples in laboratory), • Colorimetric (requires chemical addition and catalysts no standard method, needs specialist training), • Infra-red (droplet size too small for infra-red analysis). • Hydrocarbons need to be extracted from water for test, therefore requires a laboratory test), and • UV absorption (Similar technology to fluorometers which are more widely available in Australia) were evaluated but all have limitations that do not improve the environmental benefit.	NA	This strategy is not considered feasible, therefore no further ALARP assessment is conducted.	No

6.1.1.2 Additional control measures

Additional Control Measures considered *Additional control measures are evaluated in terms of them reducing an environmental impact or an environmental risk when added to the existing suite of control measures*					
Option considered	**Environmental consideration**	**Feasibility**	**Approx. Cost**	**Assessment Conclusions**	**Implemented**
Additional personnel trained to use systems for OM01.	Current arrangement provides an environmental benefit in the availability of trained personnel facilitating access to monitoring data used to inform all other response techniques. No improvement required.	No improvement can be made, all personnel in technical roles e.g. intelligence unit are trained and competent on the software systems. Personnel are trained and exercised regularly. Use of the software and systems forms part of regular work assignments and projects.	Cost for training in-house staff would be approx. A$25,000.	This option is not adopted as the current capability meets the need.	No
Additional satellite tracking buoys to enable greater area coverage.	Increased capability does not provide an environmental benefit compared to the disproportionate cost in having an additional contract in place.	Tracking buoy will be on vessel, additional needs are met from Woodside owned stocks in King Bay Supply Facility (KBSF) and Exmouth or can be provided by service provider in a timely manner.	Cost for an additional satellite tracking buoy would be A$200 per day or A$6,000 to purchase.	This option is not adopted as the current capability meets the need, but additional units are available if required.	No
Additional trained aerial observers.	Current capability meets need. WEL has access to a pool of trained, competent observers at strategic locations to ensure timely and sustainable response. Additional observers are available through current contracts with AMOSC and OSRL.	Current capability meets need. WEL has a pool of trained, competent observers at strategic locations to ensure timely and sustainable response. Additional observers are available through current contracts with AMOSC and OSRL Aviation standards and guidelines ensure all aircraft crews are competent for their roles. WEL maintains a pool of trained and competent aerial observers with various home base locations to be called upon at the time of an incident. Regular audits of oil spill response organisations ensure training and competency is maintained.	Cost for additional trained aerial observers would be A$2,000 per person per day.	This option is not adopted as the current capability meets the need, but additional observers are available via response contractors if required.	No

6.1.1.3 Improved control measures

Option considered	Environmental consideration	Feasibility	Approx. Cost	Assessment conclusions	Implemented
Improved Control Measures considered *Improved control measures are evaluated for improvements they could bring to the effectiveness of adopted control measures in terms of functionality, availability, reliability, survivability, independence and compatibility*					
Faster turnaround time from modelling contractor.	Improved control measure does not provide an environmental benefit compared to the disproportionate cost in having an additional contract in place.	External contractor on ICC roster to be called as soon as required. However initial information needs to be gathered by ICC team to request an accurate model. External contractor has person on call to respond from their own location.	Modelling service with a faster activation time would be achieved via membership of an alternative modelling service at an annual cost of A$50,000 for 24-hour access plus an initial A$5,000 per modelling run.	This option is not adopted as the minimal environmental benefit gained is disproportionate to the cost and complexity of its implementation.	No
Night-time aerial surveillance.	The risk of undertaking the aerial observations at night is disproportionate to the limited environmental benefit. The images would be of low quality and no visual cross reference verification is possible and as such the variable is not adopted.	Flights will only occur when deemed safe by the pilot. The risk of night operations is disproportionate to the benefit gained, as images from sensors (IR, UV, etc.). will be low quality. Flight time limitations will be adhered to.	No improvement can be made without risk to personnel health and safety and breaching Woodside's golden rules.	This option is not adopted as the safety considerations outweigh any environmental benefit gained.	No
Faster mobilisation time (for water quality monitoring).	Due to the restriction on accessing the spill location on day 1 there is no environmental benefit in having vessels available from day 1. The cost of having dedicated equipment and personnel is disproportionate to the environmental benefit. The availability of vessels and personnel meets the response need.	Operations are not feasible on day 1 as volatility has potential to cause health and safety concerns within the first 24 hours of the response. Current Woodside arrangements allow for water quality monitoring to commence by day 3. Shortening the timeframes for vessel availability would require dedicated response vessels on standby in Darwin and would accelerate the initiation of monitoring by 1 day.	Cost for purchase of equipment approx. A$200,000. Ongoing costs per annum for cost of hire and pre-positioning for life of asset/activity would be larger than the purchase cost. Dedicated equipment and personnel, living locally and on short notice to mobilise. The cost would be approx. A$1 million per annum, which is disproportionate to the incremental benefit this would provide, assets are already available on day 1. 2 integrated fleet vessels are available from day 1; however, these could be tasked with other operations.	This option is not adopted as the area could not be accessed earlier due to safety considerations. Additionally, the cost and complexity of implementation outweighs the benefits.	No

6.1.2 Selected control measures

Following review of alternative, additional and improved control measures as outlined above, the following controls were selected for implementation for the activity.

- Alternative
  - None selected
- Additional
  - None selected
- Improved
  - None selected

6.2 Source Control via Vessel SOPEP – ALARP Assessment

Alternative, Additional and Improved options have been assessed against the base capability described in Section 5 with those that have been selected for implementation highlighted in green. Items highlighted in red have been considered and rejected on the basis that they are not feasible, the costs are disproportionate to the environmental benefit, and/or the option is not reasonably practical. Control measures where there is not a clear justification for their inclusion or exclusion may be subject to a detailed ALARP assessment.

6.2.1 Source Control via Vessel SOPEP – Control Measure Options Analysis

6.2.1.1 Alternative control measures

Alternative Control Measures considered *Alternative, including potentially more effective and/or novel control measures are evaluated as replacements for an adopted control*				
Option considered	**Environmental consideration**	**Feasibility**	**Approx. Cost**	**Implemented**
No reasonably practical alternative control measures identified.				N/A

6.2.1.2 Additional Control Measures

Additional Control Measures considered *Additional control measures are evaluated in terms of them reducing an environmental impact or an environmental risk when added to the existing suite of control measures*				
Option considered	**Environmental consideration**	**Feasibility**	**Approx. Cost**	**Implemented**
No reasonably practical alternative control measures identified.				N/A

6.2.1.3 Improved Control Measures

Improved Control Measures considered *Improved control measures are evaluated for improvements they could bring to the effectiveness of adopted control measures in terms of functionality, availability, reliability, survivability, independence and compatibility*				
Option considered	**Environmental consideration**	**Feasibility**	**Approx. Cost**	**Implemented**
No reasonably practical alternative control measures identified.				N/A

6.2.1.4 Selected control measures

Following review of alternative, additional and improved control measures, the following controls were selected for implementation for the activity.

- Alternative
  - None selected
- Additional
  - None selected
- Improved
  - None selected

6.3 Oiled wildlife response – ALARP assessment

Alternative, Additional and Improved options have been identified and assessed against the base capability described in Section 5 with those that have been selected for implementation highlighted in green. Items highlighted in red have been considered and rejected on the basis that they are not feasible, the costs are clearly disproportionate to the environmental benefit, and/or the option is not reasonably practical. Control measures where there is not a clear justification for their inclusion or exclusion may be subject to a detailed ALARP assessment.

6.3.1 Existing capability – wildlife response

Woodside's existing level of capability is based on internal and third-party resources that are available 24 hours, 7 days per week. The capability presented below is displayed as ranges to incorporate operational factors such as weather, crew/vessel/aircraft/vehicle location and duties, survey or classification society inspection requirements, overflight/port/quarantine permits and inspections, crew/pilot duty and fatigue hours, re-fuelling/re-stocking provisions, and other similar logistic and operational limitation that are beyond Woodside's direct control.

6.3.2 Wildlife response – control measure options analysis

6.3.2.1 Alternative control measures

Alternative Control Measures considered *Alternative, including potentially more effective and/or novel control measures are evaluated as replacements for an adopted control*					
Option considered	**Environmental consideration**	**Feasibility**	**Approximate Cost**	**Assessment conclusions**	**Implemented**
Direct contracts with service providers	This option duplicates the capability accessed through AMOSC and OSRL and would compete for the same resources. Does not provide a significant increase in environmental benefit.	These delivery options provide increased effectiveness through more direct communication and control of specialists. However, no significant net benefit is anticipated.	Duplication of capability - already subscribed to through contracts with AMOSC and OSRL	This option is not adopted as the existing capability meets the need.	No

6.3.2.2 Additional control measures

Additional Control Measures considered *Additional control measures are evaluated in terms of them reducing an environmental impact or an environmental risk when added to the existing suite of control measures*					
Option considered	**Environmental consideration**	**Feasibility**	**Approximate Cost**	**Assessment conclusions**	**Implemented**
Additional wildlife treatment systems	The selected delivery options provide access to call-off contracts with selected specialist providers. The agreements ensure these resources can be mobilised to meet the required response objectives, commensurate with the progressive nature of environmental impact and the time available to monitor hydrocarbon plume trajectories. Provides response equipment and personnel by Day 3. The additional cost in having a dedicated oiled wildlife response (equipment and personnel) in place is disproportionate to environmental benefit. These selected delivery options provide capacity to carry out an oiled wildlife response if contact is predicted and to scale up the response if required to treat widespread contamination. Current capability meets the needs required and there is no additional environmental benefit in adopting the improvements.	Although hydrocarbon contact above threshold concentrations with offshore waters is expected from day one, given the low likelihood of such an event occurring and the low environmental benefit of an offshore response, the cost of implementing measures to reduce the mobilisation time is considered disproportionate to the benefit. Additionally, the remote offshore location of the release site with no predicted contact of shoreline receptors provides sufficient opportunity for the ongoing monitoring and surveillance operations to inform the scale of the response. Numbers of oiled wildlife are expected to be low in the remote offshore setting of the oiled wildlife response, given the distance from known aggregation areas. Oiled wildlife response capacity would be addressed for open Commonwealth waters through the AMOSC arrangements, as informed by operational monitoring. The cost and organisational complexity of this approach is moderate, and the overall delivery effectiveness is high.	Additional wildlife response resources could total A$1,700 per operational site per day.	This option is not adopted as the existing capability meets the need.	No
Additional trained wildlife responders	Current numbers meet the needs required and additional personnel are available through existing contracts with oil spill response organisations and environmental panel contractors. Numbers of oiled wildlife are expected to be low in the remote offshore setting of the oiled wildlife response, given the distance from known aggregation areas. The potential environmental benefit of training additional personnel is expected to be low.	The capability provides the capacity to treat approximately 600 wildlife units (primarily avian fauna) by day six, with additional capacity available from OSRL. Additional equipment and facilities would be required to support ongoing response, depending on the scale of the event and the impact to fauna. Materials for holding facilities, portable pools, enclosures and rehabilitation areas would be sourced as required.	Additional wildlife response personnel cost A$2,000 per person per day.	This option is not adopted as the existing capability meets the need.	No

6.3.2.3 Improved control measures

Improved Control Measures considered *Improved control measures are evaluated for improvements they could bring to the effectiveness of adopted control measures in terms of functionality, availability, reliability, survivability, independence and compatibility*					
Option considered	**Environmental consideration**	**Feasibility**	**Approximate Cost**	**Assessment conclusions**	**Implemented**
Faster mobilisation time for wildlife response.	Response time is limited by specialist personnel mobilisation time. Current timing is sufficient for expected first shoreline impact. This control measure provides increased effectiveness through faster mobilisation of specialists. However, no significant net environmental benefit is expected due to shoreline stranding times. The cost of having dedicated equipment and personnel available to respond faster is considered grossly disproportionate to the environmental benefit.	Pre-positioning vessels or equipment would reduce mobilisation time for oiled wildlife response activities. However, given the effectiveness of an oiled wildlife response is expected to be generally low, an earlier response would provide a marginal increase in environmental benefit. The selected delivery options provide the capacity to mobilise an oiled wildlife response capable of treating up to 600 wildlife from at least Day 6 and exceeds the maximum estimated Level three OWR response thought to be applicable. This delivery option provides the maximum expertise pooled across the participating operators, backed up by the international resources provided by OSRL. The availability of vessels and personnel meets the response need.	Wildlife response packages to preposition at vulnerable sites identified through the deterministic modelling cost A$700 per package per day.	This option is not adopted as the existing capability meets the need.	No

6.3.3 Selected control measures

Following review of alternative, additional and improved control measures, the following controls were selected for implementation for the activity.

- Alternative
  - None selected
- Additional
  - None selected
- Improved
  - None selected

6.4 Waste management – ALARP assessment

Alternative, Additional and Improved options have been identified and assessed against the base capability described in Section 5 with those that have been selected for implementation highlighted in green. Items highlighted in red have been considered and rejected on the basis that they are not feasible, the costs are clearly disproportionate to the environmental benefit, and/or the option is not reasonably practical. Control measures where there is not a clear justification for their inclusion or exclusion may be subject to a detailed ALARP assessment.

6.4.1 Existing capability – waste management

Woodside's existing level of capability is based on internal and third-party resources that are available 24 hours, 7 days per week. The capability presented below is displayed as ranges to incorporate operational factors such as weather, crew/vessel/aircraft/vehicle location and duties, survey or classification society inspection requirements, overflight/port/quarantine permits and inspections, crew/pilot duty and fatigue hours, re-fuelling/re-stocking provisions, and other similar logistic and operational limitation that are beyond Woodside's direct control.

6.4.2 Waste management – control measure options analysis

6.4.2.1 Alternative control measures

Alternative Control Measures considered *Alternative, including potentially more effective and/or novel control measures are evaluated as replacements for an adopted control*					
Option considered	**Environmental consideration**	**Feasibility**	**Approximate Cost**	**Assessment conclusions**	**Implemented**
No reasonably practical alternative control measures identified.					

6.4.2.2 Additional control measures

Additional Control Measures considered *Additional control measures are evaluated in terms of them reducing an environmental impact or an environmental risk when added to the existing suite of control measures*					
Option considered	**Environmental consideration**	**Feasibility**	**Approximate Cost**	**Assessment conclusions**	**Implemented**
Increased waste storage capability	The procurement of waste storage equipment options on the day of the event will allow immediate response and storage of collected waste. The environmental benefit of immediate waste storage is to reduce ecological consequence by safely securing waste, allowing continuous response operations to occur.	Access to Veolia's storage options provides the resources required to store and transport sufficient waste to meet the need. Access to waste contractors existing facilities enables waste to be stockpiled and gradually processed within the regional waste handling facilities. Additional temporary storage equipment is available through existing third-party contracts and arrangements with OSRL. Existing arrangements meet identified need for the activity.	Cost for increased waste disposal capability would be approximately A$1,300 per m^3. Cost for increased onshore temporary waste storage capability would be approximately A$40 per unit per day.	This option is not adopted as the existing capability meets the need.	No

6.4.2.3 Improved control measures

Improved Control Measures considered *Improved control measures are evaluated for improvements they could bring to the effectiveness of adopted control measures in terms of functionality, availability, reliability, survivability, independence and compatibility*					
Option considered	**Environmental consideration**	**Feasibility**	**Approximate Cost**	**Assessment conclusions**	**Implemented**
Faster response	The environmental benefit from successful waste storage will reduce pressure on the treatment and disposal facilities reducing ecological consequences by safely securing waste. In addition, waste storage and transport will allow continuous response operations to occur. This delivery option would increase known available storage, eliminating the risk of additional resources not being available at the time of the event. However, the environmental benefit of Woodside procuring additional waste storage is considered minor as the risk of additional storage not being available at the time of the event is considered low and existing arrangements provide adequate storage to support the response.	The credible scenario for this activity does not predict any shoreline impact and at-sea response is not appropriate for a spill of Marine Diesel thus waste storage needs will be minimal. Woodside already maintains an equipment stockpile in Exmouth to enable shorter response times to incidents. This stockpile includes temporary waste storage equipment. Woodside has access to stockpiles of waste storage and equipment in Dampier and Exmouth through existing contracts and arrangements.	The incremental benefit of having a dedicated local Woodside owned stockpile of waste equipment and transport is considered minor and cost is considered disproportionate to the benefit gained given there is no predicted shoreline impact.	This option is not adopted as the existing capability meets the need.	No

6.4.3 Selected control measures

Following review of alternative, additional and improved control measures, the following controls were selected for implementation for the activity.

- Alternative

  - None selected
- Additional
  - None selected
- Improved
  - None selected

6.5 Scientific Monitoring – ALARP Assessment

Alternative, Additional and Improved options have been identified and assessed against the base capability described in Section 5 with those that have been selected for implementation highlighted in green. Items highlighted in red have been considered and rejected on the basis that they are not feasible, the costs are clearly disproportionate to the environmental benefit, and/or the option is not reasonably practical. Control measures where there is not a clear justification for their inclusion or exclusion may be subject to a detailed ALARP assessment.

6.5.1 Existing Capability – Scientific Monitoring

Woodside's existing level of capability is based on internal and third-party resources that are available 24 hours, 7 days per week. The capability presented below is displayed as ranges to incorporate operational factors such as weather, crew/vessel/aircraft/vehicle location and duties, survey or classification society inspection requirements, overflight/port/quarantine permits and inspections, crew/pilot duty and fatigue hours, re-fuelling/re-stocking provisions, and other similar logistic and operational limitations that are beyond Woodside's direct control.

6.5.2 Scientific Monitoring – Control Measure Options Analysis

Alternative Control Measures considered
Alternative, including potentially more effective and/or novel control measures are evaluated as replacements for an adopted control

Ref	Control Measure Category	Option considered	Implemented	Environmental Consideration	Feasibility / Cost
SM01	System	Analytical laboratory facilities closer to the likely spill affected area	No	SM01 water quality monitoring requires water samples to be transported to National Association of Testing Authorities (NATA) rated laboratories in Perth or interstate. Consider the benefit of laboratory access and transportation times to deliver water samples and complete lab analysis. There is a time lag from collection of water samples to being in receipt of results and confirming hydrocarbon contact to sensitive receptors). The environmental consideration of having access to suitable laboratory facilities in Exmouth or Karratha to carry out the hydrocarbon analysis would provide faster turnaround in reporting of results only by a matter of days (as per the time to transport samples to laboratories).	Laboratory facilities and staff available at locations closer to the spill affected area can reduce reporting times only to a moderate degree (days) with associated high costs of maintaining capability do not improve the environmental benefit.
SM01	System	Dedicated contracted SMP vessel (exclusive to Woodside)	No	Would provide faster mobilisation time of scientific monitoring resources, environmental benefit associated with faster mobilisation time would be minor compared to selected options.	Chartering and equipping additional vessels on standby for scientific monitoring has been considered. The option is reasonably practicable but the sacrifice (charter costs and organisational complexity) is significant, particularly when compared with the anticipated availability of vessels and resources within in the required timeframes. The selected delivery provides capability to meet the scientific monitoring objectives, including collection of pre-emptive data where baseline knowledge gaps are identified for receptor locations where spill predictions of time to contact are >10 days. The effectiveness of this alternative control (weather dependency, availability and survivability) is rated as very low The cost and organisational complexity of employing a dedicated response vessel is considered disproportionate to the potential environmental benefit by adopting these delivery options.

Additional Control Measures considered
Additional control measures are evaluated in terms of them reducing an environmental impact or an environmental risk when added to the existing suite of control measures

Ref	Control Measure Category	Option considered	Implemented	Environmental Consideration	Feasibility / Cost
SM01	System	Determine baseline data needs and provide implementation plan in the event of an unplanned hydrocarbon release	Yes	Address resourcing needs to collect post spill (pre-contact) baseline data as spill expands in the event of a loss of well containment from the PAP activities.	Woodside relies on existing environmental baseline for receptors which have predicted hydrocarbon contact (above environment threshold) <10 days and acquiring pre-emptive data in the event of a loss of well containment from the PAP activities based on receptors predicted to have hydrocarbon contact >10 days. Ensure there is appropriate baseline for key receptors for all geographic locations that are potentially impacted <10 days of spill event, where practicable. Address resourcing needs to collect pre-emptive baseline as spill expands in the event of a loss of well containment from the activities.

6.5.3 Improved Control Measures

Improved Control Measures considered – No reasonably practicable improved Control Measures identified.

6.5.4 Selected Control Measures

Following review of alternative, additional and improved control measures as outlined above, the following controls were selected for implementation for the PAP.

- Alternative
  - None selected
- Additional
  - Determine baseline data needs and activate SMPs for any identified PBAs in the event of an unplanned hydrocarbon release
- Improved
  - None selected

6.5.5 Operational Plan

Key actions from the Scientific Monitoring Program Operational Plan for implementing the response are outlined in **Table 6-1**.

Table 6-1: Scientific monitoring program operational plan actions

Responsibility	Action
Activation	
Perth ICC Planning (ICC Planning – Environment Unit)	Mobilise SMP Lead/Manager and SMP Coordinator to the ICC Planning function.
Perth ICC Planning (ICC Planning – Environment Unit) (SMP Lead/Manager and SMP Coordinator)	Constantly assess all outputs from OM01, OM02 and OM03 (Section 5 and **Error! Reference source not found.**) to determine receptor locations and receptors at risk. Confirm sensitive receptors likely to be exposed to hydrocarbons, timeframes to specific receptor locations and which SMPs are triggered. Review baseline data for receptors at risk.
Perth ICC Planning (ICC Planning – Environment Unit) (SMP Lead/Manager and SMP Coordinator)	SMP co-ordinator stands up the SMP contractor. Stands up subject matter experts, if required.
Perth ICC Planning (ICC Planning – Environment Unit) (SMP Lead/Manager SMP Coordinator, SMP standby contractor SMP manager)	Establish if, and where, pre-contact baseline data acquisition is required. Determine practicable baseline acquisition program based on predicted timescales to contact and anticipated SMP mobilisation times. Determine scope for preliminary post-contact surveys during the Response Phase. Determine which SMP activities are required at each location based on the identified receptor sensitivities.
Perth ICC Planning (ICC Planning – Environment Unit) (SMP Lead/Manager, SMP Coordinator, SMP	If response phase data acquisition is required, stand up the contractor SMP teams for data acquisition and instruct them to standby awaiting further details for mobilisation from the ICC.

Responsibility	Action
standby contractor SMP manager)	
Perth ICC Planning (ICC Planning – Environment Unit) (SMP Lead/Manager, SMP Coordinator, SMP standby contactor SMP manager)	SMP contractor, SMP standby contractor to prepare the Field Implementation Plan. Prepare and obtain sign-off of the Response Phase SMP work plan and Field Implementation Plan. Update the IAP.
Perth ICC Planning (ICC Planning – Environment Unit) (SMP Lead/Manager, SMP Coordinator SMP standby contactor SMP manager)	Liaise with ICC Logistics, and determine the status and availability of aircraft, vessels and road transportation available to transport survey personnel and equipment to point of departure. Engage with SMP standby contactor SMP Manager and ICC Logistics to establish mobilisation plan, secure logistics resources and establish ongoing logistical support operations, including: • Vessels, vehicles and other logistics resources • Vessel fit-out specifications (as • Detailed in the Scientific Monitoring Program Operational Plan • Equipment storage and pick-up locations • Personnel pick-up/airport departure locations • Ports of departure • Land based operational centres and forward operations bases Accommodation and food requirements.
Perth ICC Planning (ICC Planning – Environment Unit) (SMP Lead/Manager, SMP Coordinator, SMP standby contactor (SMP manager)	Confirm communications procedures between Woodside SMP team, SMP contractor SMP Duty Manager, SMP Team Leads and Operations Coordinator (ICC).
Mobilisation	
Perth ICC Logistics	Engage vessels and vehicles and arrange fitting out as specified by the mobilisation Plan Confirm vessel departure windows and communicate with the SMP contractor SMP Duty Manager. Agree SMP mobilisation timeline and induction procedures with the Operations Coordinator (ICC).
Perth ICC Logistics	Coordinate with SMP contactor SMP Duty Manager to mobilise teams and equipment according to the logistics plan and Sector induction procedures.
SMP Survey Team Leads	SMP Survey Team Leader(s) coordinate on-ground/on-vessel mobilisations and support services with the Operations Coordinator (ICC).

6.5.6 ALARP and Acceptability Summary

<table>
<tr><th colspan="3">ALARP and Acceptability Summary</th></tr>
<tr><td colspan="3">Scientific Monitoring</td></tr>
<tr><td rowspan="4">ALARP Summary</td><td>X</td><td>All known reasonably practicable control measures have been adopted</td></tr>
<tr><td>X</td><td>Additional Measures: Determine baseline data needs and activate SMPs for any identified PBAs in the event of an unplanned hydrocarbon release</td></tr>
<tr><td></td><td>No reasonably practical additional, alternative, and/or improved control measure exists</td></tr>
<tr><td colspan="2">The resulting scientific monitoring capability has been assessed against the worst-case credible spill scenarios. The range of strategies provide an ongoing approach to monitoring operations to assess and evaluate the scale and extent of impacts.

All known reasonably practicable control measures have been adopted with the cost and organisational complexity of these options determined to be Moderate and the overall delivery effectiveness considered Medium. The SMP's main objectives can be met, with the addition of one alternative control measures to provide further benefit.</td></tr>
<tr><td>Acceptability Summary</td><td colspan="2">• The control measures selected for implementation manage the potential impacts and risks to ALARP.
• In the event of a hydrocarbon spill for the PAP, the control measures selected, meet or exceed the requirements of Woodside Management System and industry best-practice.
• Throughout the PAP, relevant Australian standards and codes of practice will be followed to evaluate the impacts from an unplanned hydrocarbon release.
• The level of impact and risk to the environment has been considered with regard to the principles of Environmentally Sustainable Development (ESD); and risks and impacts from a range of identified scenarios were assessed in detail. The control measures described consider the conservation of biological and ecological diversity, through both the selection of control measures and the management of their performance. The control measures have been developed to account for the worst-case credible case scenario, and uncertainty has not been used as a reason for postponing control measures.</td></tr>
<tr><td colspan="3">On the basis from the ALARP impact assessment above and in Section 6 of the EP Woodside considers the adopted controls discussed, manage the impacts and risks associated with implementing scientific monitoring activities to a level that is ALARP and acceptable.</td></tr>
</table>

7 ENVIRONMENTAL RISK ASSESSMENT OF SELECTED RESPONSE TECHNIQUES

The implementation of response techniques may modify the impacts and risks identified in the EP and response activities can introduce additional impacts and risks from response operations themselves. Therefore, it is necessary to complete an assessment to ensure these impacts and risks have been considered and specific measures are put in place to continually review and manage these further impacts and risks to ALARP and Acceptable levels. A simplified assessment process has been used to complete this task which covers the identification, analysis, evaluation and treatment of impacts and risks introduced by responding to the event.

7.1 Identification of impacts and risks from implementing response techniques

Each of the control measures can modify the impacts and risks identified in the EP. These impacts and risks have been previously assessed within the scope of the EP. Refer to the EP for details regarding how these risks are being managed. They are not discussed further in this document.

- Atmospheric emissions
- Routine and non-routine discharges
- Physical presence, proximity to other vessels (shipping and fisheries)
- Routine acoustic emissions vessels
- Lighting for night work/navigational safety
- Invasive marine species
- Collision with marine fauna
- Disturbance to Seabed

Additional impacts and risks associated with the control measures not included within the scope of the EP include:

- Vessel operations and anchoring
- Additional stress or injury caused to wildlife
- Waste generation

7.2 Analysis of impacts and risks from implementing response techniques

The table below compares the adopted control measures for this activity against the environmental values that can be affected when they are implemented.

Table 7-1: Analysis of risks and impacts

	Environmental Value						
	Soil and Groundwater	Marine Sediment Quality	Water Quality	Air Quality	Ecosystems/ Habitat	Species	Socio-Economic
Monitor and evaluate		✓	✓		✓	✓	
Source control		✓	✓	✓	✓	✓	✓
Oiled Wildlife					✓	✓	
Scientific Monitoring		✓	✓		✓	✓	✓
Waste Management	✓			✓	✓	✓	✓

7.3 Evaluation of impacts and risks from implementing response techniques

7.3.1 Vessel operations

During the implementation of response techniques, where water depths allow, it is possible that response vessels will be required to anchor (e.g. during shoreline surveys). The use of vessel anchoring will be minimal and likely to occur when the impacted shoreline is inaccessible via road. Anchoring in the nearshore environment of sensitive receptor locations will have the potential to impact coral reef, seagrass beds and other benthic communities in these areas. Recovery of benthic communities from anchor damage depends on the size of anchor and frequency of anchoring. Impacts would be highly localised (restricted to the footprint of the vessel anchor and chain) and temporary, with full recovery expected.

7.3.2 Additional stress or injury caused to wildlife

Additional stress or injury to wildlife could be caused through the following phases of a response:

- Capturing wildlife
- Transporting wildlife
- Stabilisation of wildlife
- Cleaning and rinsing of oiled wildlife
- Rehabilitation (e.g. diet, cage size, housing density)
- Release of treated wildlife

Inefficient capture techniques have the potential to cause undue stress, exhaustion or injury to wildlife, additionally pre-emptive capture could cause undue stress and impacts to wildlife when there are uncertainties in the forecast trajectory of the spill. During the transportation and stabilisation phases there is the potential for additional thermoregulation stress on captured wildlife. Additionally, during the cleaning process, it is important personnel undertaking the tasks are familiar with the relevant techniques to ensure that further injury and the removal of water proofing feathers are managed and mitigated. Finally, during the release phase it's important that wildlife is not released back into a contaminated environment.

7.3.3 Waste generation

Implementing the selected response techniques will result in the generation of the following waste streams that will require management and disposal:

- Liquids (recovered oil/water mixture), recovered from oiled wildlife response operations
- Semi-solids/solids (oily solids), collected during oiled wildlife response operations
- Debris collected during oiled wildlife response.

If not managed and disposed of correctly, wastes generated during the response have the potential for secondary contamination, impacts to wildlife through contact with or ingestion of waste materials and contamination risks if not disposed of correctly onshore.

7.4 Treatment of impacts and risks from implementing response techniques

In respect of the impacts and risks assessed the following treatment measures have been adopted. It must be recognised that this environmental assessment is seeking to identify how to maintain the level of impact and risks at levels that are ALARP and of an acceptable level rather than exploring further impact and risk reduction. It is for this reason that the treatment measures identified in this assessment will be captured in Operational Plans, Tactical Response Plans, and/or First Strike Response Plans.

7.4.1 Vessel operations and access to the nearshore environment

- If vessels are required for access, anchoring locations will be selected to minimise disturbance to benthic habitats. Where existing fixed anchoring points are not available, locations will be selected to minimise impact to nearshore benthic environments with a preference for areas of sandy seabed where they can be identified (PS 7.1).

7.4.2 Additional stress or injury caused to wildlife

- Oiled wildlife operations (including hazing) would be implemented with advice and assistance from the Oiled Wildlife Advisor from the DBCA. (PS 9.1).

7.4.3 Waste generation

- All oiled wildlife response sites zoned and marked before operations commence to prevent secondary contamination and minimise the mixing of clean and oiled waste (PS 11.1).

8 ALARP CONCLUSION

An analysis of alternative, additional and improved control measures has been undertaken to determine their reasonableness and practicability. The tables in **Section 6** document the considerations made in this evaluation. Where the costs of an alternative, additional, or improved control measure have been determined to be clearly disproportionate to the environmental benefit gained from its adoption it has been rejected. Where this is not considered to be the case the control measure has been adopted.

The risks from a hydrocarbon spill have been reduced to ALARP because:

- Woodside has a significant hydrocarbon spill response capability to respond to the WCCS through the control measures identified.
- New and modified impacts and risks associated with implementing response techniques have been considered and will not increase the risks associated with the activity.
- A consideration of alternative, additional, and improved control measures identified any other control measures that delivered proportionate environmental benefit compared to the cost of adoption for this activity ensuring that:
    - All known, reasonably practicable control measures have been adopted.
    - No additional, reasonably practicable alternative and/or improved control measures would provide further environmental benefit.
    - No reasonably practical additional, alternative, and/or improved control measure exists.
- A structured process for considering alternative, additional, and improved control measures was completed for each control measure.
- The evaluation was undertaken based on the outputs of the WCCS so that the capability in place is sufficient for all other scenario from this activity.
- The likelihood of the WCCS spill has been ignored in evaluating what was reasonably practicable.

9 ACCEPTABILITY CONCLUSION

Following the ALARP evaluation process, Woodside deems the hydrocarbon spill risks and impacts have been reduced to an acceptable level by meeting all of the following criteria:

- Techniques are consistent with Woodside's processes and relevant internal requirements including policies, culture, processes, standards, structures and systems.
- Levels of risk/ impact are deemed acceptable by relevant persons (external stakeholders) and are aligned with the uniqueness of, and/or the level of protection assigned to the environment, its sensitivity to pressures introduced by the activity, and the proximity of activities to sensitive receptors, and have been aligned with Part 3 of the EPBC Act.
- Selected control measures meet requirements of legislation and conventions to which Australia is a signatory (e.g. MARPOL, the World Heritage Convention, the Ramsar Convention, and the Biodiversity Convention etc.). In addition to these, other non-legislative requirements met include:
  - Australian IUCN reserve management principles for Commonwealth marine protected areas and bioregional marine plans.
  - National Water Quality Management Strategy and supporting guidelines for marine water quality).
  - Conditions of approval set under other legislation.
  - National and international requirements for managing pollution from ships.
  - National biosecurity requirements.
- Industry standards, best practices and widely adopted standards and other published materials have been used and referenced when defining acceptable levels. Where these are inconsistent with mandatory/ legislative regulations, explanation has been provided for the proposed deviation. Any deviation produces the same or a better level of environmental performance (or outcome).

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11 GLOSSARY AND ABBREVIATIONS

11.1 Glossary

Term	Description / Definition
ALARP	Demonstration through reasoned and supported arguments that there are no other practicable options that could reasonably be adopted to reduce risks further.
Availability	The availability of a control measure is the percentage of time that it is capable of performing its function (operating time plus standby time) divided by the total period (whether in service or not). In other words, it is the probability that the control has not failed or is undergoing a maintenance or repair function when it needs to be used.
Control	The means by which risk from events is eliminated or minimised.
Control effectiveness	A measure of how well the control measures perform their required function.
Control measure (risk control measure)	The features that eliminate, prevent, reduce or mitigate the risk to environment associated with PAP.
Credible spill scenario	A spill considered by Woodside as representative of maximum volume and characteristics of a spill that could occur as part of the PAP.
Dependency	The degree of reliance on other systems in order for the control measure to be able to perform its intended function.
Environment that may be affected	The summary of quantitative modelling where the marine environment could be exposed to hydrocarbons levels exceeding hydrocarbon threshold concentrations.
Incident	An event where a release of energy resulted in or had (with) the potential to cause injury, ill health, damage to the environment, damage to equipment or assets or company reputation.
Performance outcome	A statement of the overall goal or outcome to be achieved by a control measure
Performance standard	The parameters against which [risk] controls are assessed to ensure they reduce risk to ALARP. A statement of the key requirements (indicators) that the control measure has to achieve in order to perform as intended in relation to its functionality, availability, reliability, survivability and dependencies.
Preparedness	Measures taken before an incident in order to improve the effectiveness of a response
Reasonably practicable	... a computation ... made by the owner, in which the quantum of risk is placed on one scale and the sacrifice involved in the measures necessary for averting the risk (whether in money, time or trouble) [showing whether or not] that there is a gross disproportion between them ... made by the owner at a point of time anterior to the accident. (Judgement: Edwards v National Coal Board [1949])
Receptors at risk	Physical, biological and social resources identified as at risk from hydrocarbon contact using oil spill modelling predictions.
Receptor areas	Geographically referenced areas such as bays, islands, coastlines and/or protected area (WHA, Commonwealth or State marine reserve or park) containing one or more receptor type, e.g., Gascoyne AMP.
Receptor Sensitivities	This is a classification scheme to categorise receptor sensitivity to an oil spill. The Environmental Sensitivity Index (ESI) is a numerical classification of the relative sensitivity of a particular environment (particularly different shoreline types) to an oil spill. Refer to the Woodside Oil Pollution Emergency Arrangements (Australia) for more details.
Regulator	NOPSEMA are the Environment Regulator under the Environment Regulations.

Term	Description / Definition
Reliability	The probability that at any point in time a control measure will operate correctly for a further specified length of time.
Response technique	The key priorities and objectives to be achieved by the response plan. Measures taken in response to an event to reduce or prevent adverse consequences.
Survivability	Whether or not a control measure is able to survive a potentially damaging event is relevant for all control measures that are required to function after an incident has occurred.
Threshold	Hydrocarbon threshold concentrations applied to the risk assessment to evaluate hydrocarbon spills. These are defined as: surface hydrocarbon concentration – ≥10 g/m^2, dissolved – ≥50 ppb and entrained hydrocarbon concentrations – ≥100 ppb.

11.2 Abbreviations

Abbreviation	Meaning
ADIOS	Automated Data Inquiry for Oil Spills
AIIMS	Australasian Inter-Service Incident Management System
ALARP	As low as reasonably practicable
AMOSC	Australian Marine Oil Spill Centre
AMP	Australian Marine Park
AMSA	Australian Maritime Safety Authority
APASA	Asia Pacific ASA
BAOAC	Bonn Agreement Oil Appearance Code
CICC	Corporate Incident Coordination Centre
DM	Duty Manager
DoT	Western Australia Department of Transport
DBCA	Western Australia Department of Biodiversity, Conservation and Attractions (former Western Australian Department of Parks and Wildlife)
EMBA	Environment that May Be Affected
EP	Environment Plan
Environment Regulations	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
ESI	Environmental Sensitivity Index
ESD	Ecologically Sustainable Development
ESP	Environmental Services Panel
FSP	First Strike Response Plan
GIS	Geographic Information System
GPS	Global Positioning System
HSP	Hydrocarbon Spill Preparedness
IAP	Incident Action Plan
ICC	Incident Coordination Centre
IMT	Incident Management Team
IPIECA	International Petroleum Industry Environment Conservation Association
ITOPF	International Tanker Owners Pollution Federation
IUCN	International Union for Conservation of Nature
KBSF	King Bay Supply Facility
KICC	Karratha Incident Coordination Centre
KSAT	Kongsberg Satellite
ME	Monitor and Evaluate
MoU	Memorandum of Understanding
NEBA	Net Environmental Benefit Analysis
NOAA	National Oceanic and Atmospheric Administration
NRT	National Response Team
OILMAP	Oil Spill Model and Response System

Abbreviation	Meaning
OPEA	Oil Pollution Emergency Arrangements
OPEP	Oil Pollution Emergency Plan
OPGGSA	Offshore Petroleum and Greenhouse Gas Storage Act
OSMP	Operational and Scientific Monitoring Program
OSRL	Oil Spill Response Limited
OSTM	Oil Spill Trajectory Modelling
OWR	Oiled Wildlife Response
OWRP	Oiled Wildlife Response Plan
OWROP	Regional Oiled Wildlife Response Operational Plan
PAP	Petroleum Activities Program
PBA	Pre-emptive Baseline Areas
PPA	Priority Protection Area
PPB	Parts per billion
PPM	Parts per million
PS	Performance standard
RPA	Response Protection Area
SIMAP	Integrated Oil Spill Impact Model System
SMP	Scientific monitoring program
SOP	Standard Operating Procedure
TRP	Tactical Response Plan
WHA	World Heritage Area
Woodside/ WEL	Woodside Energy Limited
WCC	Woodside Communication Centre
WCCS	Worst Case Credible Scenario

ANNEX A: NET ENVIRONMENTAL BENEFIT ANALYSIS DETAILED OUTCOMES

A NEBA has been conducted to assess the net environmental benefit of different response techniques to selected receptors in the event of an oil spill from the PAP for marine diesel. The complete list of potential receptor locations within the EMBA for the PAP is included in Section 6 of the EP.

The NEBA was conducted for open Commonwealth waters and the Gascoyne AMP (identified as an RPA). The EMBA was not predicted by modelling to overlap any RPAs above the surface threshold of 50 g/m^2 or the shoreline accumulation threshold of 100 g/m^2. However, the Gascoyne AMP was predicted to be contacted by hydrocarbons above the entrained threshold of 100 ppb (prior to day 14).

The detailed NEBA assessment outcomes are shown below.

The full NEBA assessments are available here (Link).

Table A-1: NEBA assessment technique recommendations for a surface release due to a vessel tank rupture of marine diesel (Credible Scenario-01)

Receptor	Monitor and Evaluate	Containment and Recovery	Dispersant application: > 20 m water depth and > 10 km from shore/reefs	Shoreline protection	Shoreline clean-up (manual)	Shoreline clean-up (mechanical)	Shoreline clean-up (chemical)	Oiled Wildlife Response	In situ burning	Mechanical dispersion	Source Control
Open Commonwealth waters (Operational Area)	Yes	No	No	No	No	No	No	Potentially	No	No	Yes
Gascoyne AMP	Yes	No	No	No	No	No	No	Potentially	No	No	Yes

Overall assessment

Sensitive receptor (Sites identified in EP)	Monitor and Evaluate	Containment and Recovery	Dispersant application: > 20 m water depth and > 10 km from shore/reefs	Shoreline protection	Shoreline clean-up (manual)	Shoreline clean-up (mechanical)	Shoreline clean-up (chemical)	Oiled Wildlife Response	In situ burning	Mechanical dispersion	Source Control
Is this response Practicable?	Yes	No	No	No	No	No	No	Potentially	No	No	Yes
NEBA identifies Response potentially of Net Environmental Benefit?	Yes	No	No	No	No	No	No	Potentially	No	No	Yes

NEBA Impact Ranking Classification Guidance

To reduce variability between assessments, the following ranking descriptions have been devised to guide the workshop process:

			Degree of impact	Potential duration of impact	Equivalent Woodside Corporate Risk Matrix Consequence Level
Positive	3P	Major	Likely to prevent: • behavioural impact to biological receptors • behavioural impact to socio-economic receptors e.g. changes to day-today business operations, public opinion/behaviours (e.g. avoidance of amenities such as beaches) or regulatory designations.	Decrease in duration of impact by > 5 years	N/A
	2P	Moderate	Likely to prevent: • significant impact to a single phase of reproductive cycle of biological receptors • detectable financial impact, either directly (e.g. loss of income) or indirectly (e.g. via public perception), for socio-economic receptors.	Decrease in duration of impact by 1–5 years	N/A

	1P	Minor	Likely to prevent impacts on:
			• significant proportion of population or breeding stages of biological receptors
			• socio-economic receptors such as:
			  ○ significant impact to the sensitivity of protective designation; or
			  ○ significant and long-term impact to business/industry.
				Decrease in duration of impact by several seasons (< 1 year)	N/A

	0	Non-mitigated spill impact	**No detectable difference to unmitigated spill scenario.**		
Negative	1N	Minor	Likely to result in: • behavioural impact to biological receptors • behavioural impact to socio-economic receptors e.g. changes to day-to-day business operations, public opinion/behaviours (e.g. avoidance of amenities such as beaches), or regulatory designations. **[Note 1]**	Increase in duration of impact by several seasons (< 1 year)	Increase in risk by one sub-category, without changing category (e.g. Minor (E) to Minor (D))
	2N	Moderate	Likely to result in: • significant impact to a single phase of reproductive cycle for biological receptors; or • detectable financial impact, either directly (e.g. loss of income) or indirectly (e.g. via public perception), for socio-economic receptors. This level of negative impact is recoverable and unlikely to result in closure of business/industry in the region.	Increase in duration of impact by 1–5 years	Increase in risk by one category (e.g. Minor (D) to Moderate (C or B))

	3N	Major	Likely to result in impacts on:
			• significant proportion of population or breeding stages of biological receptors
			• socio-economic receptors resulting in either:
			  ○ significant impact to the sensitivity of protective designation; or
			  ○ significant and long-term impact to business/industry.
				Increase in duration of impact by > 5 years or unrecoverable	Increase in risk by two categories (e.g. Minor (E) to Major (A))

NOTE 1: the maximum likely impact should be considered; for example, if a spill were to directly impact the behaviour that results in an impact to reproduction and/or the breeding population (such as fish failing to aggregate to spawn), then the score should be a 2 or 3 rather than a 1. Similarly, if a change in behaviour resulted in an increased risk of mortality of a population, then it should be scored as a 2 or 3.

ANNEX B: OPERATIONAL MONITORING ACTIVATION AND TERMINATION CRITERIA

Table B-1: Operational monitoring objectives, triggers and termination criteria

Operational Monitoring Operational Plan	Objectives	Activation triggers	Termination criteria
Operational Monitoring Operational Plan 1 (OM01) Predictive Modelling of Hydrocarbons to Assess Resources at Risk	OM01 focuses on the conditions that have prevailed since a spill commenced, as well as those that are forecasted in the short term (1–3 days ahead) and longer term. OM01 utilises computer-based forecasting methods to predict hydrocarbon spill movement and guide the management and execution of spill response operations to maximise the protection of environmental resources at risk. The objectives of OM01 are to: • Provide forecasting of the movement and weathering of spilled hydrocarbons • Identify resources that are potentially at risk of contamination • Provide simulations showing the outcome of alternative response options (booming patterns etc.) to inform on-going Net Environmental Benefit Analysis (NEBA) and continually assess the efficacy of available response options in order to reduce risks to ALARP	OM01 will be triggered immediately following a level 2/3 hydrocarbon spill.	The criteria for the termination of OM01 are: • The hydrocarbon discharge has ceased • Response activities have ceased • Hydrocarbon spill modelling (as verified by OM02 surveillance observations) predicts no additional natural resources will be impacted

Operational Monitoring <u>Operational Plan</u>	Objectives	Activation triggers	Termination criteria
<u>Operational Monitoring Operational Plan 2 (OM02)</u> Surveillance and reconnaissance to detect hydrocarbons and resources at risk	OM02 aims to provide regular, on-going hydrocarbon spill surveillance throughout a broad region, in the event of a spill. The objectives of OM02 are: • Verify spill modelling results and recalibrate spill trajectory models (OM01) • Understand the behaviour, weathering and fate of surface hydrocarbons • Identify environmental receptors and locations at risk or contaminated by hydrocarbons • Inform ongoing Net Environmental Benefit Analysis (NEBA) and continually assess the efficacy of available response options in order to reduce risks to ALARP • To aid in the subsequent assessment of the short- to long-term impacts and/or recovery of natural resources (assessed in SMPs) by ensuring that the visible cause and effect relationships between the hydrocarbon spill and its impacts to natural resources have been observed and recorded during the operational phase.	OM02 will be triggered immediately following a level 2/3 hydrocarbon spill.	The termination triggers for the OM02 are: • 72 hours has elapsed since the last confirmed observation of surface hydrocarbons • Latest hydrocarbon spill modelling results (OM01) do not predict surface exposures at visible levels
<u>Operational Monitoring Operational Plan 3 (OM03)</u> Monitoring of hydrocarbon presence, properties, behaviour and weathering in water	OM03 will measure surface, entrained and dissolved hydrocarbons in the water column to inform decision-making for spill response activities. The specific objectives of OM03 are as follows: • Detect and monitor for the presence, quantity, properties, behaviour and weathering of surface, entrained and dissolved hydrocarbons • Verify predictions made by OM01 and observations made by OM02 about the presence and extent of hydrocarbon contamination Data collected in OM03 will also be used for the purpose of longer-term water quality monitoring during SM01.	OM03 will be triggered immediately following a level 2/3 hydrocarbon spill.	The criteria for the termination of OM03 are as follows: • The hydrocarbon release has ceased • Response activities have ceased • Concentrations of hydrocarbons in the water are below available ANZECC/ ARMCANZ (2000) trigger values for 99% species protection.

Operational Monitoring Operational Plan	Objectives	Activation triggers	Termination criteria
Operational Monitoring Operational Plan 4 (OM04) Pre-emptive assessment of sensitive receptors at risk	OM04 aims to undertake a rapid assessment of the presence, extent and current status of shoreline sensitive receptors prior to contact from the hydrocarbon spill, by providing categorical or semi-quantitative information on the characteristics of resources at risk. The primary objective of OM04 is to confirm understanding of the status and characteristics of environmental resources predicted by OM01 and OM02 to be at risk, to further assist in making decisions on the selection of appropriate response actions and prioritisation of resources. Indirectly, qualitative/semi-quantitative pre-contact information collected by OM04 on the status of environmental resources may also aid in the verification of environmental baseline data and provide context for the assessment of environmental impacts, as determined through subsequent SMPs.	Triggers for commencing OM04 include: • Contact of a sensitive habitat or shoreline is predicted by OM01, OM02 and/or OM03 • The pre-emptive assessment methods can be implemented before contact from hydrocarbons (once a receptor has been contacted by hydrocarbons it will be assessed under OM05)	The criteria for the termination of OM04 at any given location are: • Locations predicted to be contacted by hydrocarbons have been contacted • The location has not been contacted by hydrocarbons and is no longer predicted to be contacted by hydrocarbons (resources should be reallocated as appropriate)

Operational Monitoring Operational Plan	Objectives	Activation triggers	Termination criteria
Operational monitoring operational plan 5 (OM05) Monitoring of contaminated resources	OM05 aims to implement surveys to assess the condition of fauna and habitats contacted by hydrocarbons at sensitive habitat and shoreline locations. The primary objectives of OM05 are: • Record evidence of oiled fauna (mortalities, sub-lethal impacts, number, extent, location) and habitats (mortalities, sub-lethal impacts, type, extent of cover, area, hydrocarbon character, thickness, mass and content) throughout the response and clean-up at locations contacted by hydrocarbons to inform and prioritise clean-up efforts and resources, while minimising the potential impacts of these activities. Indirectly, the information collected by OM05 may also support the assessment of environmental impacts, as determined through subsequent SMPs.	OM05 will be triggered when a sensitive habitat or shoreline is predicted to be contacted by hydrocarbons by OM01, OM02 and/or OM03.	The criteria for the termination of OM05 at any given location are: • No additional response or clean-up of fauna or habitats is predicted • Spill response and clean-up activities have ceased OM05 survey sites established at sensitive habitat and shoreline locations will continue to be monitored during SM02. The formal transition from OM05 to SM02 will begin on cessation of spill response and clean-up activities.

ANNEX C: OIL SPILL SCIENTIFIC MONITORING PROGRAM

Oil Spill Environmental Monitoring

The following provides some further detail on Woodside's oil spill scientific monitoring Program and includes the following:

- The organisation, roles and responsibilities of the Woodside oil spill scientific monitoring team and external resourcing.
- A summary table of the ten scientific monitoring programs as per the specific focus receptor, objectives, activation triggers and termination criteria.
- Details on the oil spill environmental monitoring activation and termination decision-making processes.
- Baseline knowledge and environmental studies knowledge access via geo-spatial metadata databases.
- An outline of the reporting requirements for oil spill scientific monitoring programs.

Oil Spill Scientific Monitoring – Delivery Team Roles and Responsibilities

Woodside Oil Spill Scientific Monitoring Delivery Team

The Woodside science team are responsible for the delivery of the oil spill scientific monitoring. The roles and responsibilities of the Woodside scientific monitoring delivery team are presented in Table C-1 and the organisational structure and Incident Control Centre (ICC) linkage provided in Figure C-1.

Woodside Oil Spill Scientific monitoring program - External Resourcing

In the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors, scientific monitoring personnel and scientific equipment to implement the appropriate SMPs will be provided by SMP Standby contractor who hold a standby contract for SMP via the Woodside Environmental Services Panel (ESP). In the event that additional resources are required other consultancy capacity within the Woodside ESP will be utilised (as needed and may extend to specialist contractors such as research agencies engaged in long-term marine monitoring programs). In consultation with the SMP Standby Contractor and/or specialist contractors, the selection, field sampling and approach of the SMPs will be determined by the nature and scale of the spill.

Table C-1: Woodside and Environmental Service Provider – Oil Spill Scientific Monitoring Program Delivery Team Key Roles and Responsibilities

Role	Location	Responsibility
Woodside Roles		
SMP Lead/Manager	Onshore (Perth)	• Approves activated the SMPs based on operational monitoring data provided by the Planning Function • Provides advice to the ICC in relation to scientific monitoring • Provides technical advice regarding the implementation of scientific monitoring • Approves detailed sampling plans prepared for SMPs • Directs liaison between statutory authorities, advisors and government agencies in relation to SMPs.
SMP Co-Ordinator	Onshore (Perth)	• Activates the SMPs based on operational monitoring data provided by the Planning Function • Sits in the Planning function of the ICC. • Liaises with other ICC functions to deliver required logistics, resources and operational support from Woodside to support the Environmental Service Provider in delivering on the SMPs. Acts as the conduit for advice from the SMP Lead/Manager to the Environmental Service Provider • Manages the Environmental Service Provider's implementation of the SMPs • Liaises with the Environmental Service Provider on delivery of the SMPs • Arranges all contractual matters, on behalf of Woodside, associated with the Environmental Service Provider's delivery of the SMPs.

Role	Location	Responsibility
Environmental Service Provider Roles		
SMP standby contractor: SMP Duty Manager/Project Manager	Onshore (Perth)	• Coordinates the delivery of the SMPs • Provides costings, schedule and progress updates for delivery of SMPs • Determines the structure of the Environmental Service Provider's team to necessitate delivery of the SMPs • Verifies that HSE Plans, detailed sampling plans and other relevant deliverables are developed and implemented for delivery of the SMPs • Directs field teams to deliver SMPs • Arranges all contractual matters, on behalf of Environmental Service Provider, associated with the delivery of the SMPs to Woodside • Manages sub-consultant delivery to Woodside • Provides required personnel and equipment to deliver the SMPs
SMP Field Teams	Offshore – Monitoring Locations	• Delivers the SMPs in the field consistent with the detailed sampling plans and HSE requirements, within time and budget. • Early communication of time, budget, HSE risks associated with delivery of the SMPs to the Environmental Service Provider – Project Manager • Provides start up, progress and termination updates to the Environmental Service Provider – Project Manager (will be led in-field by a party chief).

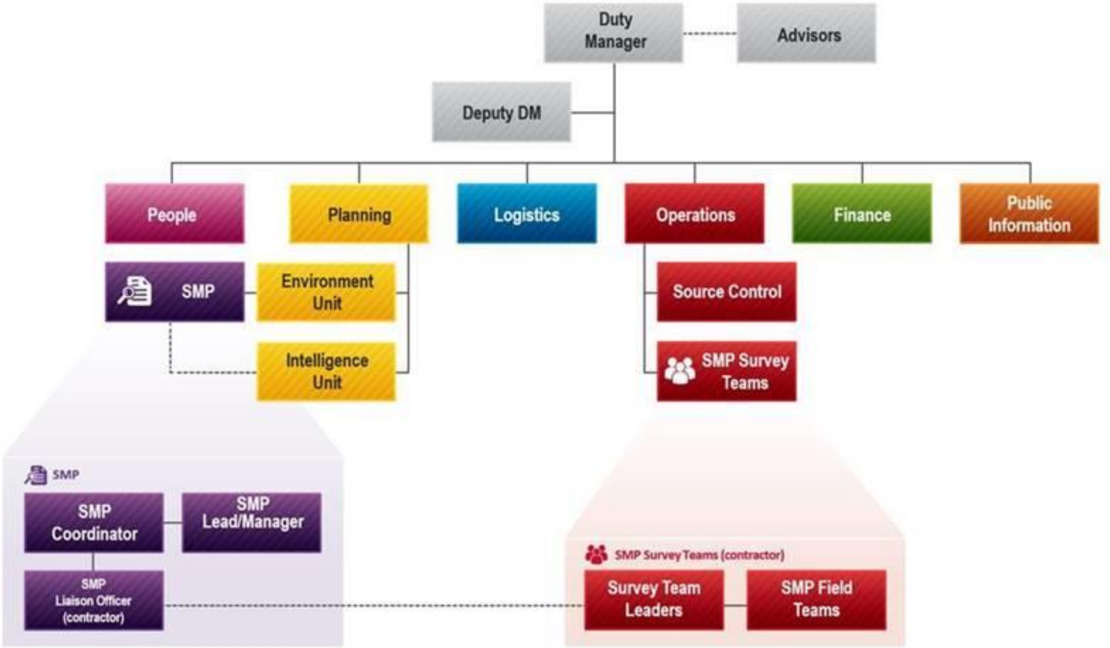

Figure C-1: Woodside Oil Spill Scientific Monitoring Program Delivery Team and Linkage to Incident Control Centre (ICC) organisational structure.

Table C-2: Oil Spill Environmental Monitoring: Scientific Monitoring Program - Objectives, Activation Triggers and Termination Criteria

Scientific monitoring Program (SMP)	Objectives	Activation Triggers	Termination Criteria
Scientific monitoring program 1 (SM01) **Assessment of Hydrocarbons in Marine Waters**	SM01 will detect and monitor the presence, extent, persistence and properties of hydrocarbons in marine waters following the spill and the response. The specific objectives of SM01 are as follows: • Assess and document the extent, severity and persistence of hydrocarbon contamination with reference to observations made during surveillance activities and / or in-water measurements made during operational monitoring; and • Provide information that may be used to interpret potential cause and effect drivers for environmental impacts recorded for sensitive receptors monitored under other SMPs.	SM01 will be initiated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors	SM01 will be terminated when: • Operational monitoring data relating to observations and / or measurements of hydrocarbons on and in water have been compiled, analysed and reported; and • The report provides details of the extent, severity and persistence of hydrocarbons which can be used for analysis of impacts recorded for sensitive receptors monitored under other SMPs. SMP monitoring of sensitive receptor sites: • Concentrations of hydrocarbons in water samples are below NOPSEMA guidance note (2019[6]) concentrations of 1 g/m^2 for floating, 10 ppb for entrained and dissolved; and • Details of the extent, severity and persistence of hydrocarbons from concentrations recorded in water have been documented at sensitive receptor sites monitored under other SMPs.
Scientific monitoring program 2 (SM02) **Assessment of the Presence, Quantity and Character of Hydrocarbons in Marine Sediments**	SM02 will detect and monitor the presence, extent, persistence and properties of hydrocarbons in marine sediments following the spill and the response. The specific objectives of SM02 are as follows: • Determine the extent, severity and persistence of hydrocarbons in marine sediments across selected sites where hydrocarbons were observed or recorded during operational monitoring; and • Provide information that may be used to interpret potential cause and effect drivers for environmental impacts recorded for sensitive receptors monitored under other SMPs.	SM02 will be initiated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented as follows: • Response activities have ceased; and • Operational monitoring results made during the response phase indicate that shoreline, intertidal or sub-tidal sediments have been exposed to surface, entrained or dissolved hydrocarbons (at or above 0.5 g/m² surface, 5 ppb for entrained/dissolved hydrocarbons and ≥1 g/m² for shoreline accumulation).	SM02 will be terminated once pre-spill condition is reached and agreed upon as per the SMP termination criteria process and include consideration of: • Concentrations of hydrocarbons in sediment samples are below ANZECC/ ARMCANZ (2013[7]) sediment quality guideline values (SQGVs) for biological disturbance; and • Details of the extent, severity and persistence of hydrocarbons from concentrations recorded in sediments have been documented.
Scientific monitoring program 3 (SM03) **Assessment of Impacts and Recovery of Subtidal and Intertidal Benthos**	The objectives of SM03 are: • Characterize the status of intertidal and subtidal benthic habitats and quantify any impacts to functional groups, abundance and density that may be a result of the spill; and • Determine the impact of the hydrocarbon spill and subsequent recovery (including impacts associated with the implementation of response options). Categories of intertidal and subtidal habitats that may be monitored include: • Coral reefs • Seagrass • Macro-algae • Filter-feeders SM03 will be supported by sediment contamination records (SM02) and characteristics of the spill derived from OMPs.	SM03 will be activated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented as follows: • As part of a pre-emptive assessment of PBAs of receptor locations identified by time to hydrocarbon contact >10 days, to target receptors and sites where it is possible to acquire pre-hydrocarbon contact baseline; and • Operational monitoring identified shoreline potential contact of hydrocarbons (at or above 0.5 g/m² surface, 5 ppb for entrained/dissolved hydrocarbons and ≥1 g/m² for shoreline accumulation) for subtidal and intertidal benthic habitat.	SM03 will be terminated once pre-spill condition is reached and agreed upon as per the SMP termination criteria process and include consideration of: • Overall impacts to benthic habitats from hydrocarbon exposure have been quantified. • Recovery of impacted benthic habitats has been evaluated. • Agreement with relevant stakeholders and regulators based on the nature and scale of the hydrocarbon spill impacts and/or that observed impacts can no longer be attributed to the spill.
Scientific monitoring program 4 (SM04) **Assessment of Impacts and Recovery of Mangroves / Saltmarsh**	The objectives of SM04 are: • Characterize the status of mangroves (and associated salt marsh habitat) at shorelines exposed/contacted by spilled hydrocarbons; • Quantify any impacts to species (abundance and density) and mangrove/saltmarsh community structure; and • Determine and monitor the impact of the hydrocarbon spill and potential subsequent recovery (including impacts associated with the implementation of response options). SM03 will be supported by sediment sampling undertaken in SM02 and characteristics of the spill derived from OMPs.	SM04 will be activated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented as follows: • As part of a pre-emptive assessment of receptor locations identified by time to hydrocarbon contact >10 days; and	SM04 will be terminated once pre-spill condition is reached and agreed upon as per the SMP termination criteria process and include consideration of: • Impacts to mangrove and saltmarsh habitat from hydrocarbon exposure have been quantified. • Recovery of impacted mangrove/saltmarsh habitat has been evaluated.

[6] NOPSEMA (2019) Bulletin #1 – Oil spill modelling – April 2019, https://www.nopsema.gov.au/assets/Bulletins/A652993.pdf
[7] Simpson SL, Batley GB and Chariton AA (2013). Revision of the ANZECC/ARMCANZ Sediment Quality Guidelines. CSIRO and Water Science Report 08/07. Land and Water, pp. 132.

Scientific monitoring Program (SMP)	Objectives	Activation Triggers	Termination Criteria
		• Operational monitoring identified shoreline potential contact of hydrocarbons (at or above 0.5 g/m² surface, 5 ppb for entrained/dissolved hydrocarbons and ≥1 g/m² for shoreline accumulation) for mangrove/saltmarsh habitat.	• Agreement with relevant stakeholders and regulators based on the nature and scale of the hydrocarbon spill impacts and/or that observed impacts can no longer be attributed to the spill.
Scientific monitoring program 5 (SM05) **Assessment of Impacts and Recovery of Seabird and Shorebird Populations**	The Objectives of SM05 are to: • Collate and quantify impacts to avian wildlife from results recorded during OM02 and OM05 (such as mortalities, oiling, rescue and release counts) and undertake a desk-based assessment to infer potential impacts at species population level; and • Undertake monitoring to quantify and assess impacts of hydrocarbon exposure to seabirds and shorebird populations at targeted breeding colonies / staging sites / important coastal wetlands where hydrocarbon contact was recorded.	SM05 will be initiated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented as follows: • As part of a pre-emptive assessment of receptor locations identified by time to hydrocarbon contact >10 days; • Operational monitoring predicts shoreline contact of hydrocarbons (at or above 0.5 g/m² surface, 5 ppb for entrained/dissolved hydrocarbons and ≥1 g/m² for shoreline accumulation) at important bird colonies / staging sites / important coastal wetland locations; or • Records of dead, oiled or injured bird species made during the hydrocarbon spill or response.	SM05 will be terminated once it is agreed that the receptor has returned to pre-spill condition. The SMP termination criteria process will be followed and include consideration of: • Impacts to seabird and shorebird populations from hydrocarbon exposure have been quantified. • Recovery of impacted seabird and shorebird populations has been evaluated. • Agreement with relevant stakeholders and regulators based on the nature and scale of the hydrocarbon spill impacts and/or that observed impacts can no longer be attributed to the spill.
Scientific monitoring program 6 (SM06) **Assessment of Impacts and Recovery of Nesting Marine Turtle Populations**	The objectives of SM06 are to: • To quantify impacts of hydrocarbon exposure or contact on marine turtle nesting populations (including impacts associated with the implementation of response options); • Collate and quantify impacts to adult and hatchling marine turtles from results recorded during OM02 and OM05 (such as mortalities, oiling, rescue and release counts) and undertake a desk-based assessment to infer potential impacts at species population levels (including impacts associated with the implementation of response options); .and • Undertake monitoring to quantify and assess impacts of hydrocarbon exposure to nesting marine turtle populations at known rookeries (including impacts associated with the implementation of response options).	SM06 will be initiated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented if operational monitoring has: • As part of a pre-emptive assessment of receptor locations identified by time to hydrocarbon contact >10 days; • Predicted shoreline contact of hydrocarbons (at or above 0.5 g/m² surface, 5 ppb for entrained/dissolved hydrocarbons and ≥1 g/m² for shoreline accumulation) at known marine turtle rookery locations; or • Records of dead, oiled or injured marine turtle species made during the hydrocarbon spill or response.	SM06 will be terminated once it is agreed that the receptor has returned to pre-spill condition. The SMP termination criteria process will be followed and include consideration of: • Impacts to nesting marine turtle populations from hydrocarbon exposure have been quantified. • Recovery of impacted nesting marine turtle populations has been evaluated. • Agreement with relevant stakeholders and regulators based on the nature and scale of the hydrocarbon spill impacts and/or that observed impacts can no longer be attributed to the spill.
Scientific monitoring program 7 (SM07) **Assessment of Impacts to Pinniped Colonies including Haul-out Site Populations**	The objectives of SM07 are to: • Quantify impacts on pinniped colonies and haul-out sites as a result of hydrocarbon exposure/contact. • Collate and quantify impacts to pinniped populations from results recorded during OM02 and OM05 (such as mortalities, oiling, rescue and release counts) and undertake a desk-based assessment to infer potential impacts at species population levels.	SM07 will be initiated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented if operational monitoring has: • As part of a pre-emptive assessment of receptor locations identified by time to hydrocarbon contact >10 days; • Identified shoreline contact of hydrocarbons ((at or above 0.5 g/m² surface, ≥5 ppb for entrained/dissolved hydrocarbons and ≥1 g/m² for shoreline accumulation) at known pinniped colony or haul-out site(s) (i.e. most northern site is the Houtman Abrolhos Islands); or • Records of dead, oiled or injured pinniped species made during the hydrocarbon spill or response.	SM07 will be terminated once it is agreed that the receptor has returned to pre-spill condition. The SMP termination criteria process will be followed and include consideration of: • Impacts to pinniped populations from hydrocarbon exposure have been quantified. • Recovery of pinniped populations has been evaluated. • Agreement with relevant stakeholders and regulators based on the nature and scale of the hydrocarbon spill impacts and/or that observed impacts can no longer be attributed to the spill.
Scientific monitoring program 8 (SM08) **Desk-Based Assessment of Impacts to Other Non-Avian Marine Megafauna**	The objective of SM08 is to provide a desk-based assessment which collates the results of OM02 and OM05 where observations relate to the mortality, stranding or oiling of mobile marine megafauna species not addressed in SM06 or SM07, including: • Cetaceans; • Dugongs; • Whale sharks and other shark and ray populations; • Sea snakes; and • Crocodiles.	SM08 will be initiated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented if operational monitoring reports records of dead, oiled or injured non-avian marine megafauna during the spill/ response phase.	SM08 will be terminated when the results of the post-spill monitoring have quantified impacts to non-avian megafauna. • Agreement with relevant stakeholders and regulators based on the nature and scale of the hydrocarbon spill impacts and/or that observed impacts can no longer be attributed to the spill.

Scientific monitoring Program (SMP)	Objectives	Activation Triggers	Termination Criteria
	The desk-based assessment will include population analysis to infer potential impacts to marine megafauna species populations.		
Scientific monitoring program 9 (SM09) **Assessment of Impacts and Recovery of Marine Fish associated with SM03 habitats**	The objectives of SM09 are: • Characterise the status of resident fish populations associated with habitats monitored in SM03 exposed/contacted by spilled hydrocarbons; • Quantify any impacts to species (abundance, richness and density) and resident fish population structure (representative functional trophic groups); and • Determine and monitor the impact of the hydrocarbon spill and potential subsequent recovery (including impacts associated with the implementation of response options).	SM09 will be initiated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented with SMO3.	SM09 will be undertaken and terminated concurrent with monitoring undertaken for SM03, as per the SMP termination criteria process • Agreement with relevant stakeholders and regulators based on the nature and scale of the hydrocarbon spill impacts and/or that observed impacts can no longer be attributed to the spill.
Scientific monitoring program 10 (SM10) **SM10 - Assessment of physiological impacts important fish and shellfish species (fish health and seafood quality/safety) and recovery**	SM10 aims to assess any physiological impacts to important commercial fish and shellfish species (assessment of fish health) and if applicable, seafood quality/safety. Monitoring will be designed to sample key commercial fish and shellfish species and analyse tissues to identify fish health indicators and biomarkers, for example: • Liver Detoxification Enzymes (ethoxyresorufin-O-deethylase (EROD) activity) • PAH Biliary Metabolites • Oxidative DNA Damage • Serum SDH • Other physiological parameters, such as condition factor (CF), liver somatic index (LSI), gonado-somatic index (GSI) and gonad histology, total weight, length, condition, parasites, egg development, testes development, abnormalities. • Seafood tainting may be included (where appropriate) using applicable sensory tests to objectively assess targeted finfish and shellfish species for hydrocarbon contamination. Results will be used to make inferences on the health of commercial fisheries and the potential magnitude of impacts to fishing industries.	SM10 will be initiated in the event of a Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors and implemented if operational monitoring (OM01, OM02 and OM05) indicates the following: • The hydrocarbon spill will or has intersected with active commercial fisheries or aquaculture activities. • Commercially targeted finfish and/or shellfish mortality has been observed/recorded. • Commercial fishing or aquaculture areas have been exposed to hydrocarbons ($\geq$0.5 g/m² surface and $\geq$5 ppb for entrained/dissolved hydrocarbons); and • Taste, odour or appearance of seafood presenting a potential human health risk is observed.	SM10 will be terminated once it is agreed that the receptor has returned to pre-spill condition. The SMP termination criteria process will be followed and include consideration of: • Physiological impacts to important commercial fish and shellfish species from hydrocarbon exposure have been quantified. • Recovery of important commercial fish and shellfish species from hydrocarbon exposure has been evaluated. • Impacts to seafood quality/safety (if applicable) have been assessed and information provided to the relevant stakeholders and regulators for the management of any impacted fisheries. • Agreement with relevant stakeholders and regulators based on the nature and scale of the hydrocarbon spill impacts and/or that observed impacts can no longer be attributed to the spill.

Activation Triggers and Termination Criteria

Scientific monitoring program Activation

The Woodside oil spill scientific monitoring team will be stood up immediately with the occurrence of a hydrocarbon spill (actual or suspected) Level 2 or 3 hydrocarbon release, or any release event with the potential to contact sensitive environmental receptors via the first strike plan for the petroleum activity programme. The presence of any level of hydrocarbons in the marine environment triggers the activation of the oil spill scientific monitoring program (SMP). This is to ensure the full range of eventualities relating to the environmental, socio-economic and health consequences of the spill are considered in the planning and execution of the SMP. The activation process also takes into consideration the management objectives, species recovery plans, conservation advices and conservations plans for any World Heritage Area (WHA), CMRs, State Marine Parks, other protected area designations (e.g., State nature reserves) and Matters of National Environmental Significance (including listed species under part 3 of the EPBC Act) potentially exposed to hydrocarbons. With the first 24-48 hours of a spill event, such information will be sourced and evaluated as part of the SMP planning process guided by Appendix D (identified receptors vulnerable to hydrocarbon contact), the information presented in the Existing Environment section of the EP as well as other information sources such as the Woodside Baseline Environmental Studies Database (Link).

The starting point for decision-making on what SMPs are activated and spatial extent of monitoring activities will be based on the predictive modelling results (OM01) in the first 24-48 hours until more information is made available from other operational monitoring activities such as aerial surveillance and shoreline surveys. Pre-emptive Baseline Areas (WHA, CMRs and State Marine Parks encompassing key ecological and socio-economic values) are a key focus of the SMP activation decision-making process, particularly, in the early spill event/response phase. As the operational monitoring progresses and further situational awareness information becomes available, it will be possible to understand the nature and scale of the spill. The SMP activation and implementation decision-making will be revisited on a daily basis to account for the updates on spill information. One of the priority focus areas in the early phase of the incident will be to identify and execute pre-emptive SMP assessments at key receptor locations, as required. The SMP activation and implementation decision tree is presented in Figure C-2.

Scientific monitoring Program Termination

The basis of the termination process for the active SMPs (SMPs 1-10) will include quantification of impacts, evaluation of recovery for the receptor at risk and consultation with relevant authorities, persons and organisations. Termination of each SMP will not be considered until the results (as presented in annual SMP reports for the duration of each program) indicate that the target receptor has returned to pre-spill condition.

Once the SMP results indicate impacted receptor(s) have returned to pre-spill condition (as identified by Woodside) a termination decision-making process will be triggered and a number of steps will be undertaken as follows:

- Woodside will engage expert opinion on whether the receptor has returned to pre-spill condition (based on monitoring data). Subject Matter Expert (SMEs) will be engaged (via the Woodside SME scientific monitoring terms of reference (Link) to review program outcomes, provide expert advice and recommendations for the duration of each SMP.
- Where expert opinion agrees that the receptor has returned to pre-spill condition, findings will then be presented to the relevant authorities, persons and organisations (as defined by the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulation 11A). Stakeholder identification, planning and engagement will be managed by Woodside's Reputation Functional Support Team (FST) and follow the stakeholder management FST (Link). These guidelines outline the FST roles and responsibilities, competencies, stakeholder communications and

planning processes. An assessment of the merits of any objection to termination will be documented in the SMP final report.

- Woodside will decide on termination of SMP based on expert opinion and merits of any stakeholder objections. The final report following termination will include: monitoring results, expert opinion and stakeholder consultation including merits of any objections.
- Termination of SMPs will also consider applicable management objectives, species recovery plans, conservation advices and conservations plans for any World Heritage Area (WHA), CMRs, State Marine Parks, other protected area designations (e.g., State nature reserves) and Matters of National Environmental Significance (including listed species under part 3 of the EPBC Act).

The SMP termination decision-making process will be applied to each active SMP and an iterative process of decision steps continued until each SMP has been terminated (refer to decision-tree diagram for SMP termination criteria, Figure C-3).

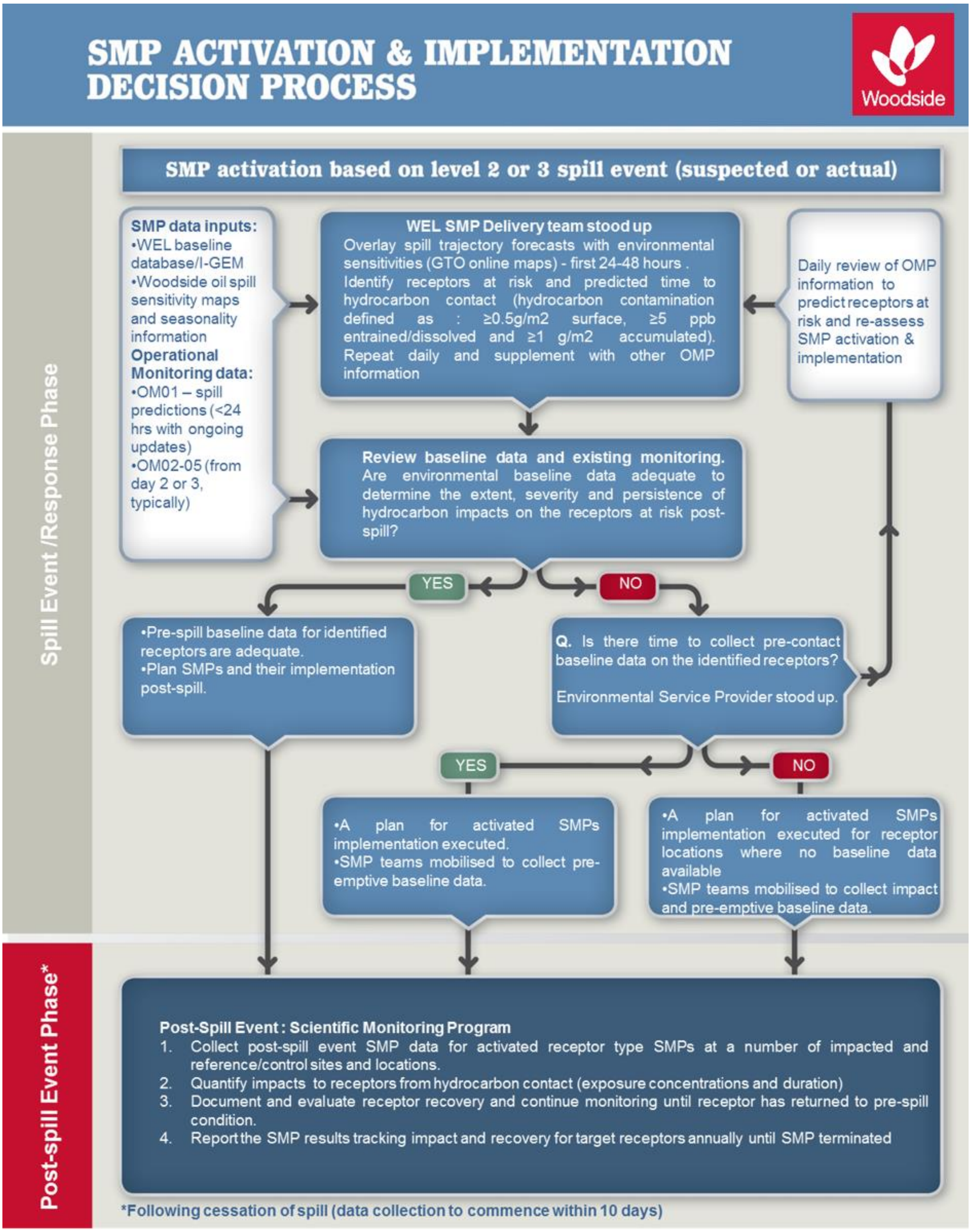

Figure C-2: Activation and Implementation Decision-tree for Oil Spill Environmental Monitoring

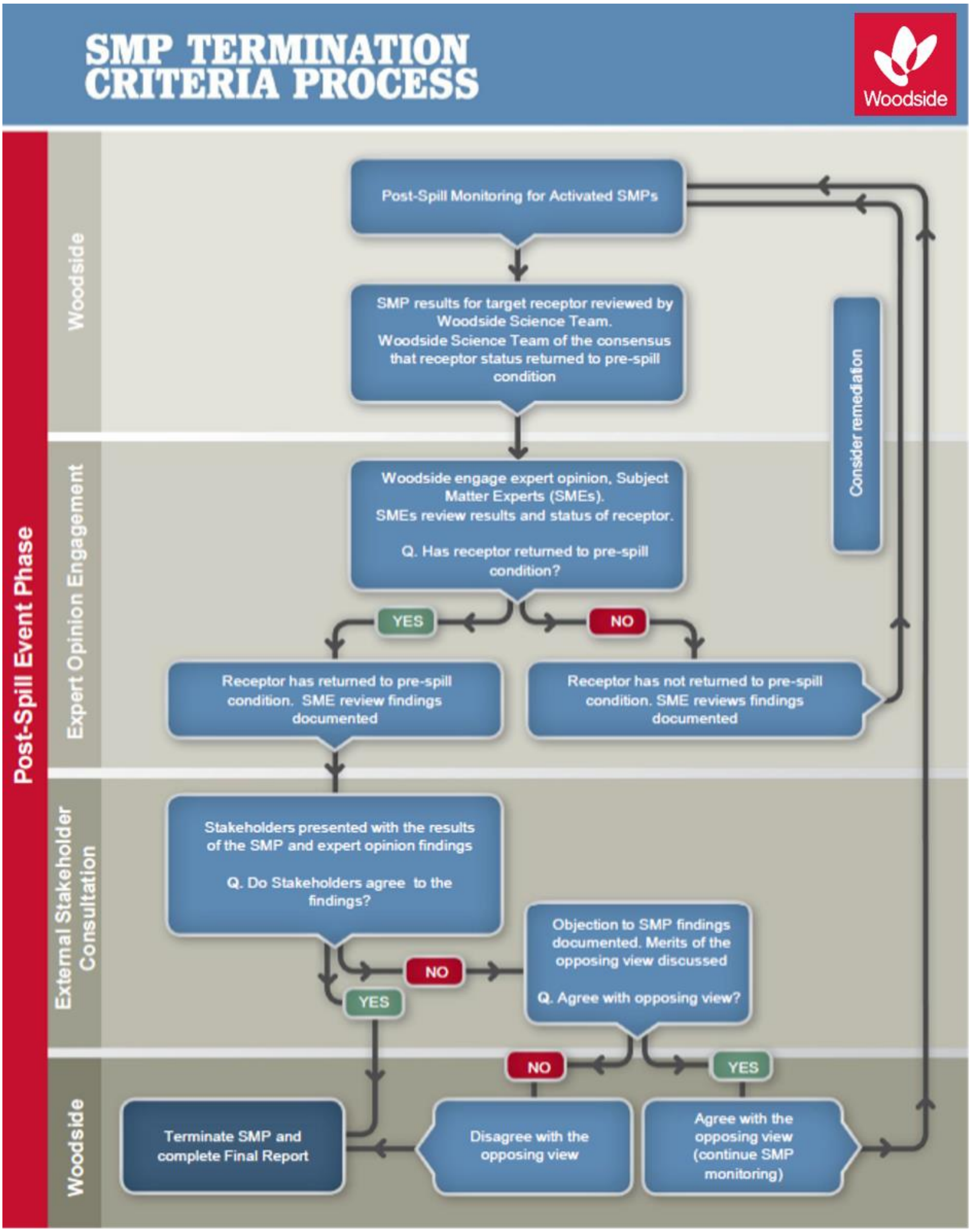

Figure C-3: Termination Criteria Decision-tree for Oil Spill Environmental Monitoring

Receptors at Risk and Baseline Knowledge

In order to assess the baseline studies available and suitability for oil spill scientific monitoring, Woodside maintains knowledge of environmental baseline studies through the upkeep and use of its Environmental Knowledge Management System.

Woodside's Environmental Knowledge Management System is a centralised platform for scientific information on the existing environment, marine biodiversity, Woodside environmental studies, key environmental impact topics, key literature and web-based resources. The system comprises a number of data directories and an environmental baseline database, as well as folders within the 'Corporate Environment' server space. The environmental baseline database was set up to support Woodside's SMP preparedness and as a SMP resource in the event of an unplanned hydrocarbon spill. The environmental baseline database is subject to updates including annual reviews completed as part of SMP standby contract. This database is accessed pre-PAP to identify Pre-emptive Baseline Areas (PBAs) where hydrocarbon contact is predicted to occur <10 days.

In addition to Woodside's Environmental Knowledge Management System, it is acknowledged that many relevant baseline datasets are held by other organisations (e.g. other oil and gas operators, government agencies, state and federal research institutions and non-governmental organisations). In order to understand the present status of environmental baseline studies a spatial environmental metadata database for Western Australia (Industry-Government Environmental Metadata, I-GEM) was established. IGEM is a collaboration comprising oil and gas operators (including Woodside), government and research agencies and other organisations. IGEM held data were integrated into the Department of Water and Environmental Regulation (WA) Index of Marine Surveys for Assessment (IMSA)[8] in 2020. The Index of Marine Surveys for Assessments (IMSA) is an online portal for information about marine-based environmental surveys in Western Australia. IMSA is a project of the Department of Water and Environmental Regulation (the department) for the systematic capture and sharing of marine data created as part of an environmental impact assessment (EIA).

In the event of an unplanned hydrocarbon release, Woodside intends to interrogate the information on baseline studies status as held by the various databases (e.g. Woodside Environmental Knowledge Management System, IMSA and other sources of existing baseline data) to identify Pre-emptive Baseline Areas (PBAs), i.e., receptors at risk where hydrocarbon contact is predicted to be >10 days, and baseline data can be collected before hydrocarbon contact.

Reporting

For the scientific monitoring program relevant regulators will be provided with:

- Annual reports summarising the SMPs deployed and active, data collection activities and available findings; and
- Final reports for each SMP summarising the quantitative assessment of environmental impacts and recovery of the receptor once returned to pre-spill condition and termination of the monitoring program.

The reporting requirements of the scientific monitoring program will be specific to the individual SMPs deployed and terms of responsibilities, report templates, schedule, QA/QC and peer-review will be agreed with the contractors engaged to conduct the SMPs. Compliance and auditing mechanisms will be incorporated into the reporting terms.

[8] https://biocollect.ala.org.au/imsa#max%3D20%26sort%3DdateCreatedSort

ANNEX D: MONITORING PROGRAM AND BASELINE STUDIES FOR THE PETROLEUM ACTIVITIES PROGRAM

Table D-1: Oil Spill Environmental Monitoring – scientific monitoring program scope for the Petroleum Activities Program based on worst case credible spill CS-01 for Scarborough 4D B1 Marine Seismic Survey

Receptors to be Monitored	Receptor Areas - Potential Impact and Reference Scientific Monitoring Sites (marked X)																																								
	Applicable SMP	Kimberley AMP	Agro-Rowley Terrace AMP	Montebello AMP	Dampier AMP	Carnarvon Canyon AMP	Ningaloo AMP	Gascoyne AMP	Shark Bay Open Ocean (including AMP)	Abrolhos AMP	Jurien AMP	Two Rocks AMP	Perth Canyon AMP	Geographe AMP	South-west Corner AMP	Ashmore Reef and AMP	Seringapatam Reef	Scott Reef (North and South)	Mermaid Reef and AMP	Clerke Reef and State Marine Park	Imperieuse Reef and State Marine Park	Rankin Bank	Glomar Shoals	Rowley Shoals (including Sate Maine Park)	Fantome Shoal	Adele Island	Lacepede Islands	Montebello Islands (including State Marine Park)	Lowendal Islands (including State Nature Reserves)	Barrow Island (including State Nature Reserves, State Marine Park and Marine Management Area)	Muiron Islands (WHA, Marine Management Area)	Pilbara Islands - Southern Island Group (Serrurier, Thevenard and Bessieres Islands - State Nature Reserves)	Pilbara Islands - Northern Island Group (Sandy Island Passage Islands - State nature reserves)	Abrolhos Islands	Kimberley Coast	Dampier Peninsula	Northern Pilbara Shoreline	Ningaloo Coast (North/North West Cape, Middle and South) (WHA, and State Marine Park)	Shark Bay - Open Ocean Coast	Shark Bay (WHA, State Marine Park)	Ngari Capes State Marine Park
Habitat																																									
Water Quality	SM01	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Marine Sediment Quality	SM02	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Coral Reef	SM03	X		X												X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	
Seagrass / Macro-Algae	SM03	X									X					X	X	X									X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Deeper Water Filter Feeders	SM03	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						X							X			
Mangroves and Saltmarsh	SM04																											X						X	X	X	X	X		X	
Species																																									
Sea Birds and Migratory Shorebirds (significant colonies / staging sites / coastal wetlands)	SM05	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Marine Turtles (significant nesting beaches)	SM06	X	X	X	X		X	X	X							X	X	X	X	X	X						X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Pinnipeds (significant colonies / haul-out sites)	SM07									X	X	X			X																										X
Cetaceans - Migratory Whales	SM08	X	X	X	X		X	X	X	X	X	X	X	X	X			X									X	X	X	X	X			X	X	X		X		X	X
Oceanic and Coastal Cetaceans	SM08	X	X	X	X		X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Dugongs	SM08	X							X							X												X	X	X	X	X	X		X	X	X	X	X	X	
Sea Snakes	SM08	X		X	X			X	X	X						X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Whale Sharks	SM08			X			X	X										X										X	X	X	X							X			
Other Shark and Ray Populations	SM08, SM09	X	X	X	X		X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fish Assemblages	SM09	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Socio-economic																																									
Fisheries - Commercial	SM10		X	X	X	X	X	X	X	X	X	X										X	X	X	X			X	X	X		X	X	X	X	X	X	X	X	X	X
Fisheries - Traditional	SM10															X	X	X									X													X	
Tourism (incl. recreational fishing)	SM10	X		X			X	X	X		X			X	X	X	X	X	X	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X

Receptor areas identified as Pre-emptive Baseline Areas (based on criteria of surface contact and/or entrained hydrocarbon contact ≤10 days (Offshore Australian Marine Parks contacted by hydrocarbons in this timeframe also noted)

Receptor areas identified as Pre-Emptive Basline Areas in the response phase >10 days (based on criteria of surface contact and/or entrained hydrocarbon contact >10 days)

Receptor areas that may be identified as impact or reference sites in the event of major hydrocarbon release and would be identified as part of the SMP planning process

Table D-2: Baseline studies for the SMPs applicable to identified pre-emptive baseline areas for the petroleum activities program

Major Baseline	Proposed Scientific monitoring operational plan and Methodology	Ningaloo and Muiron Islands	Montebello AMP
Benthic Habitat (Coral Reef)	**SM03**	**Studies:**	
	Quantitative assessment using image capture using either diver held camera or towed video. Post analysis into broad groups based on taxonomy and morphology.	1. AIMS/BCA 2014 Baseline Ningaloo and Muiron Islands Survey – repeat and expansion on the LTM (Co-funded survey: Woodside and AIMS). 2. AIMS Long Term Monitoring (LTM) Ningaloo Reef programme: 1995 and 2002. 3. DBCA LTM Ningaloo Reef programme: 1991, 1994, 1998, 1999, 2001, 2005, 2006, 2010, 2011, 2012 and 2015 *DBCA Unpublished Data – Reffer to Data request TAB (DRIMS# 9072896) 4. (WAMSI LTM Study:) Ningaloo Research node: 2009 -10 over the lenth of Ningaloo reef system (with a focus on coral and fish recruitment) 5. Ningaloo Outlook (CSIRO) - Shallow and Deep Reefs Program (2015) 6. Ningaloo Collaboration Cluster: Habitats of the Ningaloo Reef and adjacent coastal areas determined through hyperspectral imagery 7. Australian Institute of Marine Science – CReefs: Ningaloo Reef Biodiversity Expeditions (2008-2010). 8. Le Nohaic et al. 2017.Marine heatwave causes unprecedented Regional Mass Bleaching in NW Australia Coral Bay Location)	Coral Reefs & Filter Feeders 1. Montebello Marine Park, 2019, Identification and qualitative descriptions of benthic habitat. 2. Montebello Australian Marine Parks – 2019 – Baseline survey on benthic habitats. 3. Pluto Trunkline within Montebello Marine Park – Monitoring marine communities.
			Methods:
		1. LTM sites, transects, diver based video quadrat. 2. LTM transects, diver based (video) photo quadrat. 3. Video point intercept transects recorded by towed video or diver hand-held video camera. 4. Video transects. 5. LTM transects, diver based (video) photo quadrat. 6. LTM transects, diver based (video) photo quadrat. 7. LTM transects, diver based (video) photo quadrats, specimen collection 8. Intertidal walks and snorkelling transects with photo quadrats,. In situ water temperature loggers deployed for survey period.	1.ROV Transects 2. Benthic habitat mapping, multibeam acoustic swathing. 3. ROV video.
			References and Data:
		1. AIMS 2014. DATAHOLDER: AIMS. 2. AIMS unpublished data. DATAHOLDER: AIMS. 3. DBCA unpublished data. DATAHOLDER: DBCA 4. Depczynski et al. 2011. DATAHOLDER: AIMS, DBCA and WAMSI. 5. CSIRO 2015. Damian Thompson (shallow reefs) and Russell Babcock (Deep reefs) 6. Murdoch University - Kobryn et al 2011 and Keulen and Langdon 2011. 7. AIMS (2010) - http://www.aims.gov.au/creefs 8. Verna Shoepf at UWA and Western Australian Marine Science Institution, Perth,email: [redacted])	1. Advisian 2019 2. Keesing 2019 3. McLean et al. 2019

Major Baseline	Proposed Scientific monitoring operational plan and Methodology	Ningaloo and Muiron Islands	Montebello AMP
Benthic Habitat (Seagrass and Macro-algae)	**SM03** Quantitative assessment using image capture using either diver held camera or towed video. Post analysis into broad groups based on taxonomy and morphology.		**Studies:**
		1. Quantitative descriptions of Ningaloo sanctuary zones habitats types including lagoon and offshore areas – Cassata and Collins (2008). 2. CSIRO/BHP Ningaloo Outlook Program 3. Ningaloo Collaboration Cluster: Habitats of the Ningaloo Reef and adjacent coastal areas determined through hyperspectral imagery. 4. Australian Institute of Marine Science – CReefs: Ningaloo Reef Biodiversity Expeditions (2008-2010).	N/A – see Table D-1
			Methods:
		1. Video transects to ground truth aerial photographs and satellite imagery. 2. Diver video transects 3. LTM transects, diver based (video) photo quadrat. 4. LTM transects, diver based (video) photo quadrats, specimen collection	N/A – see Table D-1
			References and Data:
		1. Cassata and Collins 2008. DATAHOLDER: Curtin University – Applied Geology. 2. CSIRO Damian Thompson - [redacted] 3. Murdoch University - Kobryn et al 2011 and Keulen and Langdon 2011. 4. AIMS (2010) - http://www.aims.gov.au/creefs	N/A – see Table D-1
Benthic Habitat (Deeper Water Filter Feeders)	**SM03** Quantitative assessment using image capture using towed video. Post analysis into broad groups based on taxonomy and morphology.		**Studies:**
		1. WAMSI 2007 deep-water Ningaloo benthic communities study, Colquhoun and Heyward (2008). 2. CSIRO/BHP Ningaloo Outlook Program - Deep reef themes	See SM01
			Methods:
		1. Towed video and benthic sled (specimen sampling). 2. Sidescan sonar and AUV transects	See SM01
			References and Data:
		1. Colquhoun and Heyward (eds) 2008.DATAHOLDER: WAMSI, AIMS. 2. Russell Babcock (Deep reefs) - [redacted]	See SM01
Mangroves and Saltmarsh	**SM04** Aerial photography and satellite imagery will be used in conjunction with field surveys to map the range and distribution of mangrove communities.		**Studies:**
		1. Woodside Sentinel Imagery – May 2017. EOMAP atmospheric correction and mangrove and land cover classification 2. Woodside hold Rapid Eye imagery of the Ningaloo Reef and coastal area. 3. Hyperspectral survey (2006) of Ningaloo Reef and coastal area (not yet analysed for Mangroves). 4. North West Cape sensitivity mapping 2012 included Mangrove Bay. 5. Global mangrove distribution as mapped by the USGS and located on UNEP's Ocean Data viewer	N/A – see Table D-1
			Methods:

Major Baseline	Proposed Scientific monitoring operational plan and Methodology	Ningaloo and Muiron Islands	Montebello AMP
		1. Sentinel HR imagery of coastal margin from the Abrolhos Islands to Dampier Archipelago (including Montebellos) 2. Rapid Eye imagery – High resolution satellite imagery from October/November/December 2011. 3. Remote sensing – acquisition of HyMap airborne hyperspectral imagery and ground truthing data collection. 4. Reconnaissance surveys of the shorelines of the North West Cape and Muiron Islands. 5. Remote sensing study of global mangrove coverage	N/A – see Table D-1
			References and Data:
		1. EOMPA, 2017 DATAHOLDER: Woodside 2. AAM 2014. DATAHOLDER: Woodside. 3. Kobryn et al. 2013. DATAHOLDER: Murdoch University, AIMS; Woodside. 4. Joint Carnarvon Basin Operators, 2012. DATAHOLDER: Woodside Apache Energy Ltd. 5. http://data.unep-wcmc.org/	N/A – see Table D-1
Seabirds	**SM05** Visual counts of breeding seabirds, nest counts, intertidal bird counts at high tide.	**Studies:**	
		1. LTM Study of marine and shoreline birds: 1970-2011. 2. LTM of shorebirds within the Ningaloo coastaline (Shorebirds 2020). Available thourgh Birdlife 3. Exmouth Sub-basin Marine Avifauna Monitoring Program (Quadrant Energy/Santos) 4. Integrated Shearwater Monitoring Program (1994-2016). 5. Seabird and Shorebird baseline studies, Nignaloo Region – Report on January 2018 bird surveys 6.FieldReport – Wedge-tailed shearwater foraging behaviour in the Exmouth Region	Present, in open water, no breeding habitat.
		Methods:	
		1. Counts of nesting areas, counts of intertidal zone during high tide. 2. The Shorebirds 2020 database comprises the most complete shorebird count data available in Australia. The data have been collected by volunteer counters and BirdLife Australia staff for approximately 150 roosting and feeding sites, mainly in coastal Australia. The data go back as far as 1981 for key areas. 3. The Exmouth Sub-basin Marine Avifauna Monitoring Program undertook a detailed assessment of seabird and shorebird use in the Exmouth Sub-basin. Four aerial surveys and four island surveys were conducted between February 2013 and January 2015 for this Program, inclusive of the mainland coasts, offshore islands and a 2500km2 area of ocean adjacent to the Exmouth Sub-basin 4. Airlie and Serrurier islands, with Abutilon and Parakeelyaislands (Lowendal Island group) added in 2014 6. Shorebird counts, Shearwater Burrow Density	N/A
			References and Data:

Major Baseline	Proposed Scientific monitoring operational plan and Methodology	Ningaloo and Muiron Islands	Montebello AMP
		1. Johnstone et al. 2013. DATAHOLDER: WA MUSEUM. AMOSC/DBCA (DPaW)2014. 2. .BirdLife Australia Shorebirds 2020 programme (http://www.birdlife.org.au/projects/shorebirds-2020). 3. Santos (Libby Howitt) - Report 4. Santos 5. BirdLife Asutralia: Dataholder http://dmslink/?dmsn=140066986 6. UWA Dataholder http://dmslink/?dmsn=1400970436	N/A
Turtles	**SM06** Beach surveys (recording species, nests, and false crawls).	**Studies:**	
		1. Ningaloo LTM turtle program was established in 2002, with the most recent survey during the 2014-2015 season. The primary aim is to predict long-term trends in marine turtle populations along Ningaloo coast. 2. Exmouth Islands Turtle Monitoring Program 3. Ningaloo Turtle Program Annual Report 2016-2017 4. Turtle activity and nesting on the Muiron Islands and Nignaloo Caost (2018) 5. Field Report: Saptial and temporal ise of inter-nesting haitat by sea turtles along the Murions Islands and Ningaloo Coast (2018)	Present, in open water, no nesting habitats.
		Methods:	
		1. Beach surveys, track counts, best location, mortality counts. 2. was undertaken by Astron (on behalf of Santos) to address a gap in the knowledge of turtle numbers at key locations (offshore islands within the region) that are not currently part of an existing monitoring programs (e.g. the NTP). Field surveys were conducted in October 2013 and January 2014. Surveys were conducted on 12 islands, with each island surveyed once (with the exception of Beach 8 at North Muiron Island) and all tracks counted. 3. Long term trends in marine turtle populations, nesting levels, nesting success rates 4. onbeach monitoring and aerial surveys 5.Tagging	N/A
		References/Data:	
		1. Markovina, K, 2015. DATAHOLDERS: DBCA. Reports availabile at (http://www.ningalooturtles.org.au/media_reports.html) 2. Santos (Libby Howitt) - Report (http://dmslink/link/link.aspx?dmsn=1400394545) 3. Woodside (Author Keely Markovina) (http://dmslink/link/link.aspx?dmsn=1400385285) 4.DBCA DataHolder 5.DBCA Dataholder	N/A
Fish	**SM09**	**Studies:**	

Major Baseline	Proposed Scientific monitoring operational plan and Methodology	Ningaloo and Muiron Islands	Montebello AMP
	Baited Remote Underwater Video Stations (BRUVS), Visual Underwater Counts (VUC), Diver Operated Video (DOV).	1. AIMS/DBCA 2014 Baseline Ningaloo Survey – repeat and expansion on the LTM (Co-funded survey: Woodside and AIMS). 2. Demersal fish populations – baseline assessment (AIMS/WAMSI). 3. DBCA study measured Species Richness, Community Composition, and Target Biomass, through UVC. BRUVS studies determining max N, Species Richness, and Biomass. *DBCA Unpublished Data- Reffer to Data Request TAB. 4. Pilbara Marine Conservation Partnership Stereo BRUVS drps in shallow water (~10m) in 2014 in northern region of the Ningaloo Marine Park, in shallow water (~10m) inside the lagoonal reef of the Ningaloo Marine Park in 2016, in deep water (~40m) across the length of the Ningaloo Marine Park in 2015, in shallow water outside of Ningaloo Reef from Waroora to Jurabi in 2015 and offshore of the Muiron Islands in 2015. 5. Elasmobranch faunal composition of Ningaloo Marine Park. 6. Juvenile fish recruitment surveys at Ningaloo reef. 7. Demersal fish assemblage sampling method comparison 8. Ningaloo Outlook (CSIRO) - Shalllow and Deep Reefs Program	1. CSIRO – Fish Diversity. 2. Fish species richness and abundance.
			Methods:
		1. UVC surveys. 2. BRUVS Study with 304 video samples at three specific depth ranges (1-10 m, 10-30 m and 30-110m). 3. UVC surveys. 4. Stereo BRUVS 5. Snorkel and Scuba surveys. 6. Underwater visual census. 7. Diver operated video. 8. Diver UVS	1. Semi V Wing trawl net or an epibenthic sled. 2. ROV Video.
			References/Data:
		1. AIMS 2014. DATAHOLDER: AIMS/Woodside. 2. Fitzpatrick et al. 2012. DATAHOLDERS: WAMSI, AIMS. Contacts: Mat Vanderklift, Rick Stuart Smith, and Tom Holmes. 3. DBCA unpublished data. DATAHOLDER: DBCA/AIMS. 4. CSIRO Data DATAHOLDER: CSIRO Data Centre ([redacted]) 5. Stevens, J.D., :ast, P.R., White, W.T., McAuley, R.B., Meekan, M.G. 2009. 6. WAMSI unpublished data DATAHOLDER: AIMS ([redacted]) 7. WAMSI DATAHOLDER: Ben Fitzpatrick ([redacted]) 8. CSIRO 2015. Damian Thompson (shallow reefs) and Russell Babcock (Deep reefs). [redacted] and [redacted]	1. Keesing 2019. 2. McLean et al. 2019.

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ANNEX E: TACTICAL RESPONSE PLANS

TACTICAL RESPONSE PLANS
Exmouth
Mangrove Bay
Turquoise Bay
Yardie Creek
Muiron Islands
Jurabi to Lighthouse Beaches Exmouth
Ningaloo Reef - Refer to Mangrove/Turquoise bay and Yardie Creek
Exmouth Gulf
Shark Bay Area 1: Carnarvon to Wooramel
Shark Bay Area 2: Wooramel to Petite Point
Shark Bay Area 3: Petite Point to Dubaut Point
Shark Bay Area 4: Dubaut Point to Herald Bight
Shark Bay Area 5: Herald Bight to Eagle Bluff
Shark Bay Area 6: Eagle Bluff to Useless Loop
Shark Bay Area 7: Useless Loop to Cape Bellefin
Shark Bay Area 8: Cape Bellefin to Steep Point
Shark Bay Area 9: Western Shores of Edel Land
Shark Bay Area 10: Dirk Hartog Island
Shark Bay Area 11: Bernier and Dorre Islands
Abrohlos Islands: Pelseart Group
Abrohlos Islands: Wallabi Group
Abrohlos Islands: Easter Group
Dampier
Rankin Bank and Glomar Shoals
Barrow and Lowendal Islands
Pilbara Islands - Southern Island Group
Montebello Is - Stephenson Channel Nth
Montebello Is Champagne Bay and Chippendale channel
Montebello Is - Claret Bay
Montebello Is - Hermite/Delta Is Channel
Montebello Is - Hock Bay
Montebello Is - North and Kelvin Channel
Montebello Is - Sherry Lagoon Entrance
Withnell Bay
Holden Bay
King Bay
No Name Bay / No Name Beach
Enderby Is -Dampier
Rosemary Island - Dampier
Legendre Is - Dampier

Karratha Gas Plant
KGP to Whitnell Creek
KGP to Northern Shore
KGP Fire Pond and Estuary
KGP to No Name Creek
Broome
Sahul Shelf Submerged Banks and Shoals
Clerke Reef (Rowley Shoals)
Imperieuse Island (Rowley Shoals)
Mermaid Reef (Rowley Shoals)
Scott Reef
Oiled Wildlife Response
Exmouth
Dampier region
Shark Bay

APPENDIX E NOPSEMA REPORTING FORMS

NOPSEMA Recordable Environmental Incident monthly Reporting Form
https://www.nopsema.gov.au/assets/Forms/A198750.doc

Report of an accident, dangerous occurrence or environmental incident
https://www.nopsema.gov.au/assets/Forms/N-03000-FM0831-Report-of-an-Accident-Dangerous-Occurrence-or-Environmental-Incident-Rev-8-Jan-2015-MS-Word-2010.docx

APPENDIX F STAKEHOLDER CONSULTATION

Scarborough 4D B1 Marine Seismic Survey Environment Plan

Date: 27 August 2021

Revision: 0

TABLE OF CONTENTS

1. Consultation

1.1 Woodside Consultation Information Sheet (sent to all relevant stakeholders)

Woodside

STAKEHOLDER CONSULTATION

INFORMATION SHEET

May 2021

SCARBOROUGH 4D BASELINE MARINE SEISMIC SURVEY

NORTHERN CARNARVON BASIN

Woodside is planning to conduct a 4D baseline marine seismic survey (MSS) over the Scarborough field within Commonwealth waters, located in the Exmouth Plateau, approximately 214 km north west of Exmouth, Western Australia. The proposed activity is planned to commence in Q3 2022 for a period of between 55 and 70 days, pending approvals, final survey dimensions, vessel availability and weather constraints.

The proposed survey will be conducted over areas where the Scarborough Joint Venture has previously acquired seismic data. The objective for the proposed activity is to acquire a new 3D seismic survey that will provide the baseline for future 'time lapse' reservoir surveillance (or technically termed 4D baseline survey) over the Scarborough, North Scarborough and possibly the Jupiter gas fields (located within Petroleum Titles WA-61-L, WA-62-L & WA-61-R).

Woodside is Operator of the various joint ventures relating to the Scarborough, North Scarborough, Thebe and Jupiter fields, which comprise both Woodside and BHP (North West Shelf) Pty Ltd ("BHP"). Current equity participation of the joint venture is as described in the below table.

Gas Fields	Woodside Interest	BHP Interest
Scarborough (WA-61-L)	73.5%	26.5%
North Scarborough (WA-62-L)	73.5%	26.5%
Thebe (WA-63-R)	50%	50%
Jupiter (WA-61-R)	50%	50%

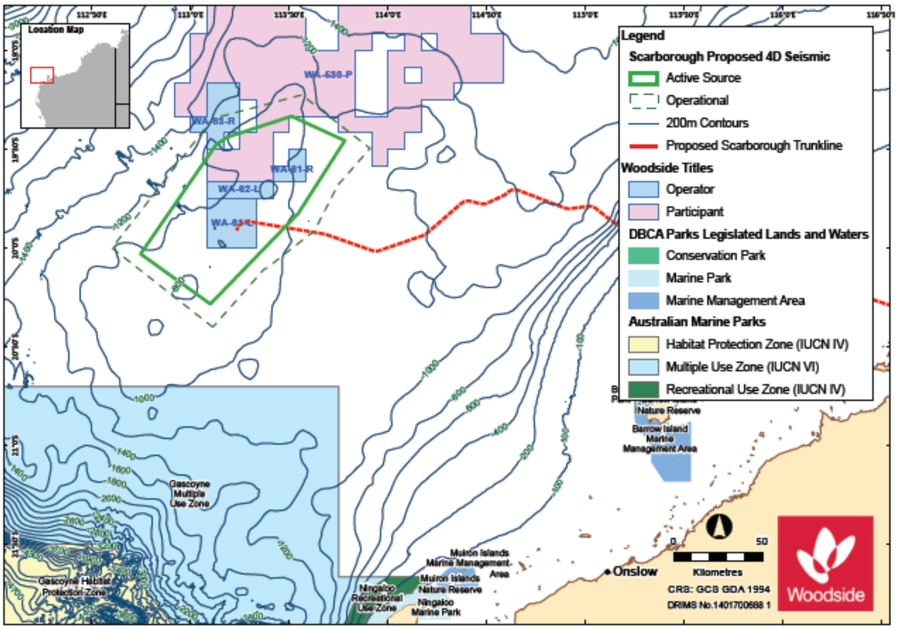


Figure 1. Proposed Scarborough 4D Baseline MSS Active Source and Operational Area

1 Scarborough 4D Baseline Marine Seismic Survey Northern Carnarvon Basin | May 2021

About Marine Seismic Surveys

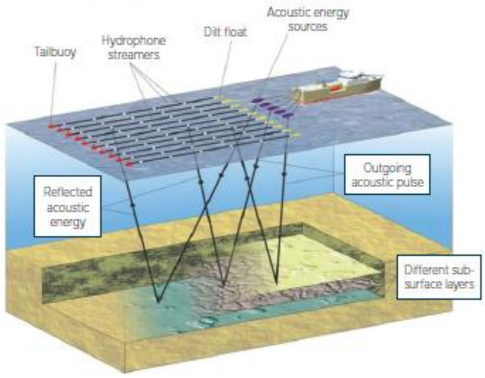
During planned activities, a seismic vessel traverses a series of pre-determined sail lines within the survey Active Source Area at a speed of approximately three to five knots (5.5 – 9.3 km/hr).

An additional buffer area, or Operational Area, around the Active Source Area is allowed for vessel manoeuvring and line turns. No discharge of the seismic source will occur in this Operational Area. Testing of the seismic source, 'soft starts', and all other operations of the seismic source during seismic lines including 'run ins' and 'run outs' will all be undertaken within the Active Source Area.

As the vessel travels along a sail line series, seismic air sources discharge compressed air to generate acoustic pulses approximately every 2 to 10 seconds.

These acoustic pulses are directed vertically through the water column and into the seabed. The released energy is reflected at geological boundaries, with the reflected signals detected by sensitive microphones called 'hydrophones, geophones or MEMS', embedded within cables, or streamers, towed directly behind the seismic vessel.

The reflected sound is recorded and then processed to generate a seismic image, providing information about the structure and composition of geological formations and the associated sedimentary properties below the seabed.



Proposed Activity

Table 1 – Activity summary

Activity	Details
Earliest commencement date	Q3 2022
Estimated duration	55 – 70 days
Active Source Area	-5,650 km²
Operational Area	-9,200 km²
Water depth in Operational Area	Approximately 800 m – 1150 m
Last acquired data	2004
Vessels	A purpose-built seismic vessel, one support vessel and a potential chase vessel
Distance from Active Source Area to nearest port/marina	214 km north-west of Exmouth
Distance from Active Source Area to nearest marine park	46 km north of Gascoyne Marine Park Multiple Use Zone

The proposed survey will be conducted by a purpose-built seismic survey vessel. The proposed marine seismic survey is typical of seismic surveys conducted in Australian marine waters, in terms of technical methods and procedures.

Woodside is proposing to acquire a 3D seismic survey to be used as a future 4D baseline within the Active Source Area. This involves the use of an acoustic source array (dual or triple) and multiple streamers towed behind the survey vessel. Woodside is also considering using a small fleet of autonomous ocean bottom seismic nodes (AUV nodes) that will also record the reflected energy over a localised area.

Seismic nodes have been widely used since the mid-2000s using remotely operated vehicles operated from a support vessel for node placement and retrieval from the seabed. However, advances in autonomous technology mean that the nodes will be able to self-reposition. The autonomous devices will make minimal noise when moving between locations and will have negligible disturbance to the seabed when positioning.

An additional support vessel will accompany the seismic vessel for assistance in the form of emergency tow as required and to re-supply the survey vessel with fuel and other logistical and operational supplies An additional chase vessel may be used to manage interactions with other marine users in the vicinity of the survey if required. Survey activities will take place 24 hrs per day.

Technical details are outlined in Table 2.

Table 2 – Technical overview

Activity	Details
Number of streamers	Up to 14
Each streamer length	- 8 km
Distance between streamers	between 50 to 100 m
Maximum width of streamer array	-up to 1.5 km
Safe navigation area (cautionary zone)	Three nautical mile radius safe navigation area around the seismic vessel, streamers and tail buoys during seismic operations
Streamer tow depth	-15 m to 20 m

Table 4 – Summary of key risks and/or impacts and management measures

Potential Risk and/or Impact	Mitigation and/or Management Measure
Planned activities	
Interests of relevant stakeholders with respect to: • Defence activities • Petroleum activities • Commercial fishing activities • Shipping activities • Infrastructure activities	• Consultation with petroleum titleholders, commercial fishers and their representative organisations, and government departments and agencies to inform decision making for the proposed activity and development of the EP. • Advice to relevant stakeholders prior to the commencement of activities. • Ongoing consultation by way of updates on vessel movements during survey activities at a frequency to meet relevant stakeholder needs.
Marine discharges	• All routine marine discharges will be managed according to legislative and regulatory requirements and Woodside's Environmental Performance Standards.
Underwater noise	• Implementation of *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Policy Statement 2.1. • Noise modelling to inform potential impacts and input to mitigation and management measures.
Vessel interaction	• Woodside will notify relevant fishery stakeholders and Government maritime safety agencies of specific start and end dates, specific vessel-on-location dates, and any exclusion zones prior to commencement of the activity. • A three nautical mile radius safe navigation area will be in place around the seismic vessel and streamers during seismic operations. • The seismic vessel will display appropriate day shapes and lights to indicate the vessel is towing and is therefore restricted in its ability to manoeuvre. • The streamers will tow surface tail buoys fitted with safe navigation devices • A visual and radar watch will be maintained on the project vessel bridge at all times. • A support vessel and a potential chase vessel will be on standby to direct any shipping traffic or commercial fishing vessels away from the seismic vessel and its towed equipment.
Waste management	• Waste generated on the vessels will be managed in accordance with legislative requirements and a Waste Management Plan. • Wastes will be managed and disposed of in a safe and environmentally responsible manner that prevents accidental loss to the environment. • Wastes transported onshore will be sent to appropriate recycling or disposal facilities by a licensed waste contractor.
Unplanned activities	
Hydrocarbon release	• Appropriate spill response plans, equipment and materials will be in place and maintained. • Appropriate refuelling procedures and equipment will be used to prevent spills to the marine environment.
Introduction of invasive marine species	• All vessels will be assessed and managed as appropriate to prevent the introduction of invasive marine species. • Compliance with Australian biosecurity requirements and guidance. • Contracted vessels comply with Australian ballast water requirements.
Marine fauna interactions	• Measures will be taken to protect marine fauna and ecosystems from vessel activities and to prevent vessel collisions and groundings. • Maintaining dedicated marine fauna observers throughout the survey. • All marine fauna sightings are recorded and reported to the Department of Agriculture, Water and the Environment.

Providing Feedback

Our intent is to minimise environmental and social impacts associated with the proposed activities, and we are seeking any interest or comments you may have to inform our decision making. If you would like to comment on the proposed activities outlined in this information sheet, or would like additional information, please contact Woodside before 14 June 2021.

Please note that your feedback and our response will be included in our Environment Plan for the proposed activity, which will be submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

Please let us know if your feedback for this activity is sensitive and we will make this known to NOPSEMA upon submission of the Environment Plan for this information to remain confidential to NOPSEMA.

Ryan Felton, Senior Corporate Affairs Adviser Woodside Energy Ltd

E: Feedback@woodside.com.au | Toll free: 1800 442 977

Please note that stakeholder feedback will be communicated to NOPSEMA as required under legislation. Woodside will communicate any material changes to the proposed activity to affected stakeholders as they arise.

Woodside

www.woodside.com.au

Activity	Details
Sound source size	~3,150 in^3

Communications with mariners

A temporary three nautical mile radius safe navigation area will be maintained around the seismic vessel and towed array during seismic operations. Marine users are requested to avoid this area during the survey to ensure the safety of the seismic vessel and third-party vessels.

The seismic vessel will be actively acquiring seismic data within the Operational Area determined for these activities. Marine notices will be issued prior to the start of work to alert vessels that maybe operating in waters nearby and that access to these areas may be limited.

Woodside will provide updates on vessel movements and their details during the activities in the form of look ahead reports at an appropriate frequency to meet relevant stakeholder needs.

The location of the Active Source Area and Operational Area are outlined in Table 3.

Table 3 – Survey location

Location point	
Latitude	Longitude
Active Source Area	
20°16'59.043"S	113°6'0.387"E
20°1'47.096"S	112°44'50.156"E
19°28'31.503"S	113°7'47.431"E
19°26'15.236"S	113°11'12.497"E
19°19'55.308"S	113°30'40.293"E
19°27'20.645"S	113°46'53.197"E
19°49'26.264"S	113°32'44.0"E
Operational Area	
20°24'2.0"S	113°6'45.162"E
19°59'57.873"S	112°36'7.851"E
19°20'39.38"S	113°6'41.252"E
19°13'25.19"S	113°33'49.172"E
19°29'41.467"S	113°54'32.011"E
19°40'50.544"S	113°44'44.882"E
19°54'42.118"S	113°37'40.185"E
20°6'2.873"S	113°23'11.168"E
20°6'31.786"S	113°22'13.473"E

Implications for Stakeholders

In support of the proposed activities, Woodside will consult relevant stakeholders whose interests, functions and activities may be affected by the proposed activities. We will also keep other stakeholders who have identified an interest informed about our planned activities.

Woodside has undertaken an assessment to identify potential risks to the marine environment and relevant stakeholders, considering timing, duration, location, and potential impacts arising from the Scarborough 4D Baseline Marine Seismic Survey.

A number of mitigation and management measures will be implemented and are summarised below.

Further details will be provided in the EP.

1.2 Email sent to DISER (13 May 2021)

Dear Stakeholder

Woodside is planning to submit an Environment Plan for a marine seismic survey in Commonwealth waters, located in the Exmouth Plateau, approximately 214 km north west of Exmouth, Western Australia.

The activity is planned to commence in Q3 2022 for a period of around 55 to 70 days, pending approvals, final survey dimensions, vessel availability and weather constraints.

An Environment Plan for this activity will be submitted in accordance with the the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

A Consultation Information Sheet is attached, which provides background on the proposed activity, including a summary of potential key risks and associated management measures. The Information Sheet is also available on our website.

Activity:

Summary:	The purpose of the survey is to improve data quality and subsurface imaging within the permit, allowing Woodside to define new and existing leads and assess commerciality of potential hydrocarbon accumulations. The survey is part of Woodside's work program commitments for the permit.
Survey type:	Woodside is proposing to acquire a 3D seismic survey to be used as a future 4D baseline within the Active Source Area. This involves the use of an acoustic source array (triple) and multiple streamers towed behind the survey vessel. Woodside is also considering using a small fleet of autonomous ocean bottom seismic nodes (AUV nodes) that will also record the reflected energy over a localised area.
Location:	214 km north-west of Exmouth; Latitude 20°16'59.043", Longitude 113°6'0.387"E
Approximate Water Depth (m):	800 m – 1150 m
Schedule:	Around Q3 2022
Duration:	Around 55 days - 70 days
Vessels:	A purpose-built seismic vessel, one support vessel and a potential chase vessel
Safe navigation zone (cautionary area)	Three nautical mile radius safe navigation area around the seismic vessel and streamers during seismic operations. Marine users are requested to avoid this area during the survey to ensure the safety of the seismic vessel and third-party vessels.

Survey location:
The location of the Active Source Area and Operational Area are outlined in the attached Consultation Information Sheet.

Feedback:
If you have any issues or concerns with these activities, or any other issues relevant to this location then please respond to Woodside at Feedback@woodside.com.au or 1800 442 977.

Your feedback and our response will be included in our Environment Plans, which will be submitted to submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

Please let us know if your feedback for this activity is sensitive and we will make this known to NOPSEMA upon submission of the Environment Plan in order for this information to remain confidential to NOPSEMA.

Please provide your views by 14 June 2021.

Regards
Corporate Affairs Adviser | North West

1.3 Email sent to ABF (13 May 2021)

Dear Stakeholder

Woodside is planning to submit an Environment Plan for a marine seismic survey in Commonwealth waters, located in the Exmouth Plateau, approximately 214 km north west of Exmouth, Western Australia.

The activity is planned to commence in Q3 2022 for a period of around 55 to 70 days, pending approvals, final survey dimensions, vessel availability and weather constraints.

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Please let us know if your feedback for this activity is sensitive and we will make this known to NOPSEMA upon submission of the Environment Plan in order for this information to remain confidential to NOPSEMA.

Please provide your views by 14 June 2021.
Regards
Corporate Affairs Adviser | North West

1.4 Email sent to DMIRS (13 May 2021)

Dear Stakeholder

Woodside is planning to submit an Environment Plan for a marine seismic survey in Commonwealth waters, located in the Exmouth Plateau, approximately 214 km north west of Exmouth, Western Australia.

The activity is planned to commence in Q3 2022 for a period of around 55 to 70 days, pending approvals, final survey dimensions, vessel availability and weather constraints.

An Environment Plan for this activity will be submitted in accordance with the the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

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Survey location:

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Please provide your views by 14 June 2021.

Regards
Corporate Affairs Adviser | North West

1.5 Email sent to DoT (13 May 2021)

Dear Stakeholder

Woodside is planning to submit an Environment Plan for a marine seismic survey in Commonwealth waters, located in the Exmouth Plateau, approximately 214 km north west of Exmouth, Western Australia.

The activity is planned to commence in Q3 2022 for a period of around 55 to 70 days, pending approvals, final survey dimensions, vessel availability and weather constraints.

An Environment Plan for this activity will be submitted in accordance with the the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

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Survey location:

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Feedback:

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Please let us know if your feedback for this activity is sensitive and we will make this known to NOPSEMA upon submission of the Environment Plan in order for this information to remain confidential to NOPSEMA.

Please provide your views by 14 June 2021.
Regards
Corporate Affairs Adviser | North West

1.6 Email sent to DBCA (13 May 2021)

Dear Stakeholder

Woodside is planning to submit an Environment Plan for a marine seismic survey in Commonwealth waters, located in the Exmouth Plateau, approximately 214 km north west of Exmouth, Western Australia.

The activity is planned to commence in Q3 2022 for a period of around 55 to 70 days, pending approvals, final survey dimensions, vessel availability and weather constraints.

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Please let us know if your feedback for this activity is sensitive and we will make this known to NOPSEMA upon submission of the Environment Plan in order for this information to remain confidential to NOPSEMA.

Please provide your views by 14 June 2021.

Regards
Corporate Affairs Adviser | North West

1.7 Email sent to APPEA (13 May 2021)

Dear Stakeholder

Woodside is planning to submit an Environment Plan for a marine seismic survey in Commonwealth waters, located in the Exmouth Plateau, approximately 214 km north west of Exmouth, Western Australia.

The activity is planned to commence in Q3 2022 for a period of around 55 to 70 days, pending approvals, final survey dimensions, vessel availability and weather constraints.

An Environment Plan for this activity will be submitted in accordance with the the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

A Consultation Information Sheet is attached, which provides background on the proposed activity, including a summary of potential key risks and associated management measures. The Information Sheet is also available on our website.

Activity:

Summary:	The purpose of the survey is to improve data quality and subsurface imaging within the permit, allowing Woodside to define new and existing leads and assess commerciality of potential hydrocarbon accumulations. The survey is part of Woodside's work program commitments for the permit.
Survey type:	Woodside is proposing to acquire a 3D seismic survey to be used as a future 4D baseline within the Active Source Area. This involves the use of an acoustic source array (triple) and multiple streamers towed behind the survey vessel. Woodside is also considering using a small fleet of autonomous ocean bottom seismic nodes (AUV nodes) that will also record the reflected energy over a localised area.
Location:	214 km north-west of Exmouth; Latitude 20°16'59.043", Longitude 113°6'0.387"E

Approximate Water Depth (m):	800 m – 1150 m
Schedule:	Around Q3 2022
Duration:	Around 55 days - 70 days
Vessels:	A purpose-built seismic vessel, one support vessel and a potential chase vessel
Safe navigation zone (cautionary area)	Three nautical mile radius safe navigation area around the seismic vessel and streamers during seismic operations. Marine users are requested to avoid this area during the survey to ensure the safety of the seismic vessel and third-party vessels.

Survey location:
The location of the Active Source Area and Operational Area are outlined in the attached Consultation Information Sheet.

Feedback:
If you have any issues or concerns with these activities, or any other issues relevant to this location then please respond to Woodside at Feedback@woodside.com.au or 1800 442 977.

Your feedback and our response will be included in our Environment Plans, which will be submitted to submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

Please let us know if your feedback for this activity is sensitive and we will make this known to NOPSEMA upon submission of the Environment Plan in order for this information to remain confidential to NOPSEMA.

Please provide your views by 14 June 2021.

Regards
Corporate Affairs Adviser | North West

1.8 Email sent to AHO (13 May 2021)

Dear Stakeholder

Woodside is planning to submit an Environment Plan for a marine seismic survey in Commonwealth waters, located in the Exmouth Plateau, approximately 214 km north west of Exmouth, Western Australia.

The activity is planned to commence in Q3 2022 for a period of around 55 to 70 days, pending approvals, final survey dimensions, vessel availability and weather constraints.

An Environment Plan for this activity will be submitted in accordance with the the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

A Consultation Information Sheet is attached, which provides background on the proposed activity, including a summary of potential key risks and associated management measures. The Information Sheet is also available on our website. A map showing vessel density is also attached for reference.

Activity:

Summary:	The purpose of the survey is to improve data quality and subsurface imaging within the permit, allowing Woodside to define new and existing leads and assess commerciality of potential hydrocarbon accumulations. The survey is part of Woodside's work program commitments for the permit.
Survey type:	Woodside is proposing to acquire a 3D seismic survey to be used as a future 4D baseline within the Active Source Area. This involves the use of an acoustic source array (triple) and multiple streamers towed behind the survey vessel. Woodside is also considering using a small fleet of autonomous ocean bottom seismic nodes (AUV nodes) that will also record the reflected energy over a localised area.
Location:	214 km north-west of Exmouth; Latitude 20°16'59.043", Longitude 113°6'0.387"E
Approximate Water Depth (m):	800 m – 1150 m
Schedule:	Around Q3 2022
Duration:	Around 55 days - 70 days
Vessels:	A purpose-built seismic vessel, one support vessel and a potential chase vessel
Safe navigation zone (cautionary area)	Three nautical mile radius safe navigation area around the seismic vessel and streamers during seismic operations. Marine users are requested to avoid this area during the survey to ensure the safety of the seismic vessel and third-party vessels.

Survey location:

The location of the Active Source Area and Operational Area are outlined in the attached Consultation Information Sheet.

Feedback:

If you have any issues or concerns with these activities, or any other issues relevant to this location then please respond to Woodside at Feedback@woodside.com.au or 1800 442 977.

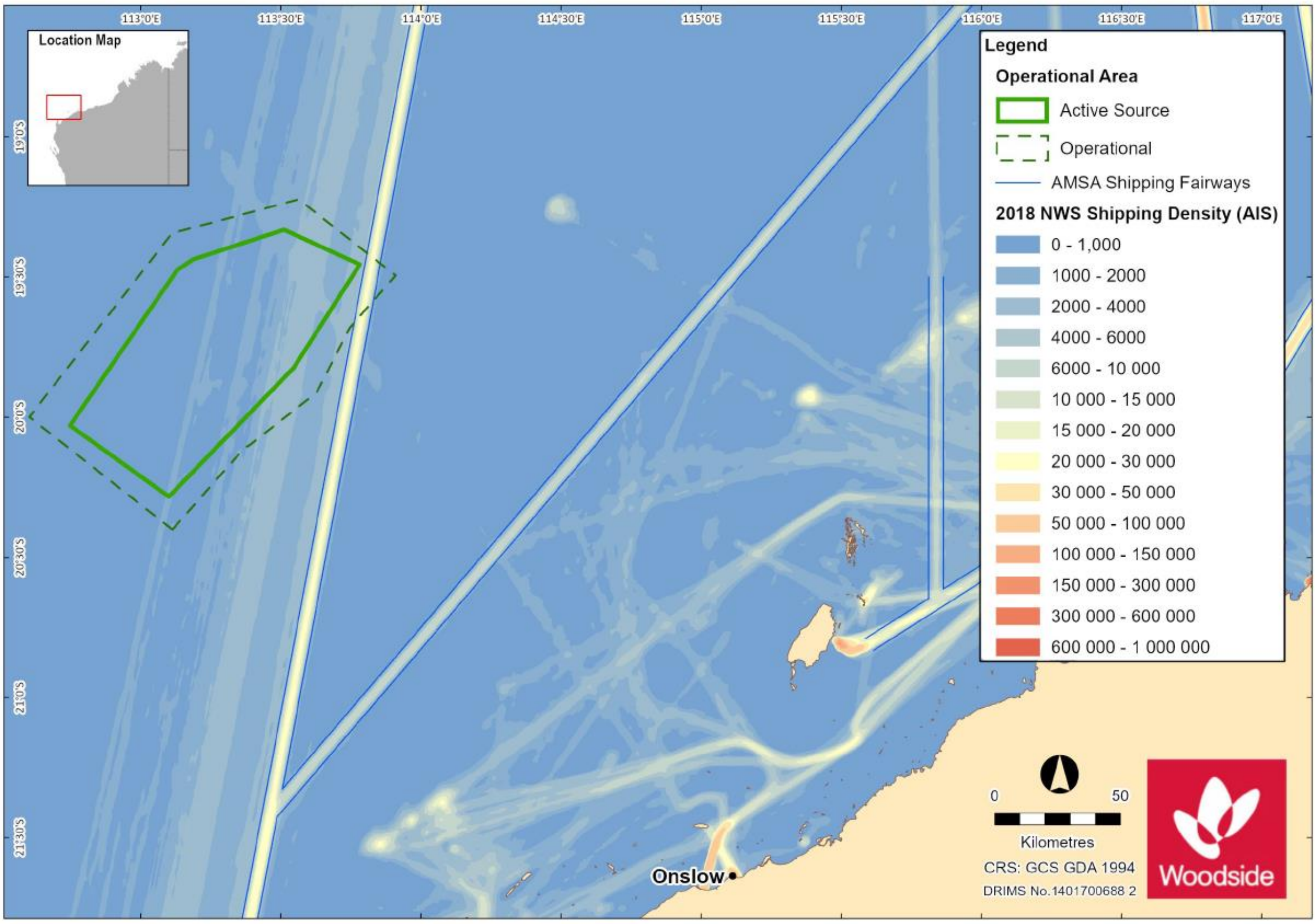
Your feedback and our response will be included in our Environment Plans, which will be submitted to submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

Please let us know if your feedback for this activity is sensitive and we will make this known to NOPSEMA upon submission of the Environment Plan in order for this information to remain confidential to NOPSEMA.

Please provide your views by 14 June 2021.

Regards
Corporate Affairs Adviser | North West

1.9 Shipping lanes map sent to AHO and AMSA (13 May 2021)



1.10 Email sent to Chevron, Western Gas and ExxonMobil (13 May 2021)

Dear Stakeholder

Woodside is planning to submit an Environment Plan for a marine seismic survey in Commonwealth waters, located in the Exmouth Plateau, approximately 214 km north west of Exmouth, Western Australia.

The activity is planned to commence in Q3 2022 for a period of around 55 to 70 days, pending approvals, final survey dimensions, vessel availability and weather constraints.

An Environment Plan for this activity will be submitted in accordance with the the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

A Consultation Information Sheet is attached, which provides background on the proposed activity, including a summary of potential key risks and associated management measures. The Information Sheet is also available on our website. A map showing the proposed activity relevant to adjacent petroleum titles is also attached.

Activity:

Summary:	The purpose of the survey is to improve data quality and subsurface imaging within the permit, allowing Woodside to define new and existing leads and assess commerciality of potential hydrocarbon accumulations. The survey is part of Woodside's work program commitments for the permit.
Survey type:	Woodside is proposing to acquire a 3D seismic survey to be used as a future 4D baseline within the Active Source Area. This involves the use of an acoustic source array (triple) and multiple streamers towed behind the survey vessel. Woodside is also considering using a small fleet of autonomous ocean bottom seismic nodes (AUV nodes) that will also record the reflected energy over a localised area.
Location:	214 km north-west of Exmouth; Latitude 20°16'59.043", Longitude 113°6'0.387"E
Approximate Water Depth (m):	800 m – 1150 m
Schedule:	Around Q3 2022
Duration:	Around 55 days - 70 days
Vessels:	A purpose-built seismic vessel, one support vessel and a potential chase vessel
Safe navigation zone (cautionary area)	Three nautical mile radius safe navigation area around the seismic vessel and streamers during seismic operations. Marine users are requested to avoid this area during the survey to ensure the safety of the seismic vessel and third-party vessels.

Survey location:

The location of the Active Source Area and Operational Area are outlined in the attached Consultation Information Sheet.

Feedback:

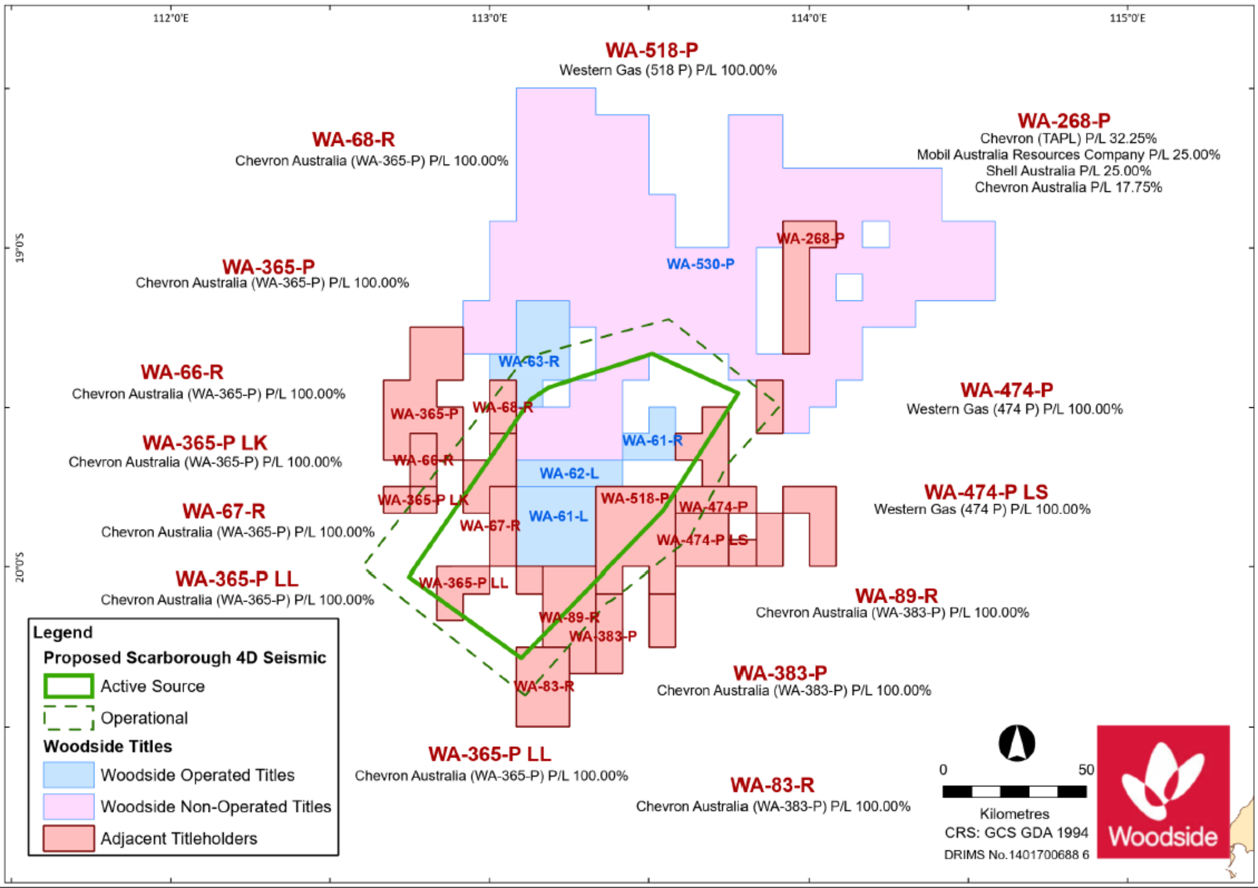
If you have any issues or concerns with these activities, or any other issues relevant to this location then please respond to Woodside at Feedback@woodside.com.au or 1800 442 977.

Your feedback and our response will be included in our Environment Plans, which will be submitted to submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

Please let us know if your feedback for this activity is sensitive and we will make this known to NOPSEMA upon submission of the Environment Plan in order for this information to remain confidential to NOPSEMA.

Please provide your views by 14 June 2021.
Regards
Corporate Affairs Adviser | North West

1.11 Adjacent Titleholders map sent to Chevron, Western Gas, ExxonMobil and Shell (13 May 2021)



1.12 Email sent to Shell (13 May 2021)

Dear [redacted]

Woodside is planning to submit an Environment Plan for a marine seismic survey in Commonwealth waters, located in the Exmouth Plateau, approximately 214 km north west of Exmouth, Western Australia.

The activity is planned to commence in Q3 2022 for a period of around 55 to 70 days, pending approvals, final survey dimensions, vessel availability and weather constraints.

An Environment Plan for this activity will be submitted in accordance with the the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

A Consultation Information Sheet is attached, which provides background on the proposed activity, including a summary of potential key risks and associated management measures. The Information Sheet is also available on our website. A map showing the proposed activity relevant to adjacent petroleum titles is also attached.

Activity:

Summary:	The purpose of the survey is to improve data quality and subsurface imaging within the permit, allowing Woodside to define new and existing leads and assess commerciality of potential hydrocarbon accumulations. The survey is part of Woodside's work program commitments for the permit.
Survey type:	Woodside is proposing to acquire a 3D seismic survey to be used as a future 4D baseline within the Active Source Area. This involves the use of an acoustic source array (triple) and multiple streamers towed behind the survey vessel. Woodside is also considering using a small fleet of autonomous ocean bottom seismic nodes (AUV nodes) that will also record the reflected energy over a localised area.
Location:	214 km north-west of Exmouth; Latitude 20°16'59.043", Longitude 113°6'0.387"E
Approximate Water Depth (m):	800 m – 1150 m
Schedule:	Around Q3 2022
Duration:	Around 55 days - 70 days
Vessels:	A purpose-built seismic vessel, one support vessel and a potential chase vessel
Safe navigation zone (cautionary area)	Three nautical mile radius safe navigation area around the seismic vessel and streamers during seismic operations. Marine users are requested to avoid this area during the survey to ensure the safety of the seismic vessel and third-party vessels.

Survey location:

The location of the Active Source Area and Operational Area are outlined in the attached Consultation Information Sheet.

Feedback:

If you have any issues or concerns with these activities, or any other issues relevant to this location then please respond to Woodside at Feedback@woodside.com.au or 1800 442 977.

Your feedback and our response will be included in our Environment Plans, which will be submitted to submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

Please let us know if your feedback for this activity is sensitive and we will make this known to NOPSEMA upon submission of the Environment Plan in order for this information to remain confidential to NOPSEMA.

Please provide your views by 14 June 2021.
Regards
Corporate Affairs Adviser | North West

1.13 Email sent to AMSA (Maritime Safety) (13 May 2021)

Dear Stakeholder

Woodside is planning to submit an Environment Plan for a marine seismic survey in Commonwealth waters, located in the Exmouth Plateau, approximately 214 km north west of Exmouth, Western Australia.

The activity is planned to commence in Q3 2022 for a period of around 55 to 70 days, pending approvals, final survey dimensions, vessel availability and weather constraints.

An Environment Plan for this activity will be submitted in accordance with the the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

A Consultation Information Sheet is attached, which provides background on the proposed activity, including a summary of potential key risks and associated management measures. The Information Sheet is also available on our website. A map showing vessel density is also attached for reference.

Activity:

Summary:	The purpose of the survey is to improve data quality and subsurface imaging within the permit, allowing Woodside to define new and existing leads and assess commerciality of potential hydrocarbon accumulations. The survey is part of Woodside's work program commitments for the permit.
Survey type:	Woodside is proposing to acquire a 3D seismic survey to be used as a future 4D baseline within the Active Source Area. This involves the use of an acoustic source array (triple) and multiple streamers towed

	behind the survey vessel. Woodside is also considering using a small fleet of autonomous ocean bottom seismic nodes (AUV nodes) that will also record the reflected energy over a localised area.
Location:	214 km north-west of Exmouth; Latitude 20°16'59.043", Longitude 113°6'0.387"E
Approximate Water Depth (m):	800 m – 1150 m
Schedule:	Around Q3 2022
Duration:	Around 55 days - 70 days
Vessels:	A purpose-built seismic vessel, one support vessel and a potential chase vessel
Safe navigation zone (cautionary area)	Three nautical mile radius safe navigation area around the seismic vessel and streamers during seismic operations. Marine users are requested to avoid this area during the survey to ensure the safety of the seismic vessel and third-party vessels.

Survey location:

The location of the Active Source Area and Operational Area are outlined in the attached Consultation Information Sheet.

Feedback:

If you have any issues or concerns with these activities, or any other issues relevant to this location then please respond to Woodside at Feedback@woodside.com.au or 1800 442 977.

Your feedback and our response will be included in our Environment Plans, which will be submitted to submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

Please let us know if your feedback for this activity is sensitive and we will make this known to NOPSEMA upon submission of the Environment Plan in order for this information to remain confidential to NOPSEMA.

Please provide your views by 14 June 2021.
Regards
Corporate Affairs Adviser | North West

1.14 Email sent to AMSA (Marine Pollution) (13 May 2021)

Dear Stakeholder

Woodside is planning to submit an Environment Plan for a marine seismic survey in Commonwealth waters, located in the Exmouth Plateau, approximately 214 km north west of Exmouth, Western Australia.

The activity is planned to commence in Q3 2022 for a period of around 55 to 70 days, pending approvals, final survey dimensions, vessel availability and weather constraints.

An Environment Plan for this activity will be submitted in accordance with the the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

A Consultation Information Sheet is attached, which provides background on the proposed activity, including a summary of potential key risks and associated management measures. The Information Sheet is also available on our website. A map showing vessel density is also attached for reference.

Activity:

Summary:	The purpose of the survey is to improve data quality and subsurface imaging within the permit, allowing Woodside to define new and existing leads and assess commerciality of potential hydrocarbon accumulations. The survey is part of Woodside's work program commitments for the permit.
Survey type:	Woodside is proposing to acquire a 3D seismic survey to be used as a future 4D baseline within the Active Source Area. This involves the use of an acoustic source array (triple) and multiple streamers towed behind the survey vessel. Woodside is also considering using a small fleet of autonomous ocean bottom seismic nodes (AUV nodes) that will also record the reflected energy over a localised area.
Location:	214 km north-west of Exmouth; Latitude 20°16'59.043", Longitude 113°6'0.387"E
Approximate Water Depth (m):	800 m – 1150 m
Schedule:	Around Q3 2022
Duration:	Around 55 days - 70 days
Vessels:	A purpose-built seismic vessel, one support vessel and a potential chase vessel
Safe navigation zone (cautionary area)	Three nautical mile radius safe navigation area around the seismic vessel and streamers during seismic operations. Marine users are requested to avoid this area during the survey to ensure the safety of the seismic vessel and third-party vessels.

Survey location:

The location of the Active Source Area and Operational Area are outlined in the attached Consultation Information Sheet.

Feedback:

If you have any issues or concerns with these activities, or any other issues relevant to this location then please respond to Woodside at Feedback@woodside.com.au or 1800 442 977.

Your feedback and our response will be included in our Environment Plans, which will be submitted to submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

Please let us know if your feedback for this activity is sensitive and we will make this known to NOPSEMA upon submission of the Environment Plan in order for this information to remain confidential to NOPSEMA.

Please provide your views by 14 June 2021.

Regards
Corporate Affairs Adviser | North West

1.15 Email sent to DoD (13 May 2021)

Dear Stakeholder

Woodside is planning to submit an Environment Plan for a marine seismic survey in Commonwealth waters, located in the Exmouth Plateau, approximately 214 km north west of Exmouth, Western Australia.

The activity is planned to commence in Q3 2022 for a period of around 55 to 70 days, pending approvals, final survey dimensions, vessel availability and weather constraints.

An Environment Plan for this activity will be submitted in accordance with the the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

A Consultation Information Sheet is attached, which provides background on the proposed activity, including a summary of potential key risks and associated management measures. The Information Sheet is also available on our website. A map of practice and training defence areas is also attached.

Activity:

Summary:	The purpose of the survey is to improve data quality and subsurface imaging within the permit, allowing Woodside to define new and existing leads and assess commerciality of potential hydrocarbon accumulations. The survey is part of Woodside's work program commitments for the permit.
Survey type:	Woodside is proposing to acquire a 3D seismic survey to be used as a future 4D baseline within the Active Source Area. This involves the use of an acoustic source array (triple) and multiple streamers towed behind the survey vessel. Woodside is also considering using a small fleet of autonomous ocean bottom seismic nodes (AUV nodes) that will also record the reflected energy over a localised area.

Location:	214 km north-west of Exmouth; Latitude 20°16'59.043", Longitude 113°6'0.387"E
Approximate Water Depth (m):	800 m – 1150 m
Schedule:	Around Q3 2022
Duration:	Around 55 days - 70 days
Vessels:	A purpose-built seismic vessel, one support vessel and a potential chase vessel
Safe navigation zone (cautionary area)	Three nautical mile radius safe navigation area around the seismic vessel and streamers during seismic operations. Marine users are requested to avoid this area during the survey to ensure the safety of the seismic vessel and third-party vessels.

Survey location:
The location of the Active Source Area and Operational Area are outlined in the attached Consultation Information Sheet.

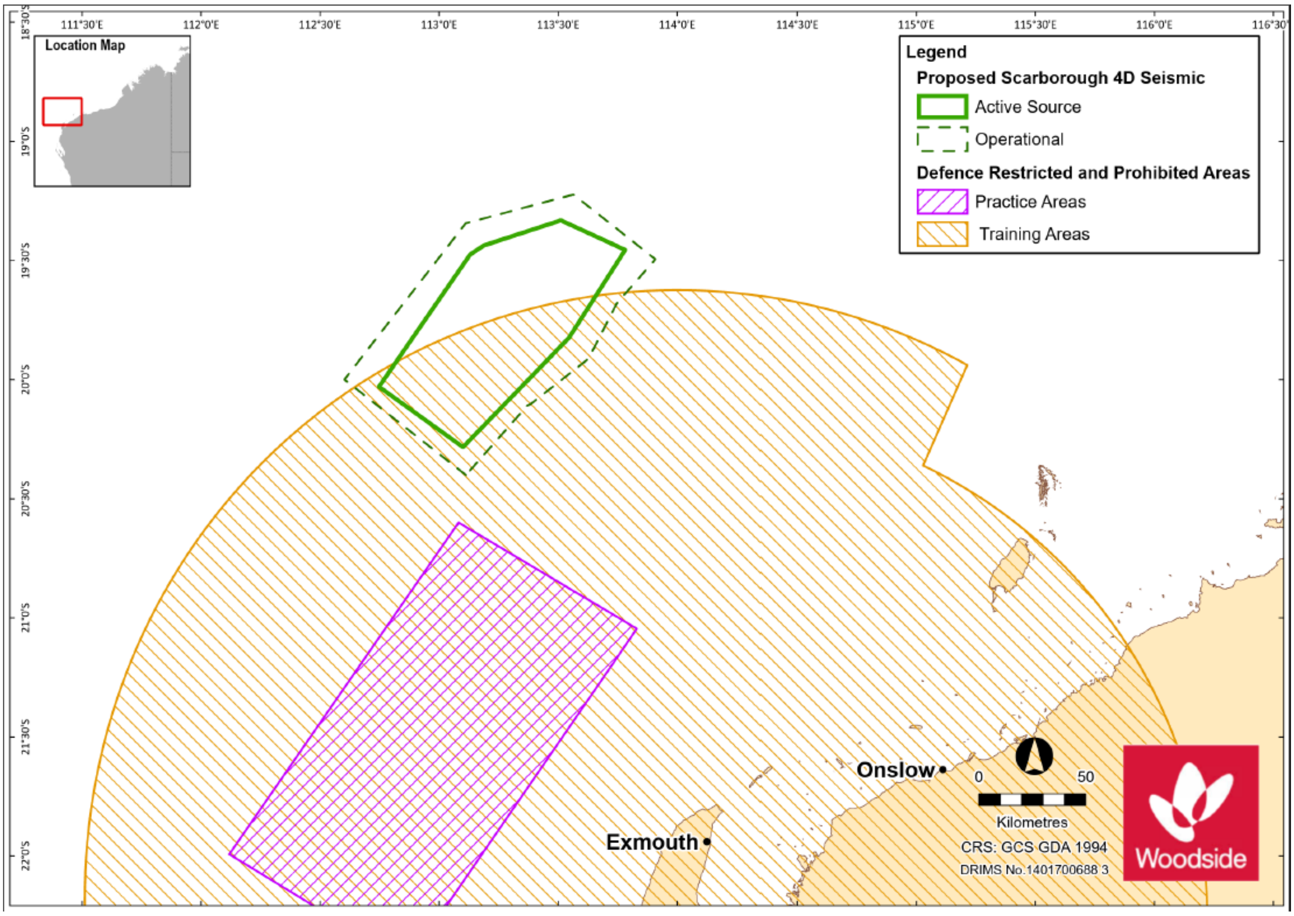
Feedback:
If you have any issues or concerns with these activities, or any other issues relevant to this location then please respond to Woodside at Feedback@woodside.com.au or 1800 442 977.

Your feedback and our response will be included in our Environment Plans, which will be submitted to submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

Please let us know if your feedback for this activity is sensitive and we will make this known to NOPSEMA upon submission of the Environment Plan in order for this information to remain confidential to NOPSEMA.

Please provide your views by 14 June 2021.
Regards
Corporate Affairs Adviser | North West

1.16 Defence area map sent to DoD (13 May 2021)



1.17 Email sent to Director of National Parks (13 May 2021)

Dear Director of National Parks

Woodside is planning to submit an Environment Plan for a marine seismic survey in Commonwealth waters, located in the Exmouth Plateau, approximately 214 km north west of Exmouth, Western Australia.

An Environment Plan for this activity will be submitted in accordance with the the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

We would also be happy to meet online should you wish to discuss the proposed activity in more detail.

Implications for Parks Australia interests

We note Australian Government Guidance on consultation activities with respect to the proposed activities and confirm that:

- We have assessed potential impacts and risks to AMPs in the development of the proposed Environment Plan for this activity and believe that there are no

credible impacts associated with planned activities that have potential to impact marine park values.
- In the unlikely event of a hydrocarbon release there is risk of hydrocarbons contacting the Montebello, Abrolhos, Carnarvon Canyon, Gascoyne and Ningaloo AMPs. The worst-case credible spill scenario assessed for this activity is a marine diesel oil spill resulting from the highly unlikely event of a vessel collision.
- A Commonwealth Government approved oil spill response plan will be in place for the duration of the activities, which includes notification to relevant agencies and organisations as to the nature and scale of the event, as soon as practicable following an occurrence. The Director of National Parks will be advised if an environmental incident occurs that may impact on the values of a marine park.

A Consultation Information Sheet about the planned activity is attached, which provides background on the activity, including a summary of potential key risk and associated management measures. The Information Sheet is also available on our website.

In line with Australian Government guidance on consultation with government agencies, can you please advise within 10 business days if you have any feedback on the proposed activity, noting that your feedback and our response will be included in an Environment Plan for consideration by the National Offshore Petroleum Safety and Environmental Management Authority, as is required under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

Comments can be made by email, letter or by phone.

Regards
Corporate Affairs Adviser | North West

1.18 Email sent to DAWE (13 May 2021)

Dear DAWE

Woodside is planning to submit an Environment Plan for a marine seismic survey in Commonwealth waters, located in the Exmouth Plateau, approximately 214 km north west of Exmouth, Western Australia.

An Environment Plan for this activity will be submitted in accordance with the the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

A Consultation Information Sheet is attached, which provides background on the proposed activity, including a summary of potential key risk and associated management measures. The Information Sheet is also available on our website.

Activity:

Summary:	The purpose of the survey is to improve data quality and subsurface imaging within the permit, allowing Woodside to define new and existing leads and assess commerciality of potential hydrocarbon accumulations. The survey is part of Woodside's work program commitments for the permit.
Survey type:	Woodside is proposing to acquire a 3D seismic survey to be used as a future 4D baseline within the Active Source Area. This involves the use of an acoustic source array (triple) and multiple streamers towed behind the survey vessel. Woodside is also considering using a small fleet of autonomous ocean bottom seismic nodes (AUV nodes) that will also record the reflected energy over a localised area.
Location:	214 km north-west of Exmouth; Latitude 20°16'59.043", Longitude 113°6'0.387"E
Approximate Water Depth (m):	800 m – 1150 m
Schedule:	Around Q3 2022
Duration:	Around 55 days - 70 days
Relevant fisheries	Commonwealth - Western Deepwater Trawl Fishery
Vessels:	A purpose-built seismic vessel, one support vessel and a potential chase vessel
Safe navigation zone (cautionary area)	Three nautical mile radius safe navigation area around the seismic vessel and streamers during seismic operations. Marine users are requested to avoid this area during the survey to ensure the safety of the seismic vessel and third-party vessels.

Survey location:
The location of the Active Source Area and Operational Area are outlined in the attached Consultation Information Sheet.

Implications for DAWE's interests
We have identified and assessed potential risks and impacts to active Commonwealth commercial fishers, biosecurity matters and the marine environment that overlap the proposed Operational Area in the development of the proposed Environment Plan for this activity.

Woodside has endeavoured to reduce these risks to an as low as reasonably practicable (ALARP) level.

Commercial fishing implications:
One Commonwealth-managed fishery has been identified as being relevant to the proposed Activity, this being the Western Deepwater Trawl Fishery.

Woodside will consult licence holders in this fishery, including the provision of a fact sheet specific to commercial fishing interests.

Fisheries were assessed for relevance on the basis of fishing licence overlap with the Operational Area, as well as consideration of government fishing effort data from recent years, fishing methods, and water depth.

Biosecurity implications:

With respect to the biosecurity matters, please note the following information below.

Potential IMS risk	*IMS mitigation management*
Introduction and establishment of IMS.	Vessels are required to comply with the Australian Biosecurity Act 2015, specifically the Australian Ballast Water Management Requirements (as defined under the Biosecurity Act 2015) (aligned with the International Convention for the Control and Management of Ships' Ballast Water and Sediments) to prevent introducing IMS. Vessels will be assessed and managed to prevent the introduction of invasive marine species in accordance with Woodside's Invasive Marine Species Management Plan. Woodside's Invasive Marine Species Management Plan includes a risk assessment process that is applied to vessels undertaking Activities. Based on the outcomes of each IMS risk assessment, Management measures commensurate with the risk (such as the treatment of internal systems, IMS inspections or cleaning) will be implemented to minimise the likelihood of IMS being introduced.

Feedback:

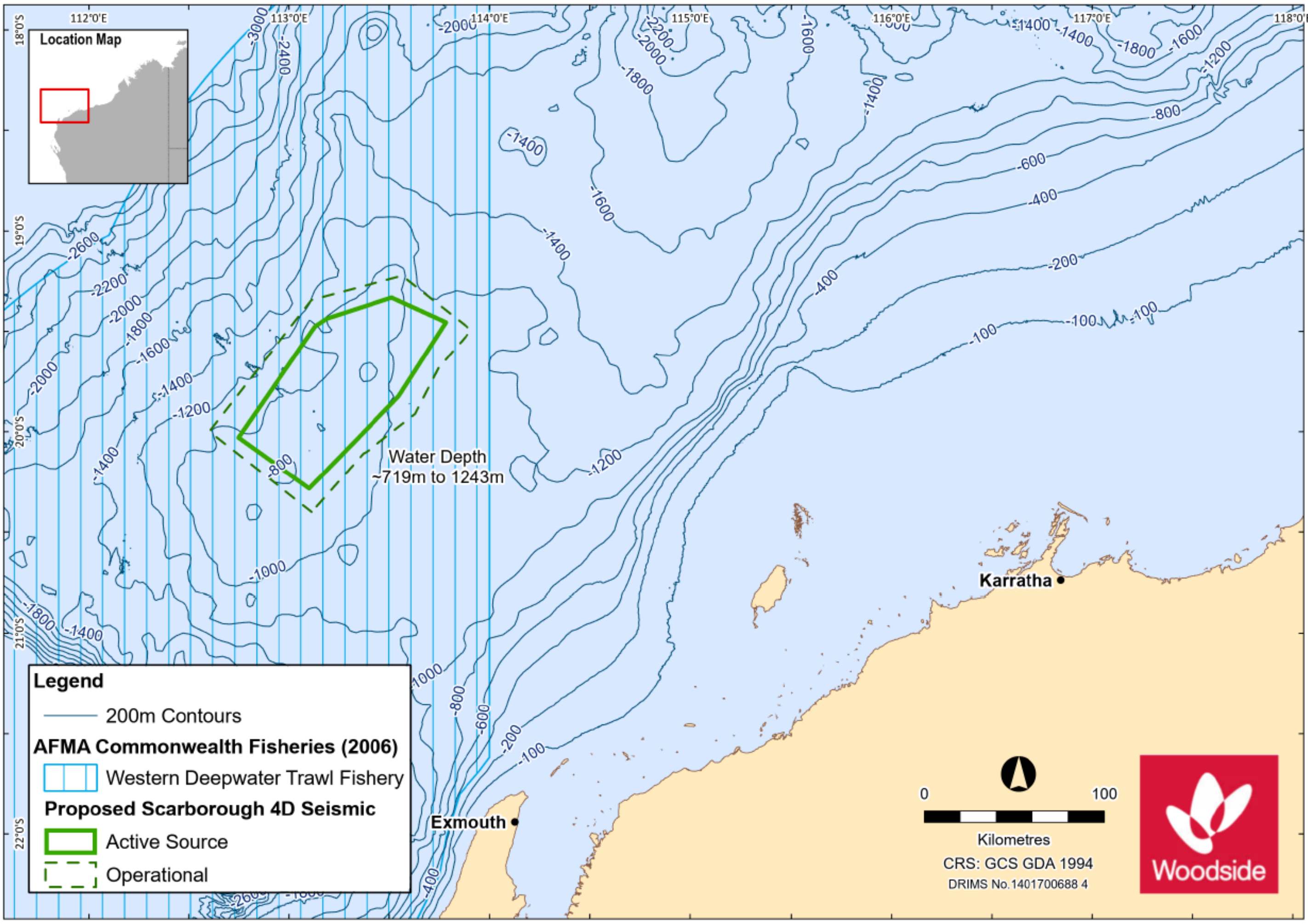
If you have any issues or concerns with these activities, or any other issues relevant to this location then please respond to Woodside at Feedback@woodside.com.au or [redacted]

Your feedback and our response will be included in our Environment Plans, which will be submitted to submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

Please let us know if your feedback for this activity is sensitive and we will make this known to NOPSEMA upon submission of the Environment Plan in order for this information to remain confidential to NOPSEMA.

Please provide your views by **14 June 2021.**
Regards
Corporate Affairs Adviser | North West

1.19 Fisheries map sent to DAWE, AFMA, Commonwealth Fisheries Association, WAFIC, Licence Holders and DPIRD (13 May 2021)



1.20 Email sent to AFMA (13 May 2021)

Dear Stakeholder

Woodside is planning to submit an Environment Plan for a marine seismic survey in Commonwealth waters, located in the Exmouth Plateau, approximately 214 km north west of Exmouth, Western Australia.

The activity is planned to commence in Q3 2022 for a period of around 55 to 70 days, pending approvals, final survey dimensions, vessel availability and weather constraints.

A temporary three nautical mile radius safe navigation area will be maintained around the seismic vessel and towed array during seismic operations. Marine users are requested to avoid this area during the survey to ensure the safety of the seismic vessel and third-party vessels.

We have identified potential impacts to commercial fishers and the environment and have endeavoured to reduce these risks to as low as reasonably practicable. Fisheries have been identified as being relevant based on fishing area overlap with the activity area, assessment of government fishing effort data from recent years, fishing methods and water depth. It is highly unlikely the proposed activity will cause significant impacts to fish spawning and recruitment in any key commercial fish species due to underwater noise. Acquisition of the survey will not overlap the peak spawning season for key target species in the region, such as ruby snapper (December to April). Impacts to fish eggs and larvae are not likely due to the short duration of the survey, and lack of overlap with the peak spawning season.

An information sheet (also on our website), and map of relevant fisheries and list of previous surveys are attached.

Activity:

Summary:	The purpose of the survey is to improve data quality and subsurface imaging within the permit, allowing Woodside to define new and existing leads and assess commerciality of potential hydrocarbon accumulations. The survey is part of Woodside's work program commitments for the permit.
Survey type:	Woodside is proposing to acquire a 3D seismic survey to be used as a future 4D baseline within the Active Source Area. This involves the use of an acoustic source array (triple) and multiple streamers towed behind the survey vessel. Woodside is also considering using a small fleet of autonomous ocean bottom seismic nodes (AUV nodes) that will also record the reflected energy over a localised area.
Location:	214 km north-west of Exmouth; Latitude 20°16'59.043", Longitude 113°6'0.387"E
Approximate Water Depth (m):	800 m – 1150 m
Schedule:	Around Q3 2022
Duration:	Around 55 days - 70 days
Relevant fisheries	Commonwealth - Western Deepwater Trawl Fishery
Vessels:	A purpose-built seismic vessel, one support vessel and a potential chase vessel
Safe navigation zone (cautionary area)	Three nautical mile radius safe navigation area around the seismic vessel and streamers during seismic operations. Marine users are requested to avoid this area during the survey to ensure the safety of the seismic vessel and third-party vessels.

Potential risks to commercial fishing and proposed mitigation measures:

Potential Risk and/or Impact	Mitigation and/or Management Measure
Planned activities	

Interests of relevant stakeholders with respect to: • Defence activities • Petroleum activities • Commercial fishing activities • Shipping activities • Infrastructure activities	• Consultation with petroleum titleholders, commercial fishers and their representative organisations, and government departments and agencies to inform decision making for the proposed activity and development of the EP. • Advice to relevant stakeholders prior to the commencement of activities. • Ongoing consultation by way of updates on vessel movements during survey activities at a frequency to meet relevant stakeholder needs.
Marine discharges	• All routine marine discharges will be managed according to legislative and regulatory requirements and Woodside's Environmental Performance Standards.
Underwater noise	• Implementation of *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Policy Statement 2.1. • Noise modelling to inform potential impacts and input to mitigation and management measures.
Vessel interaction	• Woodside will notify relevant fishery stakeholders and Government maritime safety agencies of specific start and end dates, specific vessel-on-location dates, and any exclusion zones prior to commencement of the activity. • A three nautical mile radius safe navigation area will be in place around the seismic vessel and streamers during seismic operations. • The seismic vessel will display appropriate day shapes and lights to indicate the vessel is towing and is therefore restricted in its ability to manoeuvre. • The streamers will tow surface tail buoys fitted with safe navigation devices • A visual and radar watch will be maintained on the project vessel bridge at all times. • A support vessel and a potential chase vessel will be on standby to direct any shipping traffic or commercial fishing vessels away from the seismic vessel and its towed equipment.
Waste management	• Waste generated on the vessels will be managed in accordance with legislative requirements and a Waste Management Plan. • Wastes will be managed and disposed of in a safe and environmentally responsible manner that prevents accidental loss to the environment. • Wastes transported onshore will be sent to appropriate recycling or disposal facilities by a licensed waste contractor.
Unplanned activities	
Hydrocarbon release	• Appropriate spill response plans, equipment and materials will be in place and maintained. • Appropriate refuelling procedures and equipment will be used to prevent spills to the marine environment.
Introduction of invasive marine species	• All vessels will be assessed and managed as appropriate to prevent the introduction of invasive marine species.

	• Compliance with Australian biosecurity requirements and guidance. • Contracted vessels comply with Australian ballast water requirements.
Marine fauna interactions	• Measures will be taken to protect marine fauna and ecosystems from vessel activities and to prevent vessel collisions and groundings. • Maintaining dedicated marine fauna observers throughout the survey. • All marine fauna sightings are recorded and reported to the Department of Agriculture, Water and the Environment.

Feedback:

If you have any issues or concerns with these activities, or any other issues relevant to this location then please respond to Woodside at Feedback@woodside.com.au or 1800 442 977.

Your feedback and our response will be included in our Environment Plans, which will be submitted to submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

Please let us know if your feedback for this activity is sensitive and we will make this known to NOPSEMA upon submission of the Environment Plan in order for this information to remain confidential to NOPSEMA.

Please provide your views by **14 June 2021.**
Regards
Corporate Affairs Adviser | North West

1.21 List of previous seismic surveys sent to AFMA, Commonwealth Fisheries Association, WAFIC, Licence Holders and DPIRD (13 May 2021)

Previous seismic surveys

SURVEY	2D/3D	YEAR
Scarborough 3D MSS	3D	2004
HEX03A Scarborough 3D MS	3D	2004
Bonaventure 3D MSS	3D	2006
Hex07B Thebe 3D MSS	3D	2007
Keystone 2008 3D	3D	2008
Mary Rose MR11 3D	3D	2011
Mary Rose NE Extension MC3D MSS 2011-2012	3D	2012
Honeycombs 3D HC12	3D	2012
Honeycombs MC3D	3D	2012
Mary Rose MC3D	3D	2012
Mary Rose MC3D	3D	2012
Mary Rose Northeast 3D	3D	2012
Duvalia MC 2D MSS 2012	2D	2012
Westralia Span MC2D MSS	2D	2012
Westralian SPAN 2D	2D	2013
Northwest Shelf Renaissance 2D 2016	2D	2016

1.22 Email sent to Commonwealth Fisheries Association (13 May 2021)

Dear Stakeholder

Woodside is planning to submit an Environment Plan for a marine seismic survey in Commonwealth waters, located in the Exmouth Plateau, approximately 214 km north west of Exmouth, Western Australia.

The activity is planned to commence in Q3 2022 for a period of around 55 to 70 days, pending approvals, final survey dimensions, vessel availability and weather constraints.

A temporary three nautical mile radius safe navigation area will be maintained around the seismic vessel and towed array during seismic operations. Marine users are requested to avoid this area during the survey to ensure the safety of the seismic vessel and third-party vessels.

We have identified potential impacts to commercial fishers and the environment and have endeavoured to reduce these risks to as low as reasonably practicable. Fisheries have been identified as being relevant based on fishing area overlap with the activity area, assessment of government fishing effort data from recent years, fishing methods and water depth. It is highly unlikely the proposed activity will cause significant impacts to fish spawning and recruitment in any key commercial fish species due to underwater noise. Acquisition of the survey will not overlap the peak spawning season for key target species in the region, such as ruby snapper

(December to April). Impacts to fish eggs and larvae are not likely due to the short duration of the survey, and lack of overlap with the peak spawning season.

An information sheet (also on our website), and map of relevant fisheries and list of previous surveys are attached.

Activity:

Summary:	The purpose of the survey is to improve data quality and subsurface imaging within the permit, allowing Woodside to define new and existing leads and assess commerciality of potential hydrocarbon accumulations. The survey is part of Woodside's work program commitments for the permit.
Survey type:	Woodside is proposing to acquire a 3D seismic survey to be used as a future 4D baseline within the Active Source Area. This involves the use of an acoustic source array (triple) and multiple streamers towed behind the survey vessel. Woodside is also considering using a small fleet of autonomous ocean bottom seismic nodes (AUV nodes) that will also record the reflected energy over a localised area.
Location:	214 km north-west of Exmouth; Latitude 20°16'59.043", Longitude 113°6'0.387"E
Approximate Water Depth (m):	800 m – 1150 m
Schedule:	Around Q3 2022
Duration:	Around 55 days - 70 days
Relevant fisheries	Commonwealth - Western Deepwater Trawl Fishery
Vessels:	A purpose-built seismic vessel, one support vessel and a potential chase vessel
Safe navigation zone (cautionary area)	Three nautical mile radius safe navigation area around the seismic vessel and streamers during seismic operations. Marine users are requested to avoid this area during the survey to ensure the safety of the seismic vessel and third-party vessels.

Potential risks to commercial fishing and proposed mitigation measures:

Potential Risk and/or Impact	Mitigation and/or Management Measure
Planned activities	
Interests of relevant stakeholders with respect to: • Defence activities • Petroleum activities • Commercial fishing activities • Shipping activities • Infrastructure activities	• Consultation with petroleum titleholders, commercial fishers and their representative organisations, and government departments and agencies to inform decision making for the proposed activity and development of the EP. • Advice to relevant stakeholders prior to the commencement of activities. • Ongoing consultation by way of updates on vessel movements during survey activities at a frequency to meet relevant stakeholder needs.

Marine discharges	• All routine marine discharges will be managed according to legislative and regulatory requirements and Woodside's Environmental Performance Standards.
Underwater noise	• Implementation of *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Policy Statement 2.1. • Noise modelling to inform potential impacts and input to mitigation and management measures.
Vessel interaction	• Woodside will notify relevant fishery stakeholders and Government maritime safety agencies of specific start and end dates, specific vessel-on-location dates, and any exclusion zones prior to commencement of the activity. • A three nautical mile radius safe navigation area will be in place around the seismic vessel and streamers during seismic operations. • The seismic vessel will display appropriate day shapes and lights to indicate the vessel is towing and is therefore restricted in its ability to manoeuvre. • The streamers will tow surface tail buoys fitted with safe navigation devices • A visual and radar watch will be maintained on the project vessel bridge at all times. • A support vessel and a potential chase vessel will be on standby to direct any shipping traffic or commercial fishing vessels away from the seismic vessel and its towed equipment.
Waste management	• Waste generated on the vessels will be managed in accordance with legislative requirements and a Waste Management Plan. • Wastes will be managed and disposed of in a safe and environmentally responsible manner that prevents accidental loss to the environment. • Wastes transported onshore will be sent to appropriate recycling or disposal facilities by a licensed waste contractor.
Unplanned activities	
Hydrocarbon release	• Appropriate spill response plans, equipment and materials will be in place and maintained. • Appropriate refuelling procedures and equipment will be used to prevent spills to the marine environment.
Introduction of invasive marine species	• All vessels will be assessed and managed as appropriate to prevent the introduction of invasive marine species. • Compliance with Australian biosecurity requirements and guidance. • Contracted vessels comply with Australian ballast water requirements.
Marine fauna interactions	• Measures will be taken to protect marine fauna and ecosystems from vessel activities and to prevent vessel collisions and groundings. • Maintaining dedicated marine fauna observers throughout the survey.

	• All marine fauna sightings are recorded and reported to the Department of Agriculture, Water and the Environment.

Feedback:

If you have any issues or concerns with these activities, or any other issues relevant to this location then please respond to Woodside at Feedback@woodside.com.au or 1800 442 977.

Your feedback and our response will be included in our Environment Plans, which will be submitted to submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

Please let us know if your feedback for this activity is sensitive and we will make this known to NOPSEMA upon submission of the Environment Plan in order for this information to remain confidential to NOPSEMA.

Please provide your views by **14 June 2021.**

Regards
Corporate Affairs Adviser | North West

1.23 Email sent to WAFIC (13 May 2021)

Dear Stakeholder

Woodside is planning to submit an Environment Plan for a marine seismic survey in Commonwealth waters, located in the Exmouth Plateau, approximately 214 km north west of Exmouth, Western Australia.

The activity is planned to commence in Q3 2022 for a period of around 55 to 70 days, pending approvals, final survey dimensions, vessel availability and weather constraints.

A temporary three nautical mile radius safe navigation area will be maintained around the seismic vessel and towed array during seismic operations. Marine users are requested to avoid this area during the survey to ensure the safety of the seismic vessel and third-party vessels.

We have identified potential impacts to commercial fishers and the environment and have endeavoured to reduce these risks to as low as reasonably practicable. Fisheries have been identified as being relevant based on fishing area overlap with the activity area, assessment of government fishing effort data from recent years, fishing methods and water depth. It is highly unlikely the proposed activity will cause significant impacts to fish spawning and recruitment in any key commercial fish species due to underwater noise. Acquisition of the survey will not overlap the peak spawning season for key target species in the region, such as ruby snapper

(December to April). Impacts to fish eggs and larvae are not likely due to the short duration of the survey, and lack of overlap with the peak spawning season.

An information sheet (also on our website), and map of relevant fisheries and list of previous surveys are attached.

Activity:

Summary:	The purpose of the survey is to improve data quality and subsurface imaging within the permit, allowing Woodside to define new and existing leads and assess commerciality of potential hydrocarbon accumulations. The survey is part of Woodside's work program commitments for the permit.
Survey type:	Woodside is proposing to acquire a 3D seismic survey to be used as a future 4D baseline within the Active Source Area. This involves the use of an acoustic source array (triple) and multiple streamers towed behind the survey vessel. Woodside is also considering using a small fleet of autonomous ocean bottom seismic nodes (AUV nodes) that will also record the reflected energy over a localised area.
Location:	214 km north-west of Exmouth; Latitude 20°16'59.043", Longitude 113°6'0.387"E
Approximate Water Depth (m):	800 m – 1150 m
Schedule:	Around Q3 2022
Duration:	Around 55 days - 70 days
Relevant fisheries	Commonwealth - Western Deepwater Trawl Fishery
Vessels:	A purpose-built seismic vessel, one support vessel and a potential chase vessel
Safe navigation zone (cautionary area)	Three nautical mile radius safe navigation area around the seismic vessel and streamers during seismic operations. Marine users are requested to avoid this area during the survey to ensure the safety of the seismic vessel and third-party vessels.

Potential risks to commercial fishing and proposed mitigation measures:

Potential Risk and/or Impact	Mitigation and/or Management Measure
Planned activities	
Interests of relevant stakeholders with respect to: • Defence activities • Petroleum activities • Commercial fishing activities • Shipping activities • Infrastructure activities	• Consultation with petroleum titleholders, commercial fishers and their representative organisations, and government departments and agencies to inform decision making for the proposed activity and development of the EP. • Advice to relevant stakeholders prior to the commencement of activities. • Ongoing consultation by way of updates on vessel movements during survey activities at a frequency to meet relevant stakeholder needs.

Marine discharges	• All routine marine discharges will be managed according to legislative and regulatory requirements and Woodside's Environmental Performance Standards.
Underwater noise	• Implementation of *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Policy Statement 2.1. • Noise modelling to inform potential impacts and input to mitigation and management measures.
Vessel interaction	• Woodside will notify relevant fishery stakeholders and Government maritime safety agencies of specific start and end dates, specific vessel-on-location dates, and any exclusion zones prior to commencement of the activity. • A three nautical mile radius safe navigation area will be in place around the seismic vessel and streamers during seismic operations. • The seismic vessel will display appropriate day shapes and lights to indicate the vessel is towing and is therefore restricted in its ability to manoeuvre. • The streamers will tow surface tail buoys fitted with safe navigation devices • A visual and radar watch will be maintained on the project vessel bridge at all times. • A support vessel and a potential chase vessel will be on standby to direct any shipping traffic or commercial fishing vessels away from the seismic vessel and its towed equipment.
Waste management	• Waste generated on the vessels will be managed in accordance with legislative requirements and a Waste Management Plan. • Wastes will be managed and disposed of in a safe and environmentally responsible manner that prevents accidental loss to the environment. • Wastes transported onshore will be sent to appropriate recycling or disposal facilities by a licensed waste contractor.
Unplanned activities	
Hydrocarbon release	• Appropriate spill response plans, equipment and materials will be in place and maintained. • Appropriate refuelling procedures and equipment will be used to prevent spills to the marine environment.
Introduction of invasive marine species	• All vessels will be assessed and managed as appropriate to prevent the introduction of invasive marine species. • Compliance with Australian biosecurity requirements and guidance. • Contracted vessels comply with Australian ballast water requirements.
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	• All marine fauna sightings are recorded and reported to the Department of Agriculture, Water and the Environment.

Feedback:

If you have any issues or concerns with these activities, or any other issues relevant to this location then please respond to Woodside at Feedback@woodside.com.au or 1800 442 977.

Your feedback and our response will be included in our Environment Plans, which will be submitted to submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

Please let us know if your feedback for this activity is sensitive and we will make this known to NOPSEMA upon submission of the Environment Plan in order for this information to remain confidential to NOPSEMA.

Please provide your views by **14 June 2021.**
Regards
Corporate Affairs Adviser | North West

1.24 Email sent to Licence Holders (13 May 2021)

Dear Licence Holder

Woodside is planning to submit an Environment Plan for a marine seismic survey in Commonwealth waters, located in the Exmouth Plateau, approximately 214 km north west of Exmouth, Western Australia.

The activity is planned to commence in Q3 2022 for a period of around 55 to 70 days, pending approvals, final survey dimensions, vessel availability and weather constraints.

A temporary three nautical mile radius safe navigation area will be maintained around the seismic vessel and towed array during seismic operations. Marine users are requested to avoid this area during the survey to ensure the safety of the seismic vessel and third-party vessels.

We have identified potential impacts to commercial fishers and the environment and have endeavoured to reduce these risks to as low as reasonably practicable. Fisheries have been identified as being relevant based on fishing area overlap with the activity area, assessment of government fishing effort data from recent years, fishing methods and water depth. It is highly unlikely the proposed activity will cause significant impacts to fish spawning and recruitment in any key commercial fish species due to underwater noise. Acquisition of the survey will not overlap the peak spawning season for key target species in the region, such as ruby snapper (December to April). Impacts to fish eggs and larvae are not likely due to the short duration of the survey, and lack of overlap with the peak spawning season.

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Activity:

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Duration:	Around 55 days - 70 days
Relevant fisheries	Commonwealth - Western Deepwater Trawl Fishery
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Potential risks to commercial fishing and proposed mitigation measures:

Potential Risk and/or Impact	Mitigation and/or Management Measure
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Please provide your views by **14 June 2021.**
Regards
Corporate Affairs Adviser | North West

1.25 Email sent to DPIRD (14 May 2021)

Dear Stakeholder

Woodside is planning to submit an Environment Plan for a marine seismic survey in Commonwealth waters, located in the Exmouth Plateau, approximately 214 km north west of Exmouth, Western Australia.

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	• All marine fauna sightings are recorded and reported to the Department of Agriculture, Water and the Environment.

Feedback:

If you have any issues or concerns with these activities, or any other issues relevant to this location then please respond to Woodside at Feedback@woodside.com.au or 1800 442 977.

Your feedback and our response will be included in our Environment Plans, which will be submitted to submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

Please let us know if your feedback for this activity is sensitive and we will make this known to NOPSEMA upon submission of the Environment Plan in order for this information to remain confidential to NOPSEMA.

Please provide your views by **14 June 2021.**
Regards
Corporate Affairs Adviser | North West

1.26 Email sent to AMSA (6 July 2021)

Dear [redacted]

As part of Woodside's ongoing consultation for its current and planned activities, I would like to advise Australian Maritime Safety Authority (AMSA) that Woodside are preparing the *Scarborough 4D Marine Seismic Survey Environment Plan* and would like to offer AMSA the opportunity to review or provide comment on the activity.

Information is presented as follows:

- A Consultation Information Sheet is available on our website here, providing information on the proposed petroleum activities program. Please note that this is a joint Information Sheet with Angel Operations.
- The *Scarborough 4D Marine Seismic Survey First Strike Plan* is attached. This will form part of the approval submission in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

Woodside propose to submit an EP on 27th August 2021 to support these activities.

Should you require additional information or have a comment to make about the proposed activity, please contact myself by close of business 21st August to allow us sufficient time to inform our activity planning and EP development.

Comments can be made by email, letter or by phone.

Please be aware that your feedback will be communicated to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA), as is required under legislation.

We look forward to hearing from you.

Many thanks,

Hydrocarbon Spill Coordinator | Security & Emergency Management

1.27 Email sent to DoT (8 July 2021)

Dear [redacted]

As part of Woodside's ongoing consultation for its current and planned activities, I would like to advise WA Department of Transport (DoT) that Woodside are preparing the *Scarborough 4D Marine Seismic Survey Environment Plan* and would like to offer DoT the opportunity to review or provide comment on the activity.

Information is presented as follows:

- A Consultation Information Sheet is available on our website here, providing information on the proposed petroleum activities program. Please note that this is a joint Information Sheet with Angel Operations.
- The *Scarborough 4D Marine Seismic Survey First Strike Plan* is attached. This will form part of the approval submission in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).
- In the table below, as requested in the *Offshore Petroleum Industry Guidance Note* (July 2020) and from recent engagement activities between DoT and Woodside, responses to the information requirements in a succinct summary and source of information.

Woodside propose to submit an EP on 27th August 2021 to support these activities.

Should you require additional information or have a comment to make about the proposed activity, please contact myself by close of business 21st August to allow us sufficient time to inform our activity planning and EP development.

Comments can be made by email, letter or by phone.

Please be aware that your feedback will be communicated to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA), as is required under legislation.

We look forward to hearing from you.

Many thanks,

Hydrocarbon Spill Coordinator | Security & Emergency Management

Information Requested in the Offshore Petroleum Industry Guidance Note (July 2020)	Information Provided & Reference
Description of activity, including the intended schedule, location (including coordinates), distance to nearest landfall and map.	Included in the consultation information sheet
Worst case spill volumes.	Included in Appendix A of the First Strike Plan
Known or indicative oil type/properties.	Included in Appendix A of the First Strike Plan
Amenability of oil to dispersants and window of opportunity for dispersant efficacy.	Dispersant is not deemed to be suitable for marine diesel spill.
Description of existing environment and protection priorities.	Included in section 4 of the First Strike Plan
Details of the environmental risk assessment related to marine oil pollution - describe the process and key outcomes around risk identification, risk analysis, risk evaluation and risk treatment. For further information see the Oil Pollution Risk Management Information Paper (NOPSEMA 2017).	Unplanned loss of containment events from the Petroleum Activities Program have been identified during the risk assessment process (presented in Section 7 of the EP). Further descriptions of risk, impacts and mitigation measures (which are not related to hydrocarbon preparedness and response) are provided in Section 7 of the EP. One unplanned event or credible spill scenario for the Petroleum Activities Program has been selected as representative across types, sources and incident/response levels, up to and including the WCCS. Table 2-1 of the OSPRMA presents the credible scenario for the Petroleum Activities Program. One worst-case credible scenario been used for response planning purposes for the activity as all other scenarios are of a lesser scale and extent. By demonstrating capability to meet and manage an event of this size and timescale, Woodside assumes relevant scenarios that are smaller in nature and scale can also be managed by the same capability. Response performance outcomes have been defined based on a response to the WCCS.
Outcomes of oil spill trajectory modelling, including predicted times to enter State waters and contact shorelines.	Credible Scenario-01 – surface release of marine diesel after a vessel collision 2,000 m^3 marine diesel – residue of 100 m^3 (5%) Minimum time to shoreline contact (above 100 g/m^2) in days **Shoreline receptors**: **No contact** ***Please note, no floating or shoreline impacts are predicted within State Waters, however, there may be some entrained contact at 10 ppb which enters State Waters on the Northwest Cape.***
Details on initial response actions and key activation timeframes.	Included in Section 2 and 3 of the First Strike Plan
Potential Incident Control Centre arrangements.	Included in Appendix E and F of the First Strike Plan
Potential staging areas / Forward Operating Base.	A Forward Operating Base can be established at Exmouth and/ or Dampier.
Details on response strategies.	Included in Section 2 and 3 of the First Strike Plan

Use of DoT equipment resources	Woodside has access to its own and contracted stockpiles of response equipment and acknowledges that potential use of DoT resources cannot be assumed and is at the discretion of DoT.
Details and diagrams on proposed IMT structure including integration of DoT arrangements as per this IGN.	Included in Appendix E and F of the First Strike Plan
Details on testing of arrangements of OPEP/OSCP.	• One Level 1 'First Strike' drill conducted within two weeks of activity commencement. **Testing of Oil Spill Response Arrangements** There are a number of arrangements which in the event of a spill will underpin Woodside's ability to implement a response across its petroleum activities. In order to ensure each of these arrangements is adequately tested, the Hydrocarbon Spill Preparedness Capability and Competency Coordinator ensures tests are conducted in alignment with the Hydrocarbon Spill Arrangements Testing Schedule (Woodside Doc No. 10058092). Woodside's Hydrocarbon Spill Preparedness & Response Testing Schedule aligns with international good practice for spill preparedness & response management; the testing is compatible with the IPIECA Good Practice Guide and the Australian Emergency Management Institute Handbook. The Hydrocarbon Spill Arrangements Testing Schedule (Woodside Doc No. 10058092) identifies the type of test which will be conducted annually for each arrangement, and how this type will vary over a five year rolling schedule. Testing methods may include (but are not limited to): audits, drills, field exercises, functional workshops, assurance reporting, assurance monitoring and reviews of key external dependencies. Activity specific Oil Spill Pollution First Strike Plans are developed to meet the response needs of that particular activity's Worst Credible Spill Scenario (WCCS). The ability to implement these plans may rely on specific arrangements or those common to other Woodside activities. Regardless of their commonality each arrangement will be tested in at least one of the methods annually. This ensures that personnel are familiar with spill response procedures, reporting requirements, and roles/ responsibilities. At the completion of testing a report is produced to demonstrate the outcomes achieved against the tested objectives. The report will include the lessons learned, any improvement actions and a list of the participants. Alternatively, an assurance report, assurance records, or audit report may be produced. These reports record findings and include any recommendations for improvement. Improvement actions and their close-out are actively recorded and managed. This is over and above the emergency management exercises conducted.
Additional comments	Please note some of the links in the document are still being finalised, and as such may show a reference error in the attached version.

1.28 Email sent to CCWA (20 August 2021)

Dear Mr Verstegen,

Scarborough 4D B1 Marine Seismic Survey Environment Plan

Woodside is planning to submit an Environment Plan for a marine seismic survey in Commonwealth waters, located in the Exmouth Plateau, approximately 214 km north west of Exmouth, Western Australia.

The activity is planned to commence in Q3 2022 for a period of around 55 to 70 days, pending approvals, final survey dimensions, vessel availability and weather constraints.

An Environment Plan for this activity will be submitted in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

A Consultation Information Sheet is attached, which provides background on the proposed activity, including a summary of potential key risks and associated management measures. The Information Sheet has been on our website with feedback details since May 2021 and remains available. A map showing the proposed activity relevant to adjacent petroleum titles is also attached.

If you have any comments about these activities in this location then please respond to Woodside at Feedback@woodside.com.au or 1800 442 977.

Your feedback and our response will be included in our Environment Plans, which will be submitted to submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) for acceptance in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

Please let us know if your feedback for this activity is sensitive and we will make this known to NOPSEMA upon submission of the Environment Plan in order for this information to remain confidential to NOPSEMA.

Please provide your feedback by 20 September 2021.

Woodside Feedback

APPENDIX G JASCO ACOUSTIC MODELLING REPORT

Scarborough 4D Marine Seismic Survey

Acoustic Modelling for Assessing Marine Fauna Sound Exposures and Pygmy Blue Whale Exposure Analysis

Submitted to:

Kiri Peat
Woodside Energy Limited
[redacted]

Authors:

Matthew W. Koessler
Michelle J. Weirathmueller
Dana A. Cusano
Karlee E. Zammit
Craig R. McPherson

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JASCO Applied Sciences (Australia) Pty Ltd
Unit 1, 14 Hook Street
Capalaba, Queensland, 4157
Tel: +61 7 3823 2620
www.jasco.com

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Disclaimer:

The results presented herein are relevant within the specific context described in this report. They could be misinterpreted if not considered in the light of all the information contained in this report. Accordingly, if information from this report is used in documents released to the public or to regulatory bodies, such documents must clearly cite the original report, which shall be made readily available to the recipients in integral and unedited form.

Contents

Figures

Tables

Executive Summary

JASCO Applied Sciences performed a numerical estimation study of underwater sound levels associated with the planned Woodside Scarborough 4D Marine Seismic Survey (MSS). Acoustic modelling was conducted for this survey to determine ranges to acoustic exposure thresholds representing the best available science for potential injury and behavioural disruption of marine fauna. Additionally, an acoustic exposure analysis using animal movement modelling was conducted for pygmy blue whales within the pygmy blue whale migration Biologically Important Area (BIA) to investigate any potential effects on pygmy blue whale migration from acquisition of the Scarborough 4D survey.

A specialised airgun array source model was used to predict and compare the acoustic signature of the seismic source and complementary underwater acoustic propagation models were used in conjunction with the modelled array signature to estimate sound levels over a large area around the source. Single-impulse sound fields were predicted at two sites within the survey area. The water depths at the modelled sites ranged between 924 and 1101 m. A conservative sound speed profile that would be most supportive of sound propagation for the period of the survey was defined and applied to all modelling.

The modelling methodology considered source directivity and range-dependent environmental properties in each of the two assessed locations. Estimated underwater acoustic levels are presented as sound pressure levels (SPL, L_p), zero-to-peak pressure levels (PK, L_{pk}), peak-to-peak pressure levels (PK—PK, $L_{pk\text{-}pk}$), particle acceleration (peak magnitude), and either single-impulse (i.e., per-pulse) or accumulated sound exposure levels (SEL, L_E) as appropriate for different noise effect criteria. Accumulated sound exposure fields were predicted for a representative scenario for likely survey operations within the survey area over 24 hours.

The sound footprints are highly directional, and while the maximum distances to criteria are presented in the summary, these distances may not be relevant to receptors or areas of interest in a specific direction. The orientation of the source had the greatest effect on distances to criteria because the array has a pronounced directivity pattern, with greater distances to sound levels in the broadside direction (perpendicular to the tow direction) as compared to the endfire direction (along the tow direction).

SEL_{24h} is a cumulative metric that reflects the dosimetric effect of noise levels within 24 hours, based on the assumption that an receiver (e.g. an animal) is consistently exposed to such noise levels at a fixed position. Where the corresponding SEL_{24h} radii are larger than those for peak pressure criteria, they often represent an unlikely worst-case scenario. More realistically, marine mammals, fish, and sea turtles would not stay in the same location for 24 hours (especially in the absence of location-specific habitat) but rather a shorter period, depending on the animal’s behaviour and the source’s proximity and movements. Therefore, a reported radius for SEL_{24h} criteria does not mean that marine fauna travelling within this radius of the source will be impaired, but rather that an animal could be exposed to the sound level associated with impairment (either permanent threshold shift (PTS) or temporary threshold shift (TTS)) if it remained at that location for 24 hours.

The analysis considered the distances away from the seismic source at which several effects criteria or relevant sound levels were reached. The results are summarised below for the representative single-impulse sites and accumulated SEL scenarios.

Marine mammals

Table 1. Maximum (R_{max}) horizontal distances (in km) from modelled sites or scenarios to behavioural response threshold, PTS and TTS thresholds for marine mammals.

Hearing group	Modelled distance to effect threshold (R_{max})		
	Behavioural response[1]	Impairment: TTS[2]	Impairment: PTS[2]
LF cetaceans		60.7	0.38
MF cetaceans	7.28	–	–
HF cetaceans		0.39	0.19

[1] Noise exposure criteria: NOAA (2019)
[2] Noise exposure criteria: NMFS (2018)
A dash indicates the threshold was not reached within the limits of the modelling resolution (20 m).

Sea turtles

Table 2. Maximum (R_{max}) horizontal distances (in km) from modelled sites or scenarios to behavioural response thresholds and PTS and TTS thresholds for sea.

Hearing group	Modelled distance to effect threshold (R_{max})			
	Behavioural response[a]	Behavioural disturbance[b]	Impairment: TTS[c]	Impairment: PTS[c]
Turtles	3.87	0.76	0.28	0.05

[a] Noise exposure criteria: NSF (2011)
[b] Noise exposure criteria: McCauley et al. (2000a)
[c] Noise exposure criteria: Finneran et al. (2017)

Fish, fish eggs, fish larvae and plankton

- Fish: This modelling study assessed the radial distances for quantitative criteria based on Popper et al. (2014) and considered both PK and SEL_{24h} (maximum over water column) metrics associated with mortality and potential mortal injury as well as impairment in the following groups:
  - Fish without a swim bladder (also appropriate for sharks in the absence of other information)
  - Fish with a swim bladder that do not use it for hearing
  - Fish that use their swim bladders for hearing
  - Fish eggs, fish larvae and plankton

Table 3. Summary of maximum fish, fish eggs, and larvae injury and TTS onset distances for single impulse and SEL_{24h} modelled scenario.

Relevant hearing group	Effect criteria	Metric associated with longest distance to threshold	R_{max} (km)
Fish: No swim bladder	Injury	PK	0.06
	TTS	SEL_{24h}	4.5
Fish: Swim bladder not involved in hearing and Swim bladder involved in hearing	Injury	PK	0.11
	TTS	SEL_{24h}	4.5
Fish eggs, fish larvae and plankton	Injury	PK	0.11

Animal movement modelling

Animal movement modelling ('animat modelling') focussed on migrating pygmy blue whales in the migration BIA. In this case, the moving receivers (the animats) were set to simulate the real-world movements of migrating pygmy blue whales within the migration BIA. The scenario was modelled for a 7 day period. On each day, a 24 hour segment of the planned seismic track lines was run. Using the distribution of distances of animats predicted to be exposed to sound levels above threshold, the 95th percentile exposure range ($ER_{95\%}$) was computed. The ER_{max} was also included to provide context given the sensitivity of pygmy blue whales and the limited knowledge about their behaviour within the migration BIA. Noise effect metrics included peak pressure level (PK), sound exposure levels (SEL_{24h}), and sound pressure level (SPL).

The results of the animal movement modelling predicted that no pygmy blue whales within the migration BIA would be exposed above any of the assessed threshold criteria. This outcome was driven by two primary influences. First, the closest point of approach (CPA) between the planned seismic survey lines and the BIA was 29.9 km, and second, the migrating pygmy blue whales were traveling through the area and were not present for durations which caused cumulative SEL exposures to exceed either PTS or TTS threshold criteria. These results were different than the distances predicted by the acoustic modelling, which were inherently more conservative because they did not incorporate the complex interactions of both a moving sound field and moving receivers, but rather assumed a static receiver.

Table 4. Summary of animat simulation results for migrating pygmy blue whales indicating maximum (R_{max}) horizontal distances (in km) from modelled sites or scenarios to behavioural response threshold, PTS and TTS thresholds.

Modelled distance to effect threshold (R_{max})		
Behavioural response[1]	Impairment: TTS[2]	Impairment: PTS[2]
-	-	-

[1] Noise exposure criteria: NOAA (2019)
[2] Noise exposure criteria: NMFS (2018)
A dash indicates the threshold was not reached within the limits of the modelling resolution (20 m).

1. Introduction

JASCO Applied Sciences (JASCO), performed a numerical estimation study of underwater sound levels associated with the planned Woodside Scarborough 4D Marine Seismic Survey (MSS) to assist in understanding the potential acoustic effects on receptors including marine mammals, fish, plankton and sea turtles.

JASCO's specialised Airgun Array Source Model (AASM) was used to predict acoustic signatures and spectra for a 3150 in^3 airgun array. AASM accounts for individual airgun volumes, airgun bubble interactions, and array geometry to yield accurate source predictions.

Complementary underwater acoustic propagation models were used in conjunction with the modelled array signature to estimate sound levels considering environmental effects. Single-impulse sound fields were predicted at two locations within the potential survey area, and an accumulated sound exposure field scenario was modelled for a representative acquisition pattern for survey operations over 24 h (Section 2). A sound speed profile that would be most supportive of sound propagation conditions for the potential survey periods was defined and applied throughout.

The modelling methodology considered source directivity and range-dependent environmental properties. Estimated underwater acoustic levels are presented as sound pressure levels (SPL, L_p), zero-to-peak pressure levels (PK, L_{pk}), peak-to-peak pressure levels (PK-PK; $L_{pk\text{-}pk}$), and either single-impulse (i.e., per-pulse) or accumulated sound exposure levels (SEL, L_E) as appropriate for different, species specific noise effect criteria. The resulting sound fields were used to estimate radial distance to exposure during operations of this survey in relation to permanent threshold shift (PTS), temporary threshold shift (TTS), and behavioural effect for marine mammals, fish, sea turtles, and plankton.

The acoustic modelling results were also used in conjunction with animal movement modelling simulations to predict the distance at which pygmy blue whales (*Balaenoptera musculus brevicauda*) are expected to be exposed above threshold criteria for PTS, TTS, and behavioural response. Sound exposure distribution estimates are determined by moving large numbers of simulated animals (animats) through a modelled time-evolving sound field, computed using specialised sound source and sound propagation models. This approach provides the most realistic prediction of the maximum expected SPL, PK, and SEL that are now considered the most relevant sound metrics for effect assessment.

Section 3 explains the metrics used to represent underwater acoustic fields and the effect criteria considered. Section 4 details the methodology for predicting the source levels and modelling the sound propagation, including the specifications of the seismic source and all environmental parameters the propagation models require. Section 4 also details the methodology for animat modelling of pygmy blue whales. Section 5 presents the results, which are then discussed and summarised in Section 6.

2. Modelling Scenarios

Two standalone, single-impulse sites were modelled and were used to model one accumulated SEL scenario. The locations of both modelled sites are provided in Table 5. Both sites and the acquisition lines are shown in Figure 1, along with the survey boundaries. The accumulated SEL scenario assumed that a survey vessel sailed along survey lines at ~4.5 knots, with an impulse interval of 12.5 m.

The single impulse sites and the accumulated SEL scenario were selected based on the proposed survey line plan where the survey will be acquired along survey lines orientated at approximately 40/220°. The locations of the single impulse sites were selected considering the entire line along with the seismic source where it would be operational at full-power, including run-out sections of lines. The selected locations are considered representative of the range of water depths that will be covered during the Scarborough 4D MSS and the potential sound propagation characteristics that may arise during survey acquisition.

The scenario accounted for 13722 impulses during the respective 24 h period of acquisition. During line turns, the seismic source was not operating.

The acoustic exposure analysis and animal movement (animat) scenario was modelled for a 7 day period with the same vessel speed and impulse interval as the accumulated SEL scenario discussed above. Figure 2 shows the geographic features associated with the modelled animat scenario.

Table 5. Location details for the single-impulse modelled sites.

Site	Location		MGA (GDA94), Zone 50		Water depth (m)	Tow direction (°)
	Latitude (S)	Longitude (E)	*X* (m)	*Y* (m)		
1	19° 33' 25.045"	113° 39' 54.557"	150038	7834133	1101	40 and 220
2	19° 49' 41.340"	113° 21' 55.896"	119206	7803435	925	40 and 220

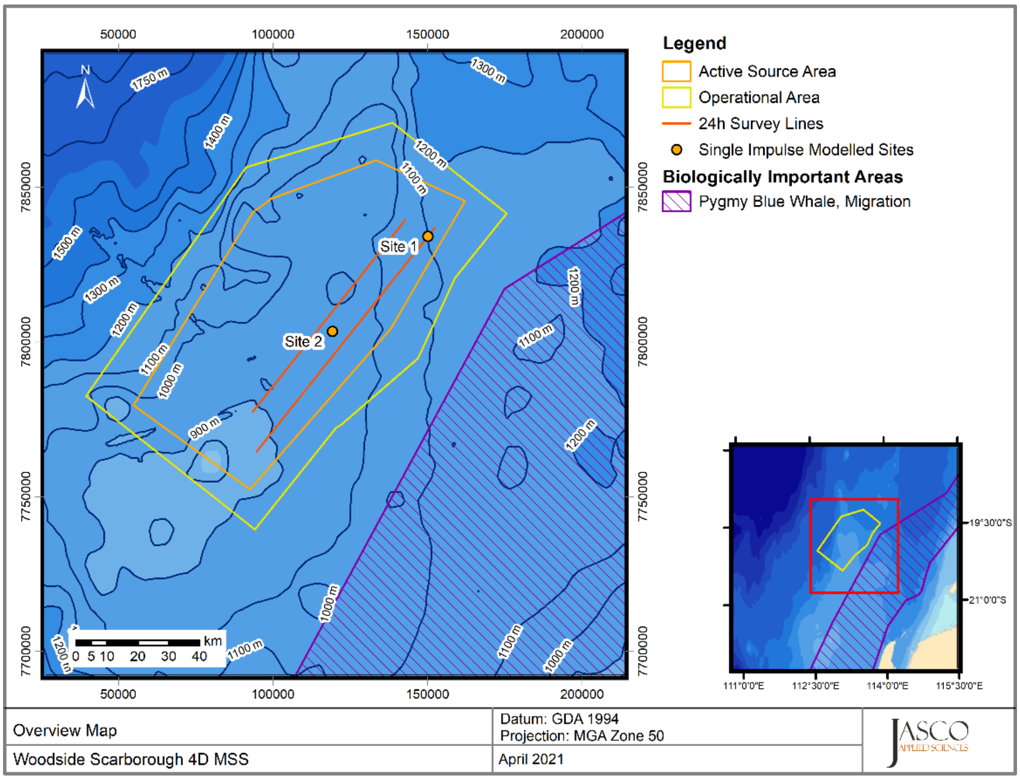

Figure 1. Overview of the modelled sites, acquisition lines, and features for the Scarborough 4D MSS.

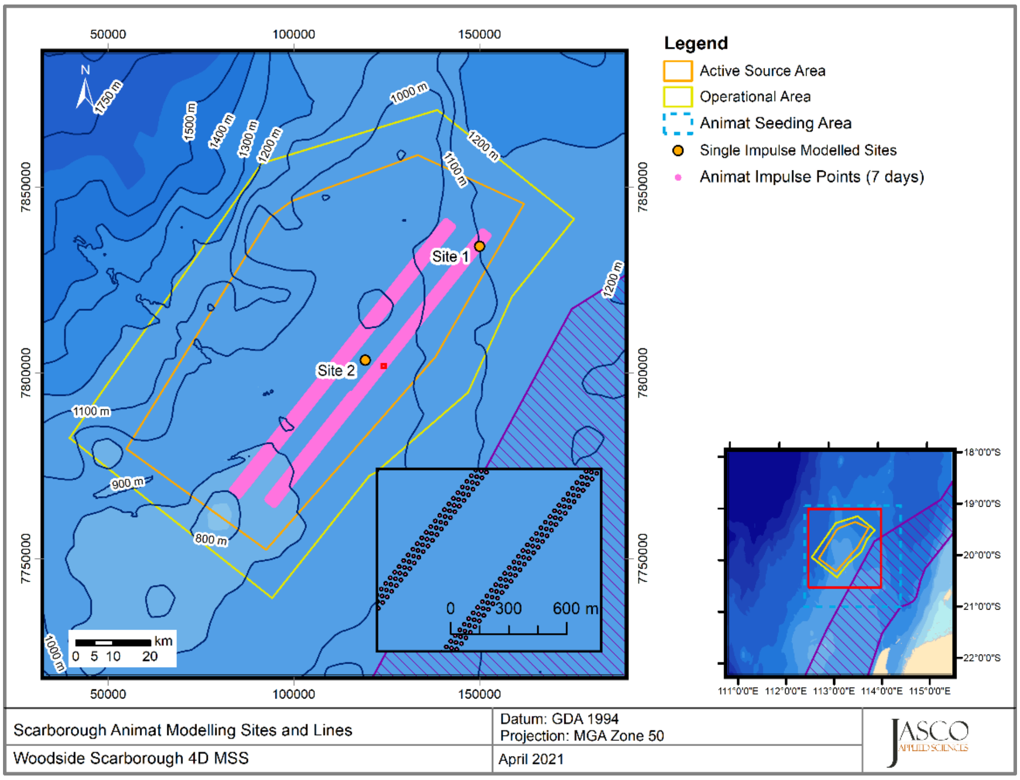

Figure 2. Overview of the features for the pygmy blue whale exposure modelling for the Scarborough 4D MSS.

3. Noise Effect Criteria

The perceived loudness of sound, especially impulsive noise such as from seismic airguns, is not generally proportional to the instantaneous acoustic pressure. Rather, perceived loudness depends on the pulse rise-time and duration, and the frequency content. Several sound level metrics, such as PK, SPL, and SEL, are commonly used to evaluate noise and its effects on marine life (Section 3). The period of accumulation associated with SEL is defined in this report over either a “per pulse” interval or over 24 h. Appropriate subscripts indicate any applied frequency weighting; unweighted SEL is defined as required. The acoustic metrics in this report reflect the updated ISO standard for acoustic terminology, ISO/DIS 18405:2017 (2017).

Whether acoustic exposure levels might injure or disturb marine mammals is an active research topic. Since 2007, several expert groups have developed SEL-based assessment approaches for evaluating auditory injury, with key works including Southall et al. (2007), Finneran and Jenkins (2012), Popper et al. (2014), and United States National Marine Fisheries Service (NMFS 2018). The number of studies that have investigated the level of behavioural disturbance to marine fauna by anthropogenic sound has also increased substantially.

The noise criteria and guidelines considered for this study were chosen because they include standard thresholds, and thresholds or guidelines suggested by the best available science (Sections 3.1–3.3 and Appendices A.3 and A.5):

1. Peak pressure levels (PK; L_{pk}) and frequency-weighted accumulated sound exposure levels (SEL; $L_{E,24\mathrm{h}}$) from the US National Oceanic and Atmospheric Administration (NOAA) Technical Guidance (NMFS 2018) for the onset of Permanent Threshold Shift (PTS) in marine mammals.
2. Marine mammal behavioural threshold based on the current US National Oceanic and Atmospheric Administration (NOAA 2019) criterion for marine mammals of 160 dB re 1 µPa (SPL; L_p) for impulsive sound sources.
3. Sound exposure guidelines for fish, fish eggs and larvae (including plankton) (Popper et al. 2014).
4. Peak pressure levels (PK; L_{pk}) and frequency-weighted accumulated sound exposure levels (SEL; $L_{E,24\mathrm{h}}$) from Finneran et al. (2017) for the onset of permanent threshold shift (PTS) and temporary threshold shift (TTS) in turtles.
5. Turtle behavioural response threshold of 166 dB re 1 µPa (SPL; L_p) (NSF 2011), as applied by the US NMFS, along with a sound level associated with behavioural disturbance 175 dB re 1 µPa (SPL; L_p) (McCauley et al. 2000b, 2000a).

Additionally, to assess the size of the low-power zone required under the Australian Environment Protection and Biodiversity Conservation (EPBC) Act Policy Statement 2.1, Department of the Environment, Water, Heritage and the Arts (DEWHA 2008), the distance to an unweighted per-pulse SEL of 160 dB re 1 µPa^2·s (SEL; L_E) is reported.

The following section expands on the thresholds and sound levels for marine mammals, fish, fish eggs, fish larvae, sea turtles, and plankton.

3.1. Marine Mammals

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

To help assess the potential for the possible injury and hearing sensitivity changes in marine mammals, this report applies the criteria recommended by NMFS (2018), considering both PTS and TTS. These criteria, along with the applied behavioural criteria (NOAA 2019), are summarised in Table 6, with descriptions included in Appendix A.3.1 (auditory impairment) and Appendix A.3.2 (behavioural response), with frequency weighting explained in Appendix A.4. The acoustic metrics in this report reflect the updated ISO standard for acoustic terminology, ISO/DIS 18405.2:2017 (2017).

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

Hearing group	NOAA (2019)	NMFS (2018)			
	Behaviour	PTS onset thresholds[a] (received level)		TTS onset thresholds[a] (received level)	
	SPL (L_p; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	PK (L_{pk}; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa²·s)	PK (L_{pk}; dB re 1 µPa)
Low-frequency cetaceans	160	183	219	168	213
Mid-frequency cetaceans		185	230	170	224
High-frequency cetaceans		155	202	140	196

[a] Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS and TTS onset.
L_p denotes sound pressure level period and has a reference value of 1 µPa.
L_{pk} denotes unweighted peak sound pressure and has a reference value of 1 µPa.
L_E denotes cumulative sound exposure over a 24-hour period and has a reference value of 1 µPa²s.
Subscripts indicate the designated marine mammal auditory weighting.

3.2. Fish, Fish Eggs, Fish Larvae and Plankton

In 2006, the Working Group on the Effects of Sound on Fish and Turtles was formed to continue developing noise exposure criteria for fish and turtles, work begun by a panel convened by NOAA two years earlier. The resulting guidelines included specific thresholds for different levels of effects and for different groups of species (Popper et al. 2014). These guidelines defined quantitative thresholds for three types of immediate effects:

- Mortality, including injury leading to death.
- Recoverable injury, including injuries unlikely to result in mortality, such as hair cell damage and minor haematoma.
- TTS.

Masking and behavioural effects can be assessed qualitatively, by assessing relative risk rather than by specific sound level thresholds. However, as these depend upon activity-based subjective distances, these effects are not addressed in this report and are included in Table 7 for completeness only. Because the presence or absence of a swim bladder has a role in hearing, fish's susceptibility to injury from noise exposure varies depending on the species and the presence and possible role of a swim bladder in hearing. Thus, different guidelines were proposed for fish without a swim bladder (also appropriate for sharks and applied to whale sharks in the absence of other information), fish with a swim bladder not used for hearing, and fish that use their swim bladders for hearing. Turtles, fish eggs, and fish larvae are considered separately. Table 7 lists relevant effects thresholds from Popper et al. (2014).

The SEL metric integrates noise intensity over some period of exposure. Because the period of integration for regulatory assessments is not well defined for sounds that do not have a clear start or end time, or for very long-lasting exposures, it is required to define a time. Popper et al. (2014) recommend applying a standard period, where this is either defined as a justified fixed period or the duration of the activity; however, Popper et al. (2014) also included caveats about how long the fish will be exposed because they can move (or remain in location) and so can the source. Popper et al. (2014) summarises that in all TTS studies considered, fish that showed TTS recovered to normal hearing levels within 18–24 hours. Due to this, a period of accumulation of 24 hours has been applied in this study for SEL, which is similar to that applied for marine mammals in NMFS (2016, 2018).

Additional information is provided in Appendix A.5.

Table 7. Guidelines for seismic noise exposure for fish, adapted from Popper et al. (2014).

Type of animal	Mortality and Potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Fish: No swim bladder (particle motion detection)	>219 dB SEL_{24h} or >213 dB PK	>216 dB SEL_{24h} or >213 dB PK	>>186 dB SEL_{24h}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: Swim bladder not involved in hearing (particle motion detection)	210 dB SEL_{24h} or >207 dB PK	203 dB SEL_{24h} or >207 dB PK	>>186 dB SEL_{24h}	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: Swim bladder involved in hearing (primarily pressure detection)	207 dB SEL_{24h} or >207 dB PK	203 dB SEL_{24h} or >207 dB PK	186 dB SEL_{24h}	(N) Low (I) Low (F) Moderate	(N) High (I) High (F) Moderate
Fish eggs and fish larvae (relevant to plankton)	>210 dB SEL_{24h} or >207 dB PK	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low

Peak sound level (PK) dB re 1 µPa; SEL_{24h} dB re 1µPa^2·s. All criteria are presented as sound pressure, even for fish without swim bladders, since no data for particle motion exist. Relative risk (high, moderate, or low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F).

3.3. Sea Turtles

There is a paucity of data regarding responses of turtles to acoustic exposure, and no studies of hearing loss due to exposure to loud sounds. Popper et al. (2014) suggested thresholds for onset of mortal injury (including PTS) and mortality for sea turtles and, in absence of taxon-specific information, adopted the levels for fish that do not hear well (suggesting that this likely would be conservative for sea turtles).

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

McCauley et al. (2000b) observed the behavioural response of caged sea turtles—green (*Chelonia mydas*) and loggerhead (*Caretta caretta*)—to an approaching seismic airgun. For received levels above 166 dB re 1 µPa (SPL), the sea turtles increased their swimming activity and above 175 dB re 1 µPa they began to behave erratically, which was interpreted as an agitated state. The 166 dB re 1 µPa level has been used as the threshold level for a behavioural disturbance response by NMFS and applied in the Arctic Programmatic Environment Impact Statement (PEIS) (NSF 2011). In addition the 175 dB re 1 µPa level from McCauley et al. (2000b) is recommended as a criterion for behavioural disturbance. The Recovery Plan for Marine Turtles in Australia (Department of the Environment and Energy et al. 2017) acknowledges the 166 dB re1 µPa SPL reported by McCauley et al. (2000b) as the level that may result in a behavioural response to marine turtles. These thresholds are shown in Table 8.

Table 8. Acoustic effects of impulsive noise on sea turtles: Unweighted SPL, SEL_{24h}, and PK thresholds.

Effect type	Criterion	SPL (L_p; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^2·s)	PK (L_{pk}; dB re 1 µPa)
Behavioural response	NSF (2011) DoEE (2017)	166	NA	
Behavioural disturbance	McCauley et al. (2000a)	175		
PTS onset thresholds* (received level)	Finneran et al. (2017)	NA	204	232
TTS onset thresholds* (received level)			189	226

* Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS and TTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered.
L_p denotes sound pressure level period and has a reference value of 1 µPa.
$L_{pk,flat}$ denotes peak sound pressure is flat weighted or unweighted and has a reference value of 1 µPa.
L_E denotes cumulative sound exposure over a 24 h period and has a reference value of 1 µPa^2s.

4. Methods

4.1. Parameters Overview

Sound propagation was modelled up to 100 km from each single-impulse modelled site (listed in Table 5). The specifications of the seismic source and the environmental parameters used in the propagation models are described in detail in Appendix C. A single sound speed profile for August was considered in this modelling study; this was identified as the month that would provide the farthest propagation over the potential operational window (January to April or July to October).

4.2. Acoustic Source Model

The pressure signature of the individual airguns and the composite decidecade-band point-source equivalent directional levels (i.e., source levels) of the seismic sources were modelled with JASCO's Airgun Array Source Model (AASM). Although AASM accounts for notional pressure signatures of each seismic source with respect to the effects of surface-reflected signals on bubble oscillations and inter-bubble interactions, the surface-reflected signal (known as surface ghost) is not included in the far-field source signatures. The acoustic propagation models account for those surface reflections, which are a property of the propagating medium rather than the source.

AASM considers:

- Array layout.
- Volume, tow depth, and firing pressure of each airgun.
- Interactions between different airguns in the array.

The seismic source considered (Appendix C.5) was modelled over AASM's full frequency range, up to 25 kHz. Appendix B.1 details this model.

4.3. Sound Propagation Models

Two sound propagation models were used to predict the acoustic field around the selected 3150 in^3 seismic source:

- Combined range-dependent parabolic equation and Gaussian beam acoustic ray-trace model (MONM-BELLHOP, 5 Hz to 25 kHz).
- Full Waveform Range-dependent Acoustic Model (FWRAM, 5 Hz to 1024 Hz).

The models were used in combination to characterise the acoustic fields in terms of SEL, SPL, PK, and PK-PK. Appendix B details each model. MONM-BELLHOP was used to calculate SEL in an area 360° around each source location. The model calculated propagation loss up to distances of 100 km, with a horizontal separation of 20 m between receiver points along the modelled radials. The sound fields were modelled with a horizontal angular resolution of $\Delta\theta$ = 2.5° for a total of N = 144 radial planes. Receiver depths were chosen to span the entire water column over the modelled area, from 2 m to a maximum of 2500 m, with step sizes that increased with depth. To supplement the MONM results, high-frequency predictions of propagation loss were modelled using Bellhop for frequencies from 2000 Hz to 25 kHz. The MONM and Bellhop predictions were combined to produce results for the full frequency-range of interest.

FWRAM was used to model synthetic seismic pulses and to generate a generalised range-dependent SEL to SPL conversion function (Appendix C.2) for the considered modelled sites. FWRAM was run to 100 km at modelled site 2, along four radials (fore and aft endfire, and port and starboard broadside) for computational efficiency. A single modelled site was used with FWRAM due to the relatively constant and similar water depths throughout the survey area. A horizontal range step of 20 m was used. Along each radial, computation was done at a variable depth increment starting at

2 m with step sizes that increased with depth. Receivers were selected to span the entire water column. The range-dependent conversion function was applied to predicted per-pulse SEL results from MONM and Bellhop to estimate SPL values. FWRAM was also used to calculate water column PK and PK-PK levels.

During a seismic survey, new sound energy is introduced into the environment with each pulse from the seismic source. While some effect criteria are based on the per-pulse energy released, others, such as the marine mammal, turtle, and fish SEL criteria used in this report account for the total acoustic energy marine fauna is subjected to over a specified period of time, defined in this report as 24 h. An accurate assessment of the accumulated sound energy depends not only on the parameters of each seismic pulse impulse, but also on the number of impulses delivered in a period and the relative positions of the impulses. Appendix C.3 provides additional details on the methods used to calculate the accumulated sound energy for the considered scenarios.

4.4. Animal Movement and Exposure Modelling

The JASCO Animal Simulation Model Including Noise Exposure (JASMINE) was used to predict the exposure of animats to sound arising from the seismic activity. JASMINE integrates the predicted sound field with biologically meaningful movement rules for each marine mammal species (pygmy blue whales for the current analysis) that result in an exposure history for each animat in the model. In JASMINE, the sound received by the animats is determined by the proposed seismic activity. As illustrated in Figure 3, animats are programmed to behave like the marine animals that may be present in the area. The parameters used for forecasting realistic behaviours (e.g., diving and foraging depth, swim speed, surface times) are determined and interpreted from marine mammal studies (e.g., tagging studies) where available, or reasonably extrapolated from related or comparable species. An individual animat's sound exposure levels are summed over a 24 h duration to determine its total received energy, and then compared to the relevant threshold criteria. For PK and SPL metrics, the maximum exposure is evaluated against single impulse threshold criteria, for each 24 h period. For additional information on JASMINE, see Appendix B.4.

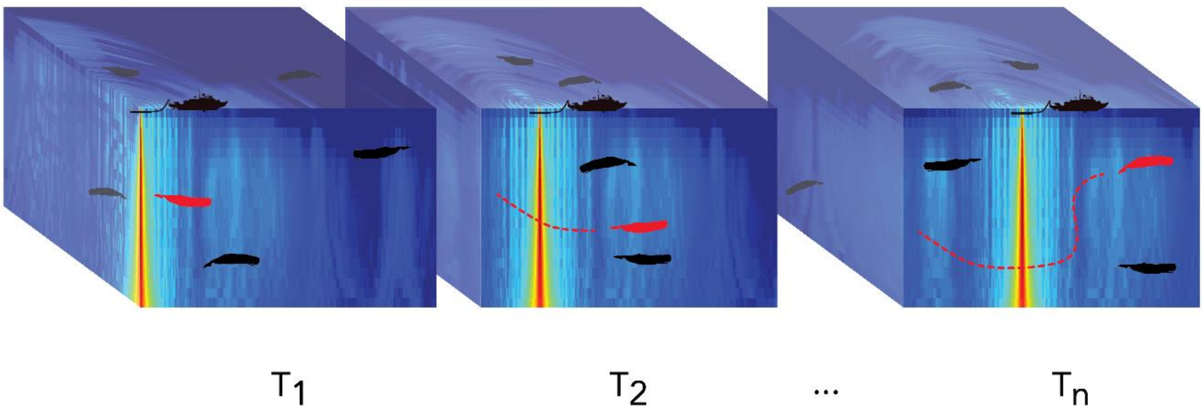

Figure 3. Cartoon of animats in a moving sound field. Example animat (red) shown moving with each time step (Tx). The acoustic exposure of each animat is determined by where it is in the sound field, and its exposure history is accumulated as the simulation steps through time.

The exposure criteria for impulsive sounds (described in Section 3) were used to determine the number of animats exceeding thresholds. To generate statistically reliable probability density functions, model simulations were run with animat densities of 2 animats/km^2, as this increases the probability of encounter, and thus more robust exposure range estimates. The modelling results are not related to real-world density estimates for pygmy blue whales within the migration BIA, as the number of animals potentially exposed is not calculated. To evaluate PTS, TTS, and behavioural response, exposure results were obtained using detailed behavioural information for migrating pygmy blue whales (described in Section 4.4.2). The simulation was run for a representative period of seven days, with the spatial distribution of animats restricted to the BIA.

The seismic source was modelled as a vessel towing an airgun array at a speed of 4.5 knots, with an impulse interval of 12.5 m. The simulated source track followed a racetrack configuration with a turn time of ~3.4 h. At the time and location of each seismic pulse, the modelled source location with the most similar water depth was selected for exposure modelling. The track lines along with the acoustic modelling locations are shown in Figure 2. Note that the closest point of approach of the acquisition lines to the migration BIA for the scenario is approximately 29.9 km.

4.4.1. Exposure-based Radial Distance Estimation

The results from the animal movement and exposure modelling provided a way to estimate radial distances to effect thresholds. The distance to the closest point of approach (CPA) for each of the animats was recorded. The $ER_{95\%}$ (95% Exposure Range) is the horizontal distance that includes 95% of the animat CPAs that exceeded a given effect threshold (Figure 4). The ER_{max} is the maximum distance at which any animat was exposed above threshold in the simulation. Within the $ER_{95\%}$ and ER_{max} radial distances, there are generally some proportion of animats that do not exceed threshold criteria. The probability that an animat is exposed above threshold within the $ER_{95\%}$ or ER_{max} is provided in the results tables.

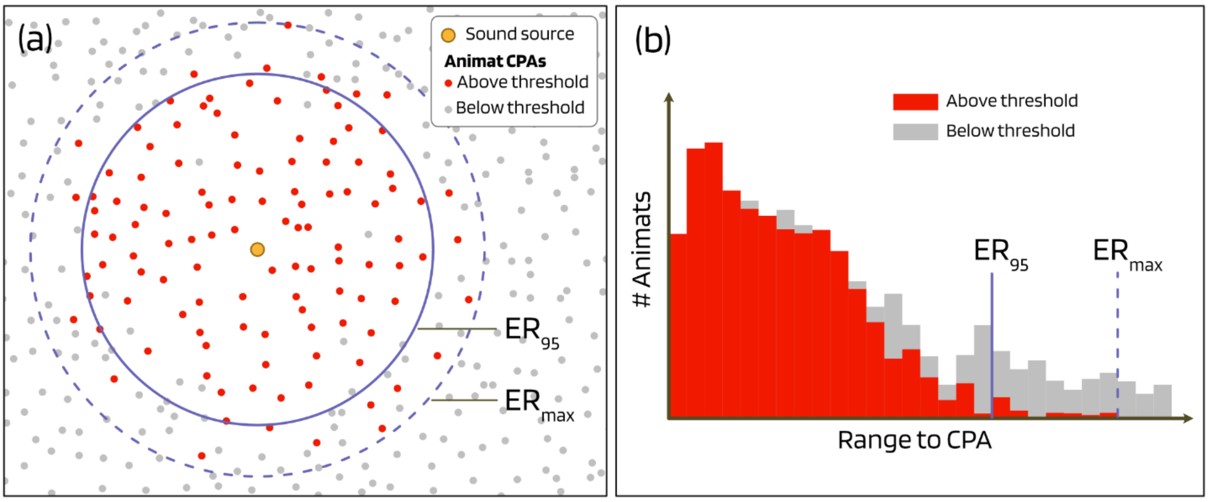

Figure 4. Example distribution of animat closest points of approach (CPAs). Panel (a) shows the horizontal distribution of animats near a sound source. Panel (b) shows the distribution of distances to animat CPAs. The 95% and maximum exposure ranges ($ER_{95\%}$ and ER_{max}) are indicated in both panels.

4.4.2. Pygmy Blue Whale Behaviour

The planned Scarborough 4D MSS is adjacent to the migration BIA for pygmy blue whales therefore, migratory behaviour was the only behavioural profile considered. Detailed information on pygmy blue whales was derived from a range of sources that used multi-sensor tags to record fine-scale dive and movement behaviour (Owen et al. 2016, Möller et al. 2020). Where information was unavailable for pygmy blue whales, parameters were derived from blue whale (*B. musculus*) tagging data (Goldbogen et al. 2011).

Multi-sensor tags typically record the depth of an animal along with various movement parameters such as swim speed and their body's orientation. Owen et al. (2016) equipped a sub-adult pygmy blue whale with a multi-sensor tag off Western Australia. They identified dives for their tagged animal as migratory, feeding, or exploratory (i.e., no lunges recorded which would indicate feeding). Pygmy blue whales in the simulation area are presumed to be migrating, and so feeding was not included in the model. Exploratory dives were considered to be part of migratory behaviour, and so the two dive types were modelled together such that the animats were migrating 95% of the time and engaged in exploratory dives 5% of the time (Owen et al. 2016). The analysis of the dive data showed that the depth of migratory dives was highly consistent over time and unrelated to local bathymetry. The mean depth of migratory dives was 14 ± 4 m while the mean maximum depth of exploratory dives was 107 ± 81 m (23–320 m range).

The behaviour of migrating pygmy blue whales was modelled to reflect animats transiting through the modelling area on a 50º track. This represents the animals migrating along the west coast of Australia, to and from Indonesia (Double et al. 2014, DoE (AU) 2015-2025).The speed of travel for migratory behaviour (1.17 ± 0.60 m/s) and exploratory dives (0.88 ± 0.14 m/s) were calculated from data presented in Möller et al. (2020).

5. Results

5.1. Acoustic Source Levels and Directivity

AASM (Section 4.2) was used to predict the horizontal and vertical overpressure signatures and corresponding power spectrum levels for the seismic sources, with results provided in Appendix C.5.1 along with the horizontal directivity plots for the selected source.

Table 9 shows the PK and per-pulse SEL source levels in the horizontal-plane broadside (perpendicular to the tow direction), endfire (along the tow direction), and vertical directions for the worst-case modelled array signature (a 3150 in^3 seismic source). The vertical source level that accounts for the "surface ghost" (the out of phase reflected pulse from the water surface) is also presented to make it easier to compare the output of other seismic source models.

Figure C-6 in Appendix C.5.1 shows the broadside, endfire, and vertical overpressure signature and corresponding power spectrum levels for the source. The signature consists of a strong primary peak, related to the initial release of high-pressure air, followed by a series of pulses associated with bubble oscillations. Most energy was produced at frequencies below 500 Hz. Frequency-dependent peaks and nulls in the spectrum result from interference among airguns in the source and correspond with the volumes and locations of the airguns relative to each other.

Table 9. Far-field source level specifications for the 3150 in^3 seismic source, for a 7 m tow depth. Source levels are for a point-like acoustic source with equivalent far-field acoustic output in the specified direction. Sound level metrics are per-pulse and unweighted.

Direction	Peak source pressure level ($L_{S,pk}$) (dB re 1 µPa m)	Per-pulse source SEL ($L_{S,E}$) (dB 1 µPa²m²s)	
		10–2000 Hz	2000–25000 Hz
Broadside	248.1	224.1	183.9
Endfire	246.3	223.2	183.9
Vertical	254.4	227.4	193.5
Vertical (surface affected source level)	254.4	230.2	196.5

5.2. Per-Pulse Sound Fields

This section presents the per-pulse sound fields in terms of maximum-over-depth SPL, SEL, PK, and PK-PK. The different metrics are presented for the following reasons:

- SPL sound fields were used to determine the distances to marine mammal and turtle behavioural thresholds (see Sections 3.1 and 3.3).
- Per-pulse SEL sound fields are used as inputs into the 24 h SEL scenarios and to provide context for the radial distance to 160 dB re 1 µPa^2·s, relevant for the EPBC Act Policy Statement 2.1 (DEWHA 2008).
- PK metrics within the water column are relevant to thresholds and guidelines for marine mammals, sea turtles, fish, fish eggs and larvae (Sections 3.1 –3.3)

The maximum and 95% distances to per-pulse SEL and SPL metrics are presented in Tables 10 and 11. The SPL sound fields, and distances to relevant isopleths can be visualised on the contour maps presented in Figures 5 to 8, whilst the per-pulse SEL sound field maps are presented in Appendix D. The SPL sound fields are also presented as vertical slices for selected sites along the endfire and broadside directions out to 50 km, with the airgun array in the centre (Figures 9 and 10).

Maximum distances to PK and PK-PK thresholds were calculated for both modelled sites in the water column, with maximum-over-depth results presented in Table 12.

5.2.1. Tabulated Results

5.2.1.1. Entire Water Column

Table 10. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the 3150 in^3 source to modelled unweighted maximum-over-depth per-pulse SEL isopleths from the modelled single impulse sites, with water depth indicated. Distances are reported as the maximum considering both tow directions at each site.

Per-pulse SEL (L_p; dB re 1 µPa^2·s)	**Site 1 (1101 m depth)**		**Site 2 (925 m depth)**	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
200	–	–	–	–
190	0.05	0.05	0.05	0.05
180	0.16	0.13	0.16	0.13
170	0.48	0.41	0.49	0.41
160[a]	2.1	1.75	2.17	1.80
150	9.28	7.4	8.40	7.12
140	34.6	25.3	33.4	27.2
130	>100	/	>100	/

[a] Low power zone assessment criteria DEWHA (2008).
A slash indicates that the $R_{95\%}$ radius to threshold is not reported because the R_{max} is greater than the maximum modelling extent.
A dash indicates the threshold was not reached within the limits of the modelling resolution (20 m).

Table 11. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) from the 3150 in^3 source to modelled maximum-over-depth SPL isopleths from the modelled single impulse sites, with water depth indicated. distances are reported as the maximum considering both tow directions at each site.

SPL (L_p; dB re 1 µPa)	**Site 1 (1101 m depth)**		**Site 2 (925 m depth)**	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
200	0.03	0.03	0.03	0.03
190	0.13	0.11	0.13	0.11
180	0.43	0.37	0.43	0.37
175[a]	0.76	0.63	0.75	0.63
170	1.74	1.32	1.86	1.51
166[b]	3.87	2.84	3.72	3.23
160[c]	7.28	4.61	6.99	6.05
150	22.3	16.8	22.6	16.9
140	84.9	60.2	86.7	65.3
130	>100	/	>100	/

[a] Threshold for turtle behavioural disturbance from impulsive noise (McCauley et al. 2000b).
[b] Threshold for turtle behavioural response to impulsive noise (NSF 2011).
[c] Marine mammal behavioural threshold for impulsive sound sources (NOAA 2019).
A slash indicates that the $R_{95\%}$ radius to threshold is not reported because the R_{max} is greater than the maximum modelling extent.

Table 12. Maximum (R_{max}) horizontal distances (km) from the 3150 in^3 array to modelled maximum-over-depth peak pressure level (PK) thresholds based on the NOAA Technical Guidance (NMFS 2018) for marine mammals, and Popper et al. (2014) for fish and Finneran et al. (2017) for turtles from the modelled single impulse Site 2, with water depth indicated.

Hearing group		**PK threshold (L_{pk}; dB re 1 µPa)**	**Distance R_{max} (km)** Site 2 (925 m depth)
Low-frequency cetaceans	PTS	219	0.03
	TTS	213	0.06
Mid-frequency cetaceans	PTS	230	–
	TTS	224	–
High-frequency cetaceans	PTS	202	0.19
	TTS	196	0.39
Sea turtles	PTS	232	–
	TTS	226	–
Fish: No swim bladder (also applied to sharks)		213	0.06
Fish: Swim bladder not involved in hearing; Swim bladder involved in hearing Fish eggs, larvae and plankton		207	0.11

A dash indicates the threshold was not reached within the limits of the modelling resolution (20 m).

5.2.2. Sound field maps and graphs

5.2.2.1. Sound Level Contour Maps

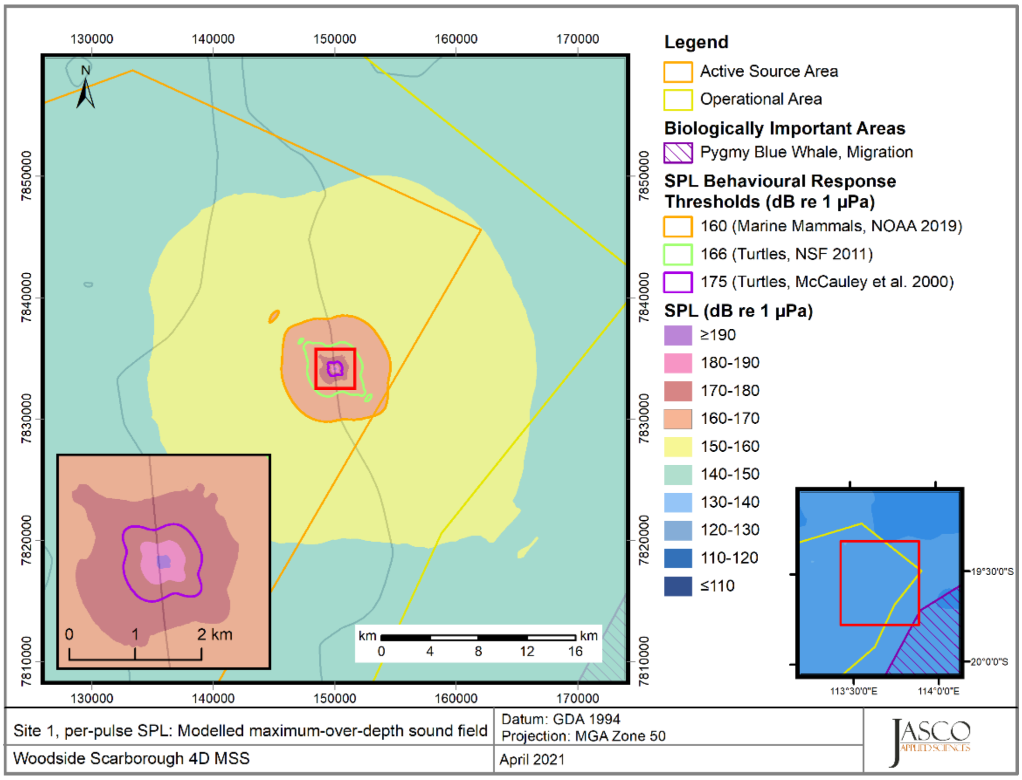

Figure 5. *Site 1, tow azimuth 40°, SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response thresholds for marine mammals and turtles.

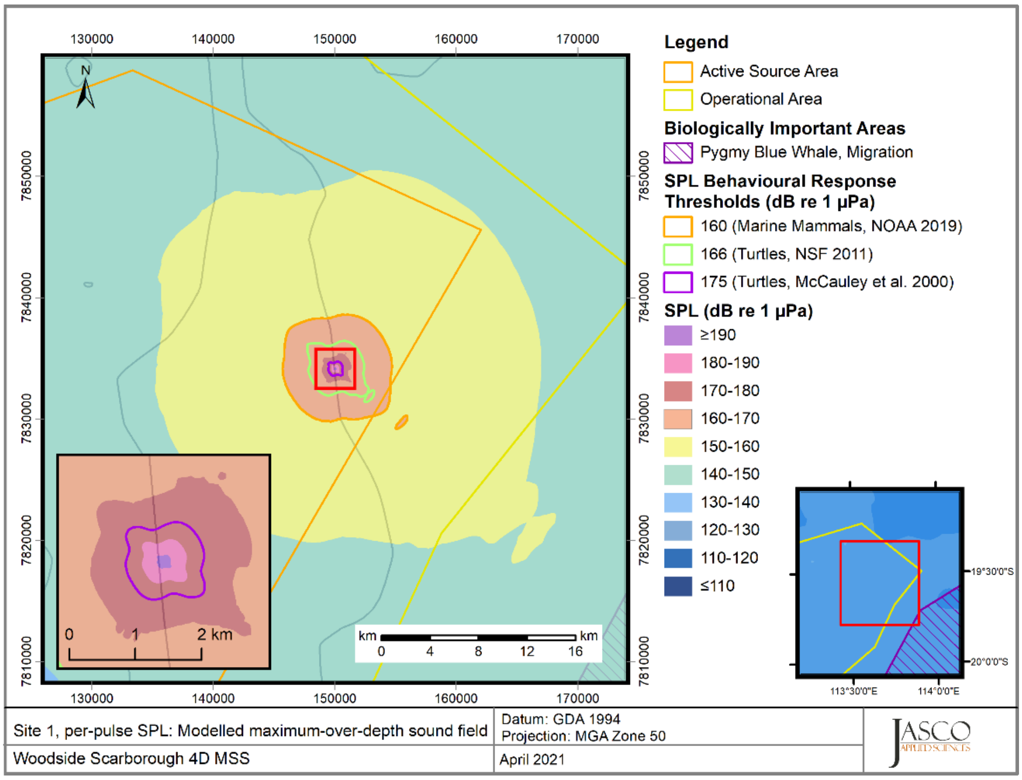

Figure 6. *Site 1, tow azimuth 220°, SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response thresholds for marine mammals and turtles.

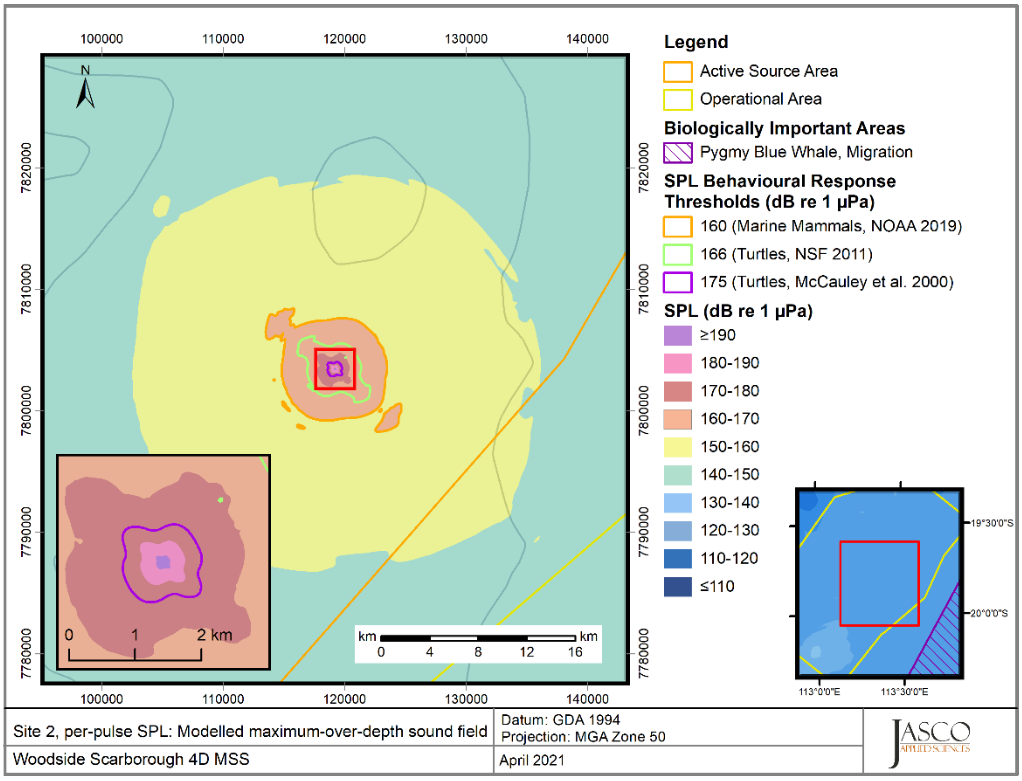

Figure 7. *Site 2, tow azimuth 40°, SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response thresholds for marine mammals and turtles.

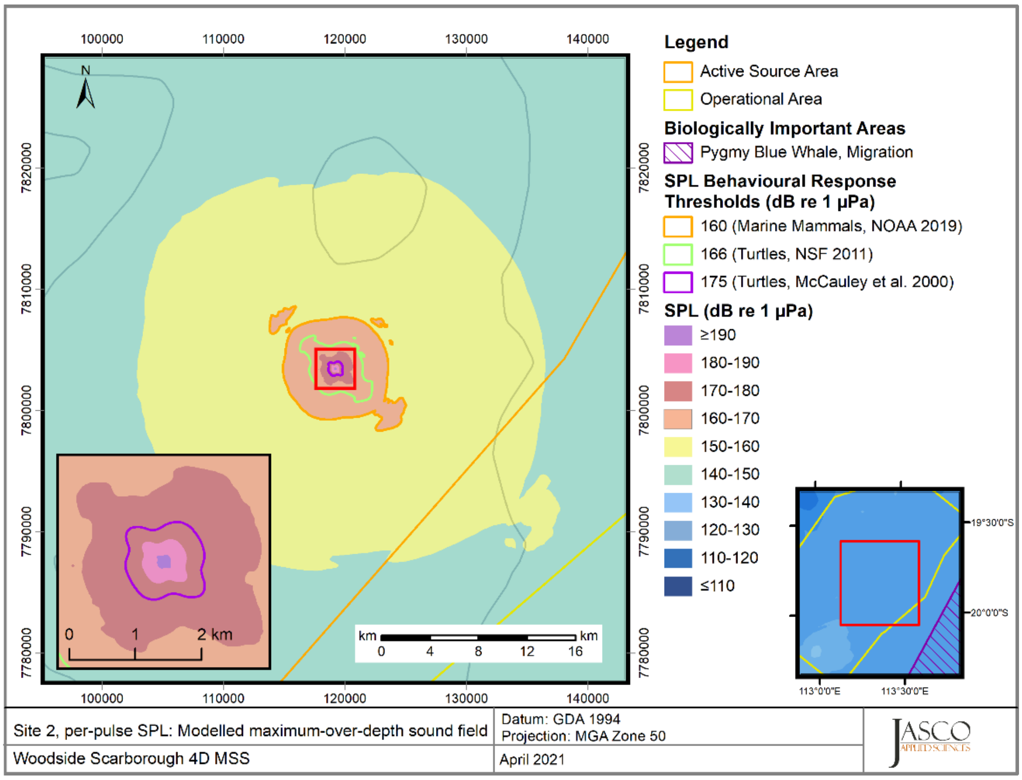

Figure 8. *Site 2, tow azimuth 220°, SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response thresholds for marine mammals and turtles.

5.2.2.2. Vertical Slices of Modelled Sound Fields

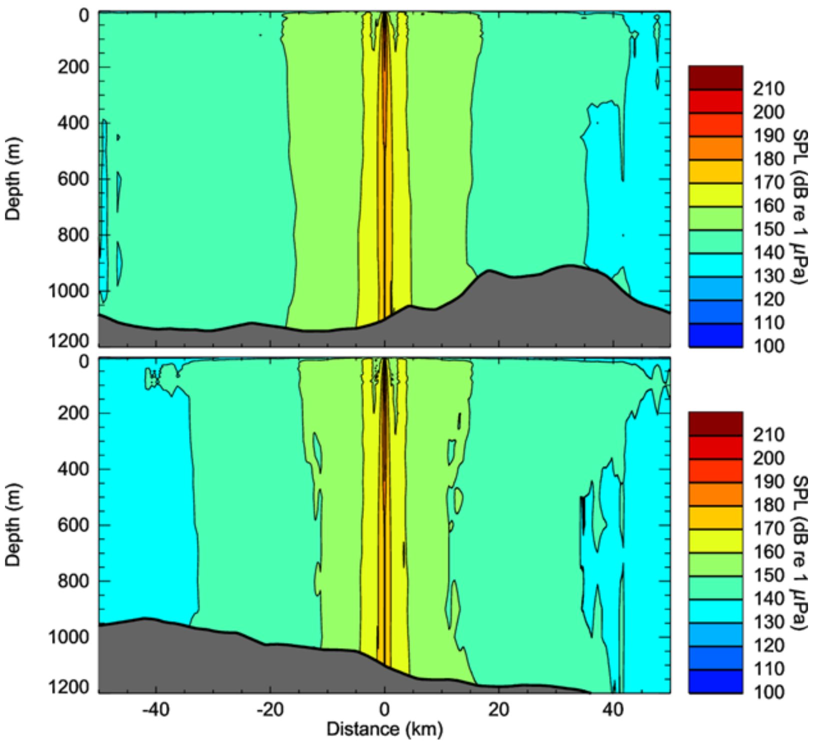

Figure 9. *Site 1, tow azimuth 40°, SPL*: Sound level contours in vertical slice of the sound field, perpendicular to (broadside, top) and along the tow direction (endfire, bottom). The positive distance direction for the broadside slice is 90° counter-clockwise (‘Port’) from the tow azimuth. The positive distance direction for the endfire slice is in line with the tow azimuth (the direction of transit).

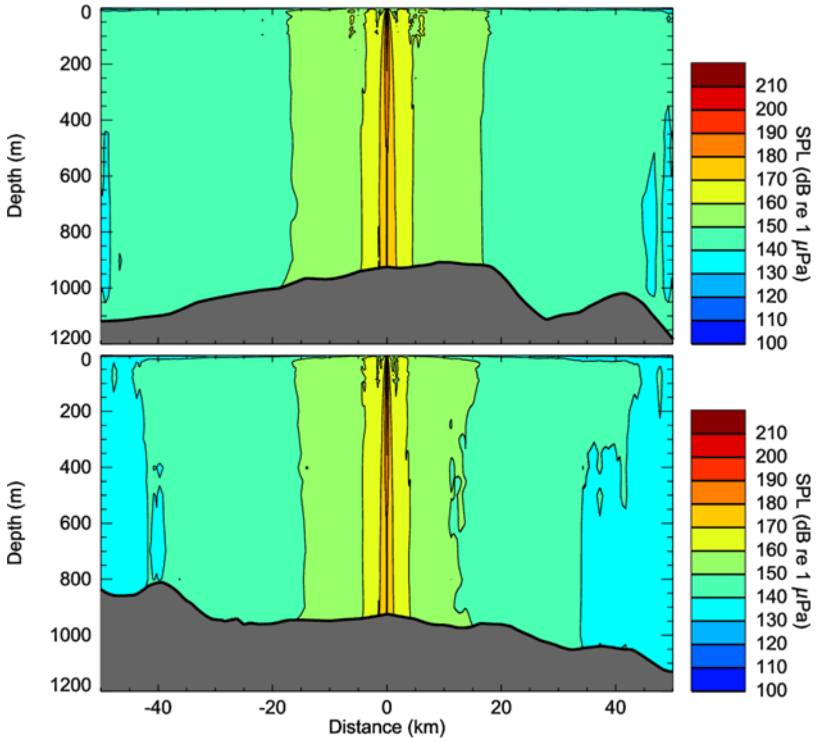

Figure 10. *Site 2, tow azimuth 40°, SPL*: Sound level contours in vertical slice of the sound field, perpendicular to (broadside, top) and along the tow direction (endfire, bottom). The positive distance directionfor the broadside slice is 90° counter-clockwise (‘Port’) from the tow azimuth. The positive distance direction for the endfire slice is in line with the tow azimuth (the direction of transit).

5.3. Multiple Pulses Sound Fields

This section presents the sound fields in terms of SEL accumulated over 24 h of survey for the modelled SEL_{24h} scenario. Frequency-weighted SEL_{24h} sound fields were used to estimate the maximum and 95% distances (R_{max} and $R_{95\%}$; calculated as detailed in Appendix C.1) to marine mammals and turtle PTS and TTS thresholds (Table 13), and to estimate maximum distance and the area to injury and TTS thresholds for fish over the entire water column (Table 14). Whilst seafloor sound levels were not specifically assessed, the distribution of the sound within the water column (Figures 9 and 10) indicates the ranges at the seafloor would not exceed maximum-over-depth distances.

The SEL_{24h} sound fields are presented as a contour map in Figure 11. This figure presents the unweighted SEL_{24h} in 10 dB steps, as well as the isopleths corresponding to criteria thresholds. Only contours at distances longer than the nearfield of the seismic source are rendered.

5.3.1. Tabulated Results

Table 13. *Marine mammal and sea turtle criteria*: Maximum (R_{max}) horizontal distances (in km) from the survey lines to permanent threshold shift (PTS) and temporary threshold shift (TTS) thresholds considering 24 h of survey activity (maximum-over-depth).

Hearing group	Weighted SEL thresholds ($L_{E,24h}$; dB re 1 µPa²·s)	R_{max} (km)	Area (km²)
PTS			
Low-frequency cetaceans	183	0.38	122
Mid-frequency cetaceans	185	–	–
High-frequency cetaceans	155	–	–
Sea turtles	204	0.05	13.8
TTS			
Low-frequency cetaceans	168	60.7	9863
Mid-frequency cetaceans	170	–	–
High-frequency cetaceans	140	0.16	52.6
Sea turtles	189	0.28	88.2

A dash indicates the threshold was not reached within the limits of the modelling resolution (20 m).

Table 14. *Fish criteria*: Maximum horizontal distances (R_{max}, in km) from the survey lines and area (km²) to injury and temporary threshold shift (TTS) thresholds considering 24 h of survey activity (maximum-over-depth).

Marine fauna group	SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)	R_{max} (km)	Area (km²)
Mortality and potential mortal injury			
I	219	0.05	13.0
II, fish eggs and fish larvae	210	0.05	13.8
III	207	0.05	13.8
Fish recoverable injury			
I	216	0.05	13.0
II, III	203	0.05	14.1
Fish TTS			
I, II, III	186	4.5	1210

Fish I–No swim bladder; Fish II–Swim bladder not involved with hearing; Fish III–Swim bladder involved with hearing.

5.3.2. Sound Level Contour Maps

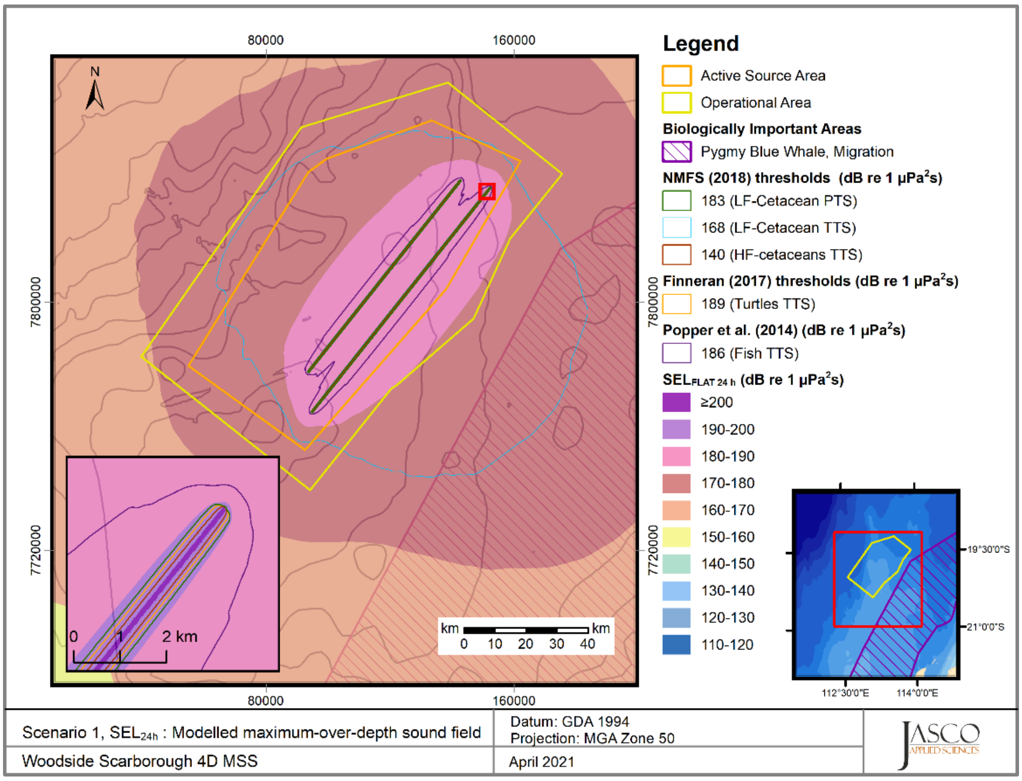

Figure 11. *Accumulated $SEL_{24\,h}$ Scenario*: Sound level contour map showing unweighted maximum-over-depth SEL_{24h} results, along with isopleths for cetaceans, turtles, and fish. Thresholds omitted here were not reached or not long enough to display graphically. Refer to Tables 13 and 14 for tabulated radii.

5.4. Animal Movement Exposure Ranges

A summary of radial distances to exposure thresholds for migrating pygmy blue whales is included in Table 15. Results include $ER_{95\%}$ and ER_{max} exposure ranges calculated for the 160 dB behavioural response threshold and PK and SEL thresholds for both TTS and PTS.

Table 15. Summary of animat simulation results for migrating pygmy blue whales. The 95th percentile exposure ranges ($ER_{95\%}$) and maximum exposure ranges (ER_{max}) in km and probability of animats being exposed above threshold within the $ER_{95\%}$ and ER_{max} are provided.

Threshold			**Maximum acoustic radial distance to threshold (km)**	**$ER_{95\%}$**		**ER_{max}**	
Description		Threshold level (dB)		Distance (km)	Probability of exposure (%)	Distance (km)	Probability of exposure (%)
TTS	PK	213[a]	0.06	*	0	*	0
	SEL_{24h}	168[b]	60.7	*	0	*	0
PTS	PK	219[a]	0.03	*	0	*	0
	SEL_{24h}	183[c]	0.38	*	0	*	0
Behavioural response		160[c]	7.28	*	0	*	0

[a] PK (L_{pk}; dB re 1 µPa)
[b] LF-weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^2·s)
[c] SPL (L_p; dB re 1 µPa)
An asterisk indicates that no animats were exposed to sound levels exceeding threshold criteria.

6. Discussion and Conclusions

This modelling study predicted underwater sound levels associated with the planned Scarborough 4D MSS. The underwater sound field was modelled for a 3150 in^3 seismic source (Appendix C.5). An analysis of seasonal sound speed profiles was conducted (Appendix C.4.2) to determine which month within the proposed acquisition period was the most conducive to sound propagation. The modelling also accounted for site-specific bathymetric variations (Appendix C.4.1) and local geoacoustic properties (Appendix C.4.3).

Most acoustic energy from the seismic sources is output at lower frequencies, in the tens to hundreds of hertz. Simulation results showed the array has a pronounced broadside directivity for 1/3-octave-bands between approximately 100 Hz to about 300 Hz (Appendix C.5.1), which leads to a noticeable axial bulge in the modelled acoustic footprints.

6.1. Per-Pulse and Multiple Pulse Sound Fields

At both single impulse sites the distance to reported isopleths were generally greater in the broadside direction than in the endfire direction, a difference apparent in footprint maps in Section 5.2.2.1. The array directionality and frequency content was the primary driver of levels at longer distances. When in deeper water, the seismic source will have a lower “cut-off frequency (f_c)” than if the source were in shallower water. The cut-off frequency is a single number that describes how much acoustic energy can propagate with minimal loss between the sea surface and seafloor interfaces. For a given acoustic signal, frequencies below f_c are subject to higher loss compared to frequencies above the f_c (Jensen et al. 2011). For this environment, the cut-off frequency was less than 10 Hz, which allows for a large amount of low-frequency energy to propagate in the water column.

Considering the NMFS (2018) SEL_{24h} criteria, low- and high-frequency cetaceans are predicted to experience PTS and TTS (Tables 12 and 13). The footprints and radial distance maxima for all accumulated SEL thresholds are influenced by the consistent water depth with the surrounding area of the survey. Water depths on average 900 m allow the large amount of low-frequency energy to propagate within the water column, which can result in levels propagating to significant distances away from the source by being continually refracted within the deep sound channel. Furthermore, the presence of a slight upward refracting layer near the sea surface also has the potential to trap levels at high frequencies which would otherwise dissipate more rapidly with distance from the source due to spreading and seabed loss.

6.2. Animal Movement Exposure Ranges

The estimated sound fields produced by source and propagation models for the seismic survey were incorporated into a sound exposure model to estimate the radial distance within which 95% of the exposure exceedances occur ($ER_{95\%}$), along with the probability that an animat with a closest point of approach within that distance would be exposed above the relevant threshold.

SEL, PK, and behavioural SPL thresholds were not exceeded since the closest point of approach to the BIA (29.9 km) was longer than the maximum possible distance to threshold (Figure 2). These results differ from the radial distances predicted by the acoustic modelling because they assumed a static receiver. Animal movement modelling simulations incorporate the real-world movements of migrating pygmy blue whales within the migration BIA.

6.3. Summary

This section presents summaries of the distances to the noise effect criteria applied in this study (Section 3) as relevant to the effect assessment. The effect criteria for impairment of marine mammals, fish, and sea turtles use dual metrics (PK and SEL_{24h}), and the longest distance associated with either metric is required to be applied, and thus is presented in this summary.

SEL_{24h} is a cumulative metric that reflects the dosimetric effect of noise levels within 24 h based on the assumption that an animal is consistently exposed to such noise levels at a fixed position. Where the corresponding SEL_{24h} radii for are longer than those for peak pressure criteria, they often represent an unlikely worst-case scenario. More realistically, marine mammals, fish, and sea turtles would not remain in the same location for 24 h, but rather a shorter period, depending upon their behaviour and the source's proximity and movements. Therefore, a reported radius for SEL_{24h} criteria does not mean that marine fauna travelling within this radius of the source will be impaired, but rather that an animal could be exposed to the sound level associated with impairment (either PTS or TTS) if it remained in that location for 24 h.

Marine mammals

- Table 16 summarises the distances to criteria for marine mammals.

Table 16. Maximum (R_{max}) horizontal distances (in km) from modelled sites or scenarios to behavioural response thresholds and PTS and TTS thresholds for marine mammals (PK values from Table 12 and SEL_{24h} values from Table 13).

Hearing group	Modelled distance to effect threshold (R_{max})		
	Behavioural response[a]	Impairment: TTS[b]	Impairment: PTS[b]
LF cetaceans	7.28	60.7	0.38
MF cetaceans		–	–
HF cetaceans		0.39	0.19

[a] Noise exposure criteria: NOAA (2019)
[b] Noise exposure criteria: NMFS (2018)
A dash indicates the threshold was not reached within the limits of the modelling resolution (20 m).

Sea turtles

- Table 17 summarises the distances to criteria for sea turtles.

Table 17. Maximum (R_{max}) horizontal distances (in km) from modelled sites or scenarios to behavioural response thresholds and PTS and TTS thresholds for sea turtles (PK values from Table 12 and SEL_{24h} values from Table 13).

Hearing group	Modelled distance to effect threshold (R_{max})			
	Behavioural response[a]	Behavioural disturbance[b]	Impairment: TTS[c]	Impairment: PTS[c]
Turtles	3.87	0.76	0.28	0.05

[a] Noise exposure criteria: NSF (2011)
[b] Noise exposure criteria: McCauley et al. (2000a)
[c] Noise exposure criteria: Finneran et al. (2017)

Fish, fish eggs, fish larvae and plankton

- This modelling study assessed the radial distances to quantitative guidelines based on Popper et al. (2014) and considered both PK and SEL_{24h} (maximum over water column) metrics associated with mortality and potential mortal injury as well as impairment in the following groups:
  - Fish without a swim bladder (also appropriate for sharks in the absence of other information)
  - Fish with a swim bladder that do not use it for hearing
  - Fish that use their swim bladders for hearing
  - Fish eggs, fish larvae and plankton

- Table 18 summarises the distances to injury guidelines for fish, fish eggs, fish larvae and plankton along with the relevant metric and the location of the information within this report.

Table 18. Summary of maximum fish, fish eggs, and larvae injury and TTS onset distances for single impulse and SEL_{24h} modelled scenarios (PK values from Table 12 and SEL_{24h} values from Table 14).

Relevant hearing group	**Effect criteria**	**Scenario 1**	
		Metric associated with longest distance to criteria	R_{max} (km)
Fish: No swim bladder	Injury	PK	0.06
	TTS	SEL_{24h}	4.5
Fish: Swim bladder not involved in hearing and Swim bladder involved in hearing	Injury	PK	0.11
	TTS	SEL_{24h}	4.5
Fish eggs, fish larvae and plankton	Injury	PK	0.11

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Appendix A. Acoustic Metrics

A.1. Pressure Related Acoustic Metrics

Underwater sound pressure amplitude is measured in decibels (dB) relative to a fixed reference pressure of p_0 = 1 µPa. Because the perceived loudness of sound, especially pulsed sound such as from seismic airguns, pile driving, and sonar, is not generally proportional to the instantaneous acoustic pressure, several sound level metrics are commonly used to evaluate sound and its effects on marine life. Here we provide specific definitions of relevant metrics used in the accompanying report. Where possible, we follow the American National Standard Institute and International Organization for Standardization definitions and symbols for sound metrics (e.g., ISO 2017, ANSI S1.1-2013), but these standards are not always consistent.

The zero-to-peak sound pressure, or peak sound pressure (PK or $L_{p,pk}$; dB re 1 µPa), is the decibel level of the maximum instantaneous acoustic pressure in a stated frequency band attained by an acoustic pressure signal, $p(t)$:

$$L_{p,\mathrm{pk}} = 10\log_{10}\left(\frac{\max|p^2(t)|}{p_0^2}\right) = 20\log_{10}\left(\frac{\max|p(t)|}{p_0}\right) \tag{A-1}$$

PK is often included as a criterion for assessing whether a sound is potentially injurious; however, because it does not account for the duration of an acoustic event, it is generally a poor indicator of perceived loudness.

The peak-to-peak sound pressure (PK-PK or $L_{p,pk\text{-}pk}$; dB re 1 µPa) is the difference between the maximum and minimum instantaneous sound pressure, possibly filtered in a stated frequency band, attained by an impulsive sound, $p(t)$:

$$L_{p,\mathrm{pk\text{-}pk}} = 10\log_{10}\left(\frac{[\max(p(t)) - \min(p(t))]^2}{p_0^2}\right) \tag{A-2}$$

The sound pressure level (SPL or L_p; dB re 1 µPa) is the root-mean-square (rms) pressure level in a stated frequency band over a specified time window (T; s). It is important to note that SPL always refers to an rms pressure level and therefore not instantaneous pressure:

$$L_p = 10\log_{10}\left(\frac{1}{T}\int_T g(t)\,p^2(t)\,dt \Big/ p_0^2\right) \tag{A-3}$$

where $g(t)$ is an optional time weighting function. In many cases, the start time of the integration is marched forward in small time steps to produce a time-varying SPL function. For short acoustic events, such as sonar pulses and marine mammal vocalizations, it is important to choose an appropriate time window that matches the duration of the signal. For in-air studies, when evaluating the perceived loudness of sounds with rapid amplitude variations in time, the time weighting function $g(t)$ is often set to a decaying exponential function that emphasizes more recent pressure signals. This function mimics the leaky integration nature of mammalian hearing. For example, human-based fast time-weighted SPL ($L_{p,fast}$) applies an exponential function with time constant 125 ms. A related simpler approach used in underwater acoustics sets $g(t)$ to a boxcar (unity amplitude) function of width 125 ms; the results can be referred to as $L_{p,boxcar\ 125ms}$. Another approach, historically used to evaluate SPL of impulsive signals underwater, defines $g(t)$ as a boxcar function with edges set to the times corresponding to 5% and 95% of the cumulative square pressure function encompassing the duration of an impulsive acoustic event. This calculation is applied individually to each impulse signal, and the results have been referred to as 90% SPL ($L_{p,90\%}$). In this report, SPL refers to $L_{p,boxcar\ 125ms}$.

The sound exposure level (SEL or L_E; dB re 1 µPa²·s) is the time-integral of the squared acoustic pressure over a duration (T):

$$L_E = 10\log_{10}\left(\int_T p^2(t)\,dt \Big/ T_0 p_0^2\right) \tag{A-4}$$

where T_0 is a reference time interval of 1 s. SEL continues to increase with time when non-zero pressure signals are present. It is a dose-type measurement, so the integration time applied must be carefully considered for its relevance to effect to the exposed recipients.

SEL can be calculated over a fixed duration, such as the time of a single event or a period with multiple acoustic events. When applied to pulsed sounds, SEL can be calculated by summing the SEL of the N individual pulses. For a fixed duration, the square pressure is integrated over the duration of interest. For multiple events, the SEL can be computed by summing (in linear units) the SEL of the N individual events:

$$L_{E,N} = 10\log_{10}\sum_{i=1}^{N} 10^{\frac{L_{E,i}}{10}} \tag{A-5}$$

Because the SPL and SEL are both computed from the integral of square pressure, these metrics are related numerically by the following expression, which depends only on the duration of the time window T:

$$L_p = L_E - 10\log_{10}(T) \tag{A-6}$$

When applied, the frequency weighting of an acoustic event should be specified, as in the case of weighted SEL (e.g., $L_{E,LF,24h}$; see Appendix A.4).

A.2. Decidecade Band Analysis

The distribution of a sound's power with frequency is described by the sound's spectrum. The sound spectrum can be split into a series of adjacent frequency bands. Splitting a spectrum into 1 Hz wide bands, called passbands, yields the power spectral density of the sound. This splitting of the spectrum into passbands of a constant width of 1 Hz, however, does not represent how animals perceive sound.

Because animals perceive exponential increases in frequency rather than linear increases, analysing a sound spectrum with passbands that increase exponentially in size better approximates real-world scenarios. In underwater acoustics, a spectrum is commonly split into decidecade bands, which are one tenth of a decade wide. They are approximately one third of an octave (base 2) wide and are therefore often referred to as 1/3-octave-bands. Each octave represents a doubling in sound frequency. The centre frequency of the ith band, $f_c(i)$, is defined as:

$$f_c(i) = 10^{\frac{i}{10}}\,\text{kHz} \tag{A-7}$$

and the low (f_{lo}) and high (f_{hi}) frequency limits of the ith decade band are defined as:

$$f_{lo,i} = 10^{\frac{-1}{20}} f_c(i) \quad \text{and} \quad f_{hi,i} = 10^{\frac{1}{20}} f_c(i) \tag{A-8}$$

The decidecade bands become wider with increasing frequency, and on a logarithmic scale the bands appear equally spaced (Figure A-1). The acoustic modelling spans from band 7 (f_c (7) = 5 Hz) to band 44 ($f_c(44)$ = 25 kHz).

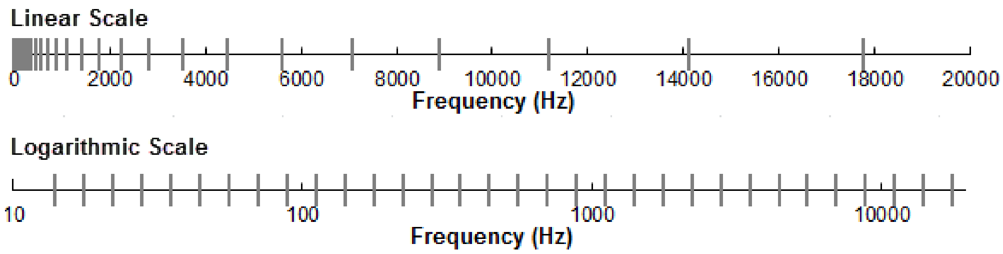

Figure A-1. Decidecade frequency bands (vertical lines) shown on a linear frequency scale and a logarithmic scale.

The sound pressure level in the ith band ($L_{p,i}$) is computed from the spectrum $S(f)$ between $f_{\mathrm{lo},i}$ and $f_{\mathrm{hi},i}$:

$$L_{p,i} = 10\log_{10} \int_{f_{\mathrm{lo},i}}^{f_{\mathrm{hi},i}} S(f)\,df \tag{A-9}$$

Summing the sound pressure level of all the bands yields the broadband sound pressure level:

$$\text{Broadband SPL} = 10\log_{10} \sum_i 10^{\frac{L_{p,i}}{10}} \tag{A-10}$$

Figure A-2 shows an example of how the decidecade band sound pressure levels compare to the sound pressure spectral density levels of an ambient noise signal. Because the decidecade bands are wider with increasing frequency, the decidecade band SPL is higher than the spectral levels at higher frequencies. Acoustic modelling of decidecade bands requires less computation time than 1 Hz bands and still resolves the frequency-dependence of the sound source and the propagation environment.

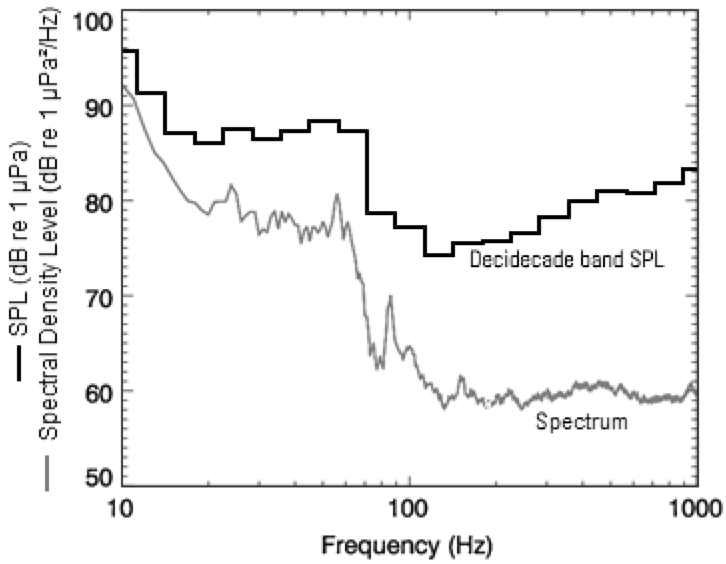

Figure A-2. Sound pressure spectral density levels and the corresponding decidecade band sound pressure levels of example ambient noise shown on a logarithmic frequency scale.

A.3. Marine Mammal Effect Criteria

It has been long recognised that marine mammals can be adversely affected by underwater anthropogenic noise. For example, Payne and Webb (1971) suggested that communication distances of fin whales are reduced by shipping sounds. Subsequently, similar concerns arose regarding effects of other underwater noise sources and the possibility that impulsive sources–primarily airguns used in seismic surveys–could cause auditory injury. This led to a series of workshops held in the late 1990s, conducted to address acoustic mitigation requirements for seismic surveys and other underwater noise sources (NMFS 1998, ONR 1998, Nedwell and Turnpenny 1998, HESS 1999, Ellison and Stein 1999). In the years since these early workshops, a variety of thresholds have been proposed for both injury and disturbance. The following sections summarize the recent development of thresholds; however, this field remains an active research topic.

A.3.1. Auditory Impairment

There are two categories of auditory threshold shifts (also termed Noise Induced Threshold Shift, NITS): Permanent Threshold Shift (PTS), a physical injury to an animal's hearing system; and Temporary Threshold Shift (TTS), a temporary reduction in an animal's hearing sensitivity as the result of physiological and mechanical processes in the inner ear. While PTS undoubtedly constitutes an injury, TTS (as a temporary effect) was not considered in the same way. However, recent research clearly indicates that already moderate levels (<12 dB) of TTS produced an accelerated hearing loss (PTS) resulting from progressive neural degeneration with age (Kujawa and Liberman 2006, 2009, Maison et al. 2013, Kujawa and Liberman 2015).

The criteria for assessing possible effects of impulsive sounds (such as pile driving or seismic impulses) noise on marine mammals, NMFS (2018), was applied in this study.

A.3.2. Behavioural Response

Numerous studies on marine mammal behavioural responses to sound exposure have not resulted in consensus in the scientific community regarding the appropriate metric for assessing behavioural reactions. However, it is recognised that the context in which the sound is received affects the nature and extent of responses to a stimulus (Southall et al. 2007, Ellison and Frankel 2012, Southall et al. 2016).

For non-impulsive noise, NMFS currently uses step function (all-or-none) threshold of 120 dB re 1 µPa SPL (unweighted) to assess and regulate noise-induced behavioural effects for marine mammals (NOAA 2019). The 120 dB re 1 µPa threshold is associated with continuous sources and was derived based on studies examining behavioural responses to drilling and dredging (NOAA 2018), referring to Malme et al. (1983), Malme et al. (1984), and Malme et al. (1986), which were considered in , referring to Malme et al. (1983), Malme et al. (1984), and Malme et al. (1986), which were considered in Southall et al. (2007). Malme et al. (1986) found that playback of drillship noise did not produce clear evidence of disturbance or avoidance for levels below 110 dB re 1 µPa (SPL), possible avoidance occurred for exposure levels approaching 119 dB re 1 µPa. Malme et al. (1984) determined that measurable reactions usually consisted of rather subtle short-term changes in speed and/or heading of the whale(s) under observation. It has been shown that both received level and proximity of the sound source is a contributing factor in eliciting behavioural reactions in humpback whales (Dunlop et al. 2017, Dunlop et al. 2018).

For impulsive noise, NMFS currently uses step function thresholds of 160 dB re 1 µPa SPL (unweighted) to assess and regulate noise-induced behavioural effects for marine mammals (NOAA 2018, NOAA 2019). The threshold for impulsive sound is derived from the High-Energy Seismic Survey (HESS) panel (HESS 1999) report that, in turn, is based on the responses of migrating mysticete whales to airgun sounds (Malme et al. 1984). The HESS team recognised that behavioural responses to sound may occur at lower levels, but significant responses were only likely to occur above a SPL of 140 dB re 1 µPa. Southall et al. (2007) found varying responses for most marine mammals between a SPL of 140 and 180 dB re 1 µPa, consistent with the HESS (1999) report, but lack of convergence in the data prevented them from suggesting explicit step functions.

A.4. Marine Mammal Frequency Weighting

The potential for noise to affect animals depends on how well the animals can hear it. Noises are less likely to disturb or injure an animal if they are at frequencies that the animal cannot hear well. An exception occurs when the sound pressure is so high that it can physically injure an animal by non-auditory means (i.e., barotrauma). For sound levels below such extremes, the importance of sound components at particular frequencies can be scaled by frequency weighting relevant to an animal's sensitivity to those frequencies (Nedwell and Turnpenny 1998, Nedwell et al. 2007).

A.4.1. Marine Mammal Frequency Weighting Functions

In 2015, a US Navy technical report by Finneran (2015) recommended new auditory weighting functions. The overall shape of the auditory weighting functions is similar to human A-weighting functions, which follows the sensitivity of the human ear at low sound levels. The new frequency-weighting function is expressed as:

$$G(f) = K + 10\log_{10}\left[\left(\frac{(f/f_{lo})^{2a}}{\left[1+(f/f_{lo})^2\right]^a\left[1+(f/f_{hi})^2\right]^b}\right)\right] \tag{A-11}$$

Finneran (2015) proposed five functional hearing groups for marine mammals in water: low-, mid-, and high-frequency cetaceans, phocid pinnipeds, and otariid pinnipeds. The parameters for these frequency-weighting functions were further modified the following year (Finneran 2016) and were adopted in NOAA's technical guidance that assesses noise effects on marine mammals (NMFS 2016, NMFS 2018). Table A-1 lists the frequency-weighting parameters for each hearing group; Figure A-3 shows the resulting frequency-weighting curves.

Table A-1. Parameters for the auditory weighting functions used in this project as recommended by NMFS (2018).

Hearing group	a	b	f_{lo} (Hz)	f_{hi} (kHz)	K (dB)
Low-frequency cetaceans (baleen whales)	1.0	2	200	19,000	0.13
Mid-frequency cetaceans (dolphins, plus toothed, beaked, and bottlenose whales)	1.6	2	8,800	110,000	1.20
High-frequency cetaceans (true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* and *L. australis*)	1.8	2	12,000	140,000	1.36

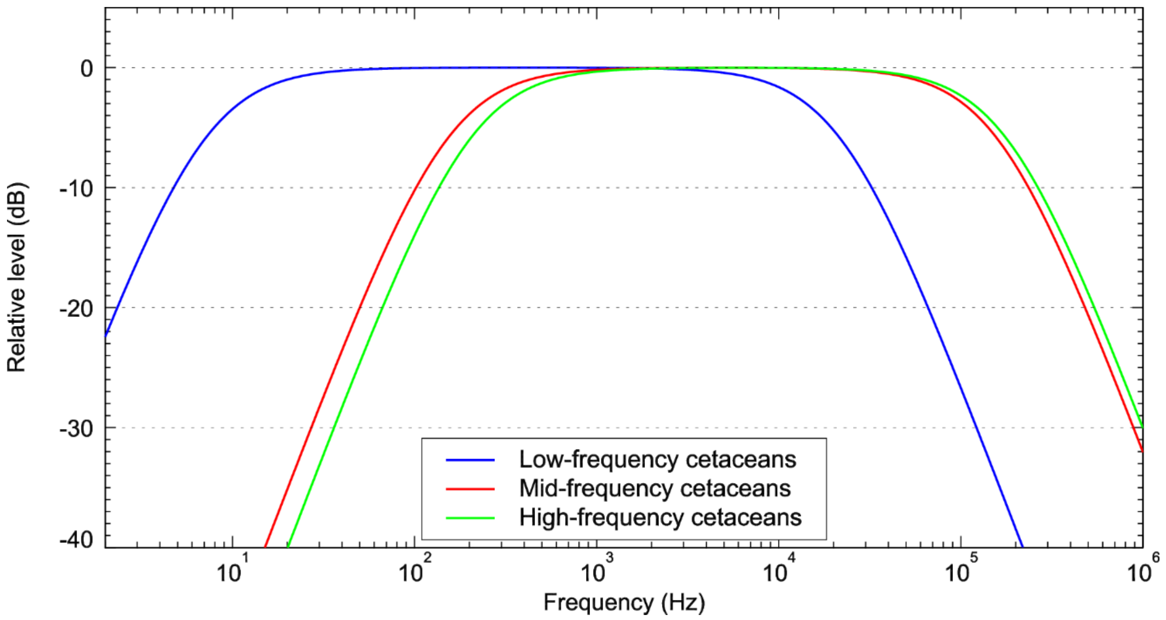

Figure A-3. Auditory weighting functions for functional marine mammal hearing groups used in this project as recommended by NMFS (2018).

A.5. Fish, Fish Eggs, Fish Larvae and Plankton Guidelines

In general, any adverse effects of seismic sound on fish behaviour depends on the species, the state of the individuals exposed, and other factors. We note that, despite mortality being a possibility for fish exposed to airgun sounds, Popper et al. (2014) do not reference an actual occurrence of this effect. Since the publication of that work, newer studies have further examined the question of possible mortality. Popper et al. (2016) adds further information to the possible levels of impulsive seismic airgun sound to which adult fish can be exposed without immediate mortality. They found that the two fish species in their study, with body masses in the range 200–400 g, exposed to a single-impulse of a maximum received level of either 231 dB re 1 µPa (PK) or 205 dB re 1 µPa^2·s (SEL), remained alive for 7 days after exposure and that the probability of mortal injury did not differ between exposed and control fish.

In the discussion of the criteria, Popper et al. (2014) discuss the complications in determining a relevant period of mobile seismic surveys, as the received levels at the fish change between impulses because the source is moving, and that in reality a revised guideline based on the closest PK or the per-pulse SEL might be more useful than one based on accumulated SEL. This is because exposures at the closest point of approach (CPA) are the primary exposures contributing to a receiver's accumulated level (Gedamke et al. 2011). Additionally, several important factors determine the likelihood and duration a receiver is expected to be in close proximity to a sound source (i.e., overlap in space and time between the source and receiver). For example, accumulation time for fast moving (relative to the receiver) mobile sources is driven primarily by the characteristics of the source (i.e., speed, duty cycle; NMFS 2016, 2018).

As discussed in Popper (2018), many fish species move around, some over large distances. The author suggests that it is reasonable to think that if the sound of a seismic source becomes too loud, the fish will move away from the source because they are able to determine the direction of a sound source. If the fish moves away, the amount of energy to which it is exposed is likely to be one or a few seismic pulses, and these would not likely be loud enough to result in any effect because the fish would move away at a much lower-level signal than could cause harm. Data on TTS for fish are very limited, with the only study that examined recovery from seismic impulses being Popper et al. (2005). Popper (2018) states that if this study had been conducted on wild, free-swimming fish instead of caged ones, there would have been no effect whatsoever because they were likely to have moved away from the source as it approached them, as would happen with normally free-moving demersal and pelagic fish species associated with a 3-D seismic survey in northern Australian waters, extrapolating from the Bethany 3-D assessed in Popper (2018).

Therefore, the time over which energy should be accumulated in each individual fish in the survey area should be limited to the time over which fish receives the maximum exposure, and 24 h is likely too long a period for calculating the accumulation of energy in determining potential harm (e.g., damage or TTS) (Popper 2018). Even if fish do show some TTS, recovery will start as soon as the most intense sounds end, and recovery is likely to even occur, to a limited degree, between seismic pulses. Based on very limited data, recovery within 24 h (or less) is very likely. If TTS does occur, the duration of exposure to the most intense sounds that could result in TTS will be over just a few hours. Thus, energy accumulating over longer periods than a few hours is probably inappropriate (Popper 2018).

Appendix B. Models

B.1. Acoustic Source Model

The source levels and directivity of the seismic source were predicted with JASCO's Airgun Array Source Model (AASM). AASM includes low- and high-frequency modules for predicting different components of the seismic source spectrum. The low-frequency module is based on the physics of oscillation and radiation of airgun bubbles, as originally described by Ziolkowski (1970), that solves the set of parallel differential equations that govern bubble oscillations. Physical effects accounted for in the simulation include pressure interactions between airguns, port throttling, bubble damping, and generator-injector (GI) gun behaviour discussed by Dragoset (1984), Laws et al. (1990), and Landrø (1992). A global optimisation algorithm tunes free parameters in the model to a large library of airgun source signatures.

While airgun signatures are highly repeatable at the low frequencies, which are used for seismic imaging, their sound emissions have a large random component at higher frequencies that cannot be predicted using a deterministic model. Therefore, AASM uses a stochastic simulation to predict the high-frequency (800−25,000 Hz) sound emissions of individual airguns, using a data-driven multiple-regression model. The multiple-regression model is based on a statistical analysis of a large collection of high quality seismic source signature data recently obtained from the Joint Industry Program (JIP) on Sound and Marine Life (Mattsson and Jenkerson 2008). The stochastic model uses a Monte-Carlo simulation to simulate the random component of the high-frequency spectrum of each airgun in an array. The mean high-frequency spectra from the stochastic model augment the low-frequency signatures from the physical model, allowing AASM to predict airgun source levels at frequencies up to 25,000 Hz.

AASM produces a set of "notional" signatures for each array element based on:

- Array layout
- Volume, tow depth, and firing pressure of each airgun
- Interactions between different airguns in the array

These notional signatures are the pressure waveforms of the individual airguns at a standard reference distance of 1 m; they account for the interactions with the other airguns in the array. The signatures are summed with the appropriate phase delays to obtain the far-field source signature of the entire array in all directions. This far-field array signature is filtered into decidecade frequency bands to compute the source levels of the array as a function of frequency band and azimuthal angle in the horizontal plane (at the source depth), after which it is considered a directional point source in the far field.

A seismic array consists of many sources and the point source assumption is invalid in the near field where the array elements add incoherently. The maximum extent of the near field of an array (R_{nf}) is:

$$R_{\mathrm{nf}} < \frac{l^2}{4\lambda} \tag{B-1}$$

where λ is the sound wavelength and l is the longest dimension of the array (Lurton 2002, §5.2.4). For example, a seismic source length of l = 21 m yields a near-field range of 147 m at 2 kHz and 7 m at 100 Hz. Beyond this R_{nf} range, the array is assumed to radiate like a directional point source and is treated as such for propagation modelling.

The interactions between individual elements of the array create directionality in the overall acoustic emission. Generally, this directionality is prominent mainly at frequencies in the mid-range between tens of hertz to several hundred hertz. At lower frequencies, with acoustic wavelengths much larger than the inter-airgun separation distances, the directionality is small. At higher frequencies, the pattern of lobes is too finely spaced to be resolved and the effective directivity is less.

B.2. Sound Propagation Models

B.2.1. MONM-BELLHOP

Long-range sound fields were computed using JASCO's Marine Operations Noise Model (MONM). Compared to VSTACK, MONM less accurately predicts steep-angle propagation for environments with higher shear speed but is well suited for effective longer-range estimation. This model computes sound propagation at frequencies of 5 Hz to 2 kHz via a wide-angle parabolic equation solution to the acoustic wave equation (Collins 1993) based on a version of the US Naval Research Laboratory's Range-dependent Acoustic Model (RAM), which has been modified to account for a solid seabed (Zhang and Tindle 1995). MONM computes sound propagation at frequencies > 2 kHz via the BELLHOP Gaussian beam acoustic ray-trace model (Porter and Liu 1994).

The parabolic equation method has been extensively benchmarked and is widely employed in the underwater acoustics community (Collins et al. 1996). MONM accounts for the additional reflection loss at the seabed, which results from partial conversion of incident compressional waves to shear waves at the seabed and sub-bottom interfaces, and it includes wave attenuations in all layers. MONM incorporates the following site-specific environmental properties: a bathymetric grid of the modelled area, underwater sound speed as a function of depth, and a geoacoustic profile based on the overall stratified composition of the seafloor.

MONM computes acoustic fields in three dimensions by modelling transmission loss within two-dimensional (2-D) vertical planes aligned along radials covering a 360° swath from the source, an approach commonly referred to as N×2-D. These vertical radial planes are separated by an angular step size of $\Delta\theta$, yielding N = 360°/$\Delta\theta$ number of planes (Figure B-1).

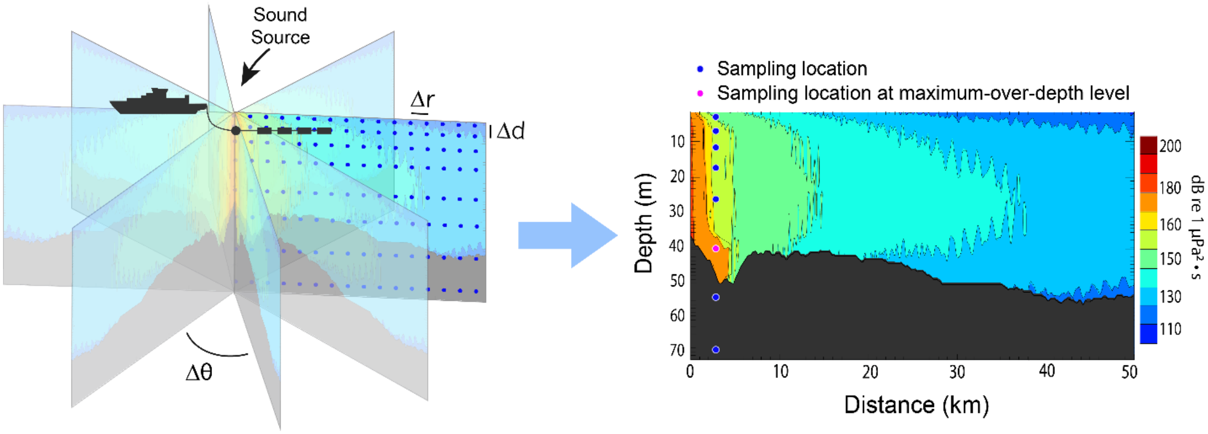

Figure B-1. The N×2-D and maximum-over-depth modelling approach used by MONM.

MONM treats frequency dependence by computing acoustic transmission loss at the centre frequencies of decidecade bands. Sufficiently many frequency bands, starting at 5 Hz, are modelled to include most of the acoustic energy emitted by the source. At each centre frequency, the transmission loss is modelled within each of the N vertical planes as a function of depth and distance from the source. The decidecade-band received per-pulse SEL are computed by subtracting the band transmission loss values from the directional source level in that frequency band. Composite broadband received per-pulse SEL are then computed by summing the received decidecade-band levels.

The received per-pulse SEL sound field within each vertical radial plane is sampled at various radial distances from the source, generally with a fixed radial step size. At each sampling range along the surface, the sound field is sampled at various depths, with the step size between samples increasing with depth below the surface. The step sizes are chosen to provide increased coverage near the depth of the source and at depths of interest in terms of the sound speed profile. For areas with deep water, sampling is not performed at depths beyond those reachable by marine mammals. The received per-pulse SEL at a surface sampling location is taken as the maximum value that occurs over all samples within the water column, i.e., the maximum-over-depth received per-pulse SEL. These maximum-over-depth per-pulse SEL are presented as colour contours around the source.

B.2.2. Full Waveform Range-dependent Acoustic Model: FWRAM

For impulsive sounds from the seismic source, time-domain representations of the pressure waves generated in the water are required to calculate SPL and PK. Furthermore, the seismic source must be represented as a distributed source to accurately characterise vertical directivity effects in the near-field zone. For this study, synthetic pressure waveforms were computed using FWRAM, which is a time-domain acoustic model based on the same wide-angle parabolic equation (PE) algorithm as MONM. FWRAM computes synthetic pressure waveforms versus range and depth for range-varying marine acoustic environments, and it takes the same environmental inputs as MONM (bathymetry, water sound speed profile, and seafloor geoacoustic profile). Unlike MONM, FWRAM computes pressure waveforms via Fourier synthesis of the modelled acoustic transfer function in closely spaced frequency bands. FWRAM employs the array starter method to accurately model sound propagation from a spatially distributed source (MacGillivray and Chapman 2012).

Besides providing direct calculations of the PK and SPL, the synthetic waveforms from FWRAM can also be used to convert the SEL values from MONM to SPL.

B.3. Model Validation Information

Predictions from JASCO's Airgun Array Source Model (AASM) and propagation models (MONM, FWRAM and VSTACK) have been validated against experimental data from a number of underwater acoustic measurement programs conducted by JASCO globally, including the United States and Canadian Artic, Canadian and southern United States waters, Greenland, Russia and Australia (Hannay and Racca 2005, Aerts et al. 2008, Funk et al. 2008, Ireland et al. 2009, O'Neill et al. 2010, Warner et al. 2010, Racca et al. 2012a, Racca et al. 2012b, Matthews and MacGillivray 2013, Martin et al. 2015, Racca et al. 2015, Martin et al. 2017a, Martin et al. 2017b, Warner et al. 2017, MacGillivray 2018, McPherson et al. 2018, McPherson and Martin 2018).

In addition, JASCO has conducted measurement programs associated with a significant number of anthropogenic activities which have included internal validation of the modelling (including McCrodan et al. 2011, Austin and Warner 2012, McPherson and Warner 2012, Austin and Bailey 2013, Austin et al. 2013, Zykov and MacDonnell 2013, Austin 2014, Austin et al. 2015, Austin and Li 2016, Martin and Popper 2016).

B.4. Animal Movement and Exposure Modelling

Animal movement and exposure modelling considers the movement of both sound sources (if mobile) and animals over time. Acoustic source and propagation modelling are used to generate 3-D sound fields that vary as a function of distance to source, depth, and azimuth. Sound sources are modelled at representative sites and the resulting sound fields are assigned to source locations using the minimum Euclidean distance. The sound received by an animal at any given time depends on its location relative to the source. Because the true locations of the animals within the sound fields are unknown, realistic animal movements are simulated using repeated random sampling of various behavioural parameters. The Monte Carlo method of simulating many animals within the operations area is used to estimate the sound exposure history of the population of simulated animals (animats).

Monte Carlo methods provide a heuristic approach for determining the probability distribution function (PDF) of complex situations, such as animals moving in a sound field. The probability of an event's occurrence is determined by the frequency with which it occurs in the simulation. The greater the number of random samples, in this case the more simulated animats, the better the approximation of the PDF. Animats are randomly placed, or seeded, within the simulation boundary at a specified density (animats/km^2). Higher densities provide a finer PDF estimate resolution but require more computational resources. To ensure good representation of the PDF, the animat density is set as high as practical allowing for computation time. The animat density is much higher than the real-world density to ensure good representation of the PDF. The resulting PDF is scaled using the real-world density.

Several models for marine mammal movement have been developed (Ellison et al. 1987, Frankel et al. 2002, Houser 2006). These models use an underlying Markov chain to transition from one state to another based on probabilities determined from measured swimming behaviour. The parameters may represent simple states, such as the speed or heading of the animal, or complex states, such as likelihood of participating in foraging, play, rest, or travel. Attractions and aversions to variables like anthropogenic sounds and different depth ranges can be included in the models.

The JASCO Animal Simulation Model Including Noise Exposure (JASMINE) was based on the open-source marine mammal movement and behaviour model (3MB, Houser 2006) and used to predict the exposure of animats to sound arising from the anthropogenic activities. Animats are programmed to behave like the species likely to be present in the survey area. The parameters used for forecasting realistic behaviours (e.g., diving, foraging, aversion, surface times, etc.) are determined and interpreted from marine species studies (e.g., tagging studies) where available, or reasonably extrapolated from related species. An individual animat's modelled sound exposure levels are summed over the total simulation duration to determine its total received energy, and then compared to the assumed threshold criteria.

JASMINE uses the same animal movement algorithms as 3MB (Houser, 2006), but has been extended to be directly compatible with JASCO's Marine Operations Noise Model (MONM) and Full Waveform Range-dependent Acoustic Model acoustic field predictions, for inclusion of source tracks, and importantly for animats to change behavioural states based on time and space dependent modelled variables such as received levels for aversion behaviour, although aversion was not considered in this study.

B.4.1. Animal Movement Parameters

JASMINE uses previously measured behaviour to forecast behaviour in new situations and locations. The parameters used for forecasting realistic behaviour are determined (and interpreted) from marine species studies (e.g., tagging studies). Each parameter in the model is described as a probability distribution. When limited or no information is available for a species parameter, a Gaussian or uniform distribution may be chosen for that parameter. For the Gaussian distribution, the user determines the mean and standard deviation of the distribution from which parameter values are drawn. For the uniform distribution, the user determines the maximum and minimum distribution from which parameter values are drawn. When detailed information about the movement and behaviour of a species are available, a user-created distribution vector, including cumulative transition probabilities, may be used (referred to here as a vector model; Houser 2006). Different sets of parameters can be defined for different behaviour states. The probability of an animat starting out in or transitioning into a given behaviour state can in turn be defined in terms of the animat's current behavioural state, depth, and the time of day. In addition, each travel parameter and behavioural state has a termination function that governs how long the parameter value or overall behavioural state persists in simulation.

The parameters used in JASMINE describe animal movement in both the vertical and horizontal planes. The parameters relating to travel in these two planes are briefly described below.

Travel sub-models

- **Direction**– determines an animat's choice of direction in the horizontal plane. Sub-models are available for determining the heading of animats, allowing for movement to range from strongly biased to undirected. A random walk model can be used for behaviours with no directional preference, such as feeding and playing. In a random walk, all bearings are equally likely at each parameter transition time step. A correlated random walk can be used to smooth the changes in bearing by using the current heading as the mean of the distribution from which to draw the next heading. An additional variant of the correlated random walk is available that includes a directional bias for use in situations where animals have a preferred absolute direction, such as migration. A user-defined vector of directional probabilities can also be input to control animat heading. For more detailed discussion of these parameters, see Houser (2006) and Houser and Cross (1999).

- **Travel rate**–defines an animat's rate of travel in the horizontal plane. When combined with vertical speed and dive depth, the dive profile of the animat is produced.

Dive sub-models

- **Ascent rate**–defines an animat's rate of travel in the vertical plane during the ascent portion of a dive.
- **Descent rate**–defines an animat's rate of travel in the vertical plane during the descent portion of a dive.
- **Depth**–defines an animat's maximum dive depth.
- **Reversals**–determines whether multiple vertical excursions occur once an animat reaches the maximum dive depth. This behaviour is used to emulate the foraging behaviour of some marine mammal species at depth. Reversal-specific ascent and descent rates may be specified.
- **Surface interval**–determines the duration an animat spends at, or near, the surface before diving again.

B.4.2. Exposure Integration Time

The interval over which acoustic exposure (L_E) should be integrated and maximal exposure (L_p) determined is not well defined. Both Southall et al. (2007) and the NMFS (2018) recommend a 24 h baseline accumulation period, but state that there may be situations where this is not appropriate (e.g., a high-level source and confined population). Resetting the integration after 24 h can lead to overestimating the number of individual animals exposed because individuals can be counted multiple times during an operation. The type of animal movement engine used in this study simulates realistic movement using swimming behaviour collected over relatively short periods (hours to days) and does not include large-scale movement such as migratory circulation patterns. For this study, 7 days were modelled, with results for the full period and also scaled down to 24 h.

Ideally, a simulation area is large enough to encompass the entire range of a population so that any animal that could approach the source during an operation is included. However, there are limits to the simulation area, and computational overhead increases with area. For practical reasons, the simulation area is limited. In the simulation, every animat that reaches a border is replaced by another animat entering at the opposing border—e.g., an animat crossing the northern border of the simulation is replaced by one entering the southern border at the same longitude. When this action places the animat in an inappropriate water depth, the animat is randomly placed on the map at a depth suited to its species definition. The exposures of all animats (including those leaving the simulation and those entering) are kept for analysis. This approach maintains a consistent animat density and allows for longer integration periods with finite simulation areas.

B.4.3. Seeding Density and Scaling

The exposure criteria for continuous sounds were used to determine the number of animats exceeding exposure thresholds. To generate statistically reliable probability density functions, all simulations were seeded with an animat density of 2 animat/km^2 over the entire simulation area.

Appendix C. Methods and Parameters

This section describes the specifications of the seismic source that was used at all sites and the environmental parameters used in the propagation models.

C.1. Estimating Distance to Threshold Levels

Sound level contours were calculated based on the underwater sound fields predicted by the propagation models, sampled by taking the maximum value over all modelled depths above the sea floor for each location in the modelled region. The predicted distances to specific levels were computed from these contours. Two distances relative to the source are reported for each sound level: 1) R_{max}, the maximum range to the given sound level over all azimuths, and 2) $R_{95\%}$, the range to the given sound level after the 5% farthest points were excluded (see examples in Figure C-1).

The $R_{95\%}$ is used because sound field footprints are often irregular in shape. In some cases, a sound level contour might have small protrusions or anomalous isolated fringes. This is demonstrated in the image in Figure C-1(a). In cases such as this, where relatively few points are excluded in any given direction, R_{max} can misrepresent the area of the region exposed to such effects, and $R_{95\%}$ is considered more representative. In strongly asymmetric cases such as shown in Figure C-1(b), on the other hand, $R_{95\%}$ neglects to account for significant protrusions in the footprint. In such cases R_{max} might better represent the region of effect in specific directions. Cases such as this are usually associated with bathymetric features affecting propagation. The difference between R_{max} and $R_{95\%}$ depends on the source directivity and the non-uniformity of the acoustic environment.

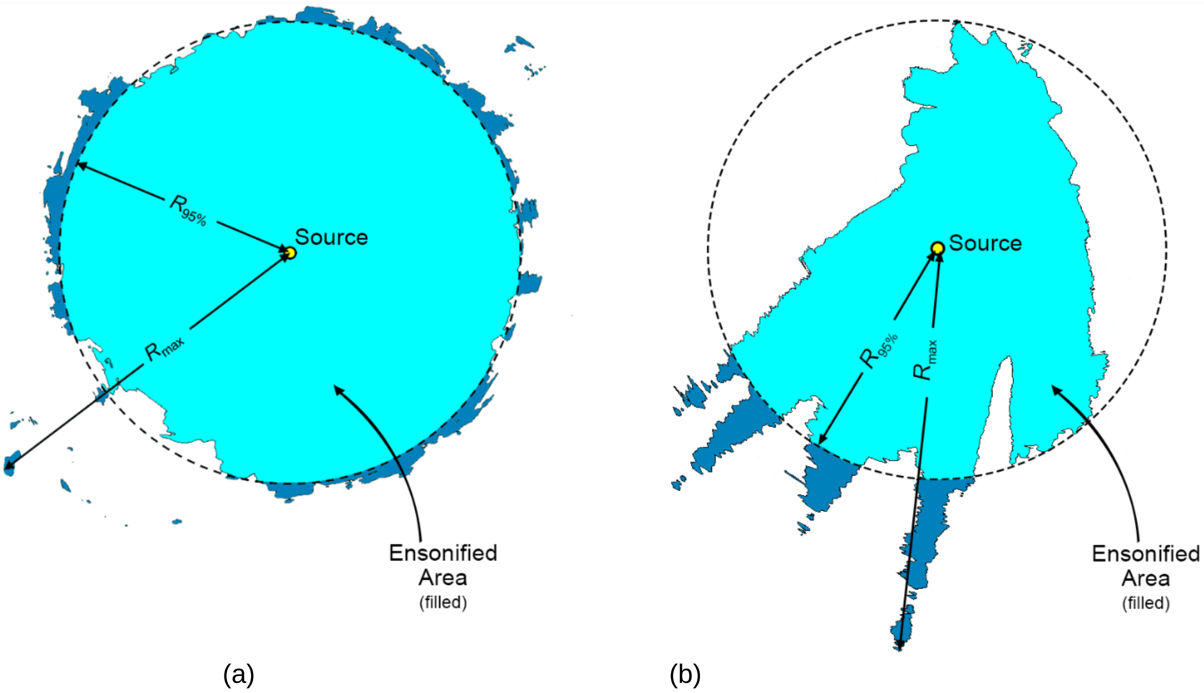

Figure C-1. Sample areas ensonified to an arbitrary sound level with R_{max} and $R_{95\%}$ ranges shown for two different scenarios. (a) Largely symmetric sound level contour with small protrusions. (b) Strongly asymmetric sound level contour with long protrusions. Light blue indicates the ensonified areas bounded by $R_{95\%}$; darker blue indicates the areas outside this boundary which determine R_{max}.

C.2. Estimating SPL from Modelled SEL Results

The per-pulse SEL of sound pulses is an energy-like metric related to the dose of sound received over a pulse's entire duration. The pulse SPL on the other hand, is related to its intensity over a specified time interval. Seismic pulses typically lengthen in duration as they propagate away from their source, due to seafloor and surface reflections, and other waveguide dispersion effects. The changes in pulse length, and therefore the time window considered, affect the numeric relationship between SPL and SEL. This study has applied a fixed window duration to calculate SPL (T_{fix} = 125 ms; see Appendix A.1), as implemented in Martin et al. (2017b). Full-waveform modelling was used to estimate SPL, but this type of modelling is computationally intensive, and can be prohibitively time consuming when run at high spatial resolution over large areas.

For the current study, FWRAM (Appendix B.2.2) was used to model synthetic seismic pulses over the frequency range 5–1024 Hz. This was performed along all broadside and endfire radials at one site due to the relatively constant and similar water depths throughout the survey area. FWRAM uses Fourier synthesis to recreate the signal in the time domain so that both the SEL and SPL from the source can be calculated. The differences between the SEL and SPL were extracted for all ranges and depths that corresponded to those generated from the high spatial-resolution results from MONM. A 125 ms fixed time window positioned to maximize the SPL over the pulse duration was applied. The resulting SEL -to-SPL offsets were averaged in 20 m range bins along each modelled radial and depth, and the 90th percentile was selected at each range to generate a generalised range-dependent conversion function for each site. The range- dependent conversion function was averaged between the two sites and applied to predicted per-pulse SEL results from MONM to model SPL values. Figure C-2 show the conversion offsets for Site 2; the spatial variation is caused by changes in the received airgun pulse as it propagates from the source.

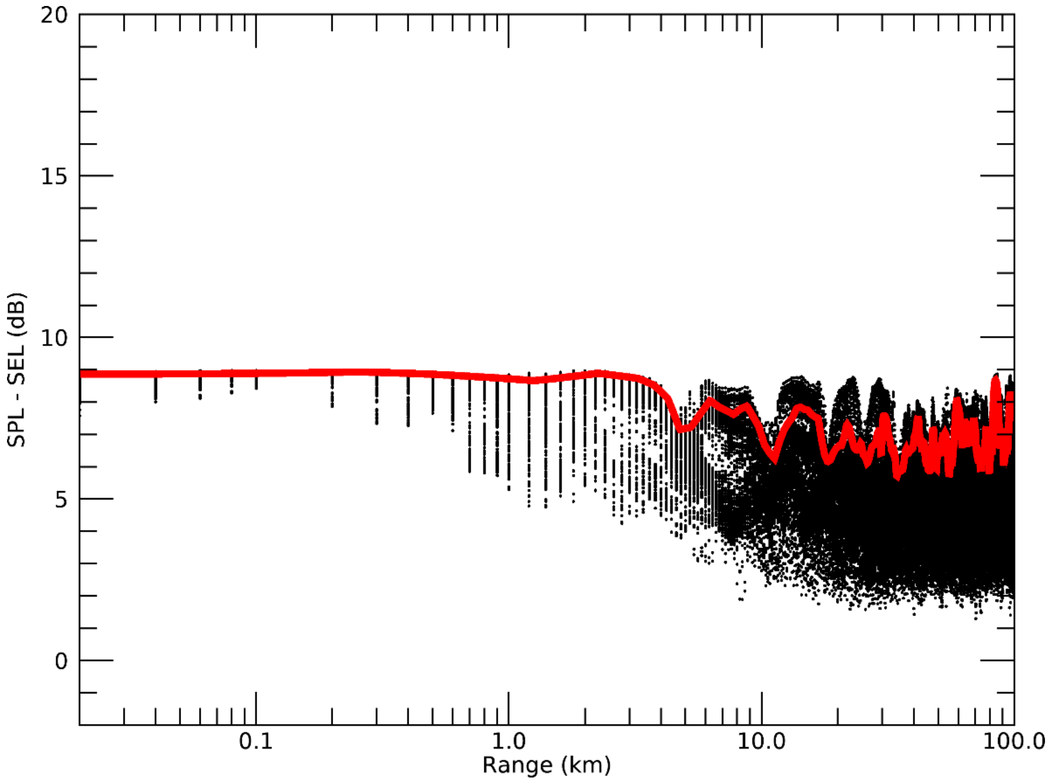

Figure C-2. *Site 2*: Range-and-depth-dependent conversion offsets for converting SEL to SPL for seismic pulses. Slices are shown for the 3150 in^3 seismic source. Black lines are the modelled differences between SEL and SPL across different radials and receiver depths; the solid red line is the 90th percentile of the modelled differences at each range.

C.3. Accumulated SEL Calculation

When there are many seismic pulses, it becomes computationally prohibitive to perform sound propagation modelling for every single event. The distance between the consecutive seismic impulses is small enough, however, that the environmental parameters that influence sound propagation are virtually the same for many impulse points. The acoustic fields can, therefore, be modelled for a subset of seismic pulses and estimated at several adjacent ones. After sound fields from representative impulse locations are calculated, they are adjusted to account for the source position for nearby impulses.

Although estimating the cumulative sound field with the described approach is not as precise as modelling sound propagation at every impulse location, small-scale, site-specific sound propagation features tend to blur and become less relevant when sound fields from adjacent impulses are summed. Larger scale sound propagation features, primarily dependent on water depth, dominate the cumulative field. The accuracy of the present method acceptably reflects those large-scale features, thus providing a meaningful estimate of a wide area SEL field in a computationally feasible framework.

To produce the map of accumulated received sound level distributions and calculate distances to specified sound level thresholds, the maximum-over-depth level was calculated at each sampling point within the modelled region. The radial grids of maximum-over-depth sound levels for each impulse were then resampled (by linear triangulation) to produce a regular Cartesian grid. The sound field grids from all impulses were summed (Equation A-5) to produce the cumulative sound field grid with cell sizes of 20 m. The contours and threshold ranges were calculated from these flat Cartesian projections of the modelled acoustic fields. The single-impulse SEL fields were computed over model grids approximately 100 × 100 km in range, which encompasses the full area of the cumulative grid (the entire survey area).

The unweighted (fish) and frequency-weighted (mammals and sea turtles) SEL_{24h} results were rendered as contour maps, including contours that focus on the relevant criteria-based thresholds. Only contours at ranges larger than the nearfield of the seismic source were rendered.

C.4. Environmental Parameters

C.4.1. Bathymetry

Water depths throughout the modelled area were extracted from the Australian Bathymetry and Topography Grid, a 9 arc-second grid rendered for Australian waters (Whiteway 2009) for the region shown in Figure C-3. Bathymetry data were extracted and re-gridded onto a Universal Transverse Mercator (UTM) coordinate projection (Zone 50) with a regular grid spacing of 100 × 100 m to generate the bathymetry in Figure C-3 (note the data is re-projected or the display in the Map Grid of Australia (MGA) coordinate system).

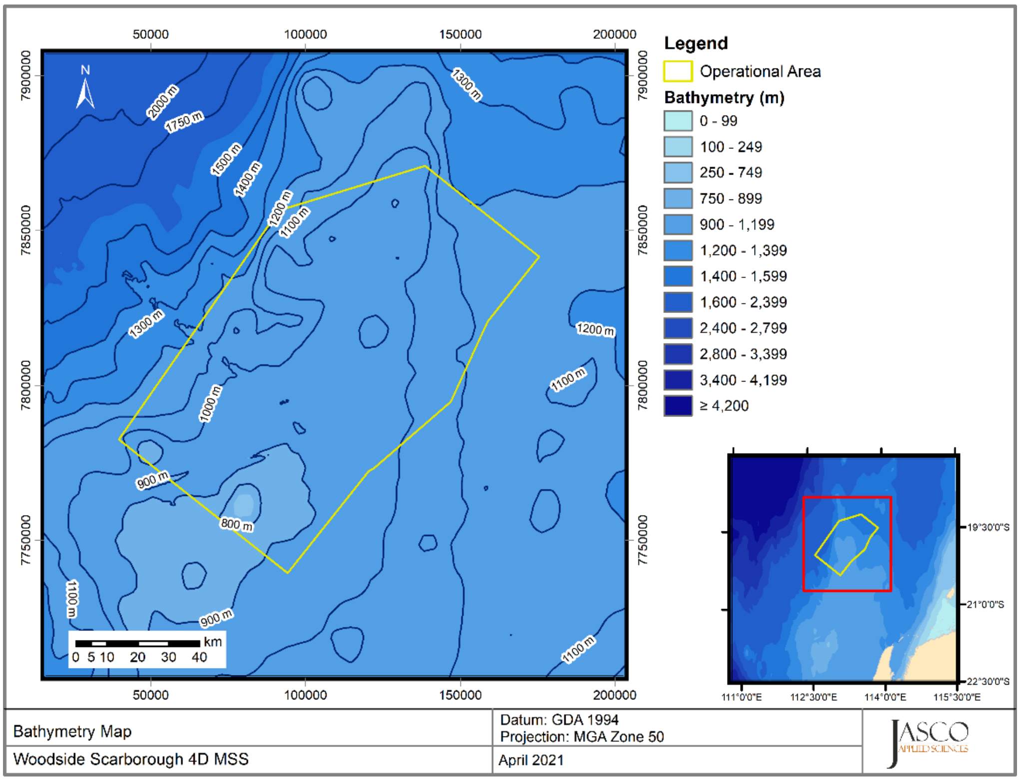

Figure C-3. Map of the modelling area presenting the variation in water depth.

C.4.2. Sound Speed Profile

The sound speed profiles for the modelled sites were derived from temperature and salinity profiles from the US Naval Oceanographic Office's Generalized Digital Environmental Model V 3.0 (GDEM; Teague et al. 1990, Carnes 2009). GDEM provides an ocean climatology of temperature and salinity for the world's oceans on a latitude-longitude grid with 0.25° resolution, with a temporal resolution of one month, based on global historical observations from the US Navy's Master Oceanographic Observational Data Set (MOODS). The climatology profiles include 78 fixed depth points to a maximum depth of 6800 m (where the ocean is that deep). The GDEM temperature-salinity profiles were converted to sound speed profiles according to Coppens (1981).

A mean sound speed profile for August (representative of potential operational period, January to April or July to October) was derived from the GDEM profiles within a 100 km box radius encompassing all modelling sites. The sound speed profile in August is expected to be most favourable to longer-range sound propagation during the proposed survey time frame due to a slight upward refracting profile in the upper 50 m. As such, August was selected for sound propagation modelling to ensure precautionary estimates of distances to received sound level thresholds. Figure C-4 shows the resulting profile used as input to the sound propagation modelling.

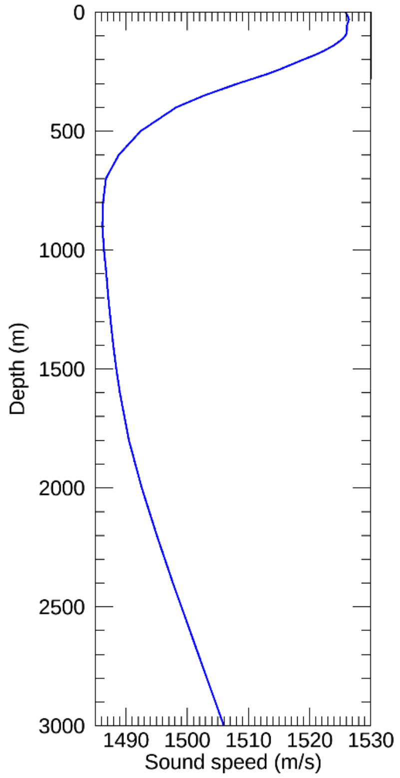

Figure C-4. Monthly averaged sound speed profile for August. The profile for August was used in modelling all sound fields. All profiles were calculated from temperature and salinity profiles from GDEM V 3.0 (GDEM; Teague et al. 1990, Carnes 2009).

C.4.3. Geoacoustics

Deep core samples (Exon and Willcox 1980) show the presence of a thick package of pelagic sediments below the seafloor that is bounded by sedimentary bedrock at a depth of ~2000 m. Table C-1 shows the derived geoacoustic profile that was based on geologic information and descriptions from core samples, generic properties for carbonate sediments and calcarenite from Hamilton (1980) and Duncan et al. (2013).

Table C-1. Geoacoustic profile for the Sites 1–2. Within each depth range, each parameter varies linearly within the stated range. The compressional wave is the primary wave and the shear wave is the secondary wave.

Depth below seafloor (m)	Material	Density (g/cm³)	Compressional wave		Shear wave	
			Speed (m/s)	Attenuation (dB/λ)	Speed (m/s)	Attenuation (dB/λ)
0–30	Foraminifera/nannofossil ooze, calcisiltit	1.52–1.56	1560–1600	0.12–0.13	250	3.65
30–100		1.56–1.65	1600–1700	0.13–0.15		
100–2000	Calcarenite/calcisiltit	1.90–2.20	2100–2600	0.25–0.52		
>2000	Sedimentary bedrock	2.54	3500	0.11		

C.5. Seismic Sources

The layout of the 3150 in^3 seismic source used for modelling in this study is provided in Figure C-5 Details of the airgun parameters are provided in Table C-2.

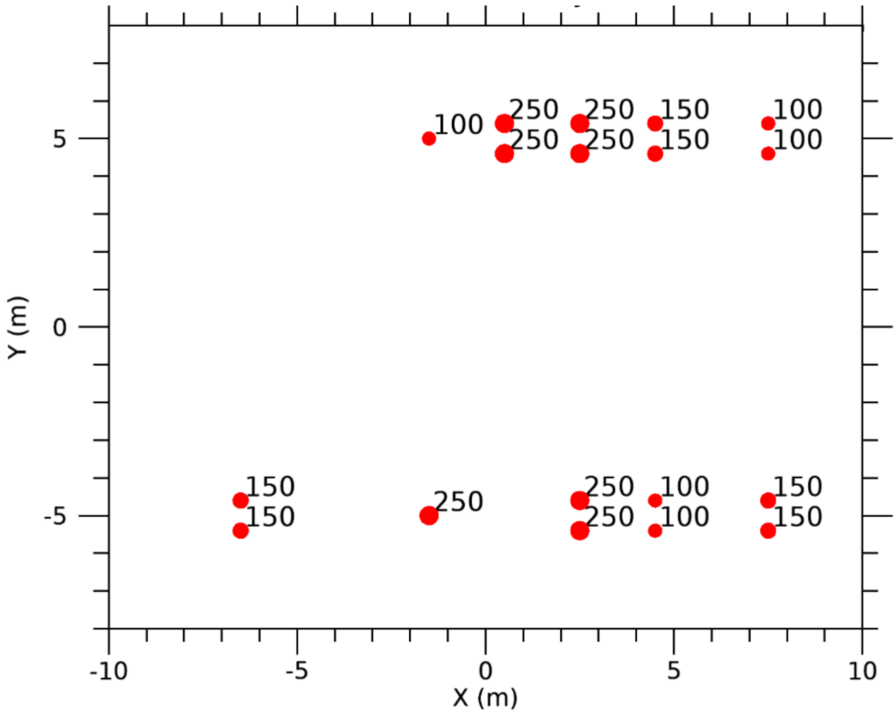

Figure C-5. Layout of the modelled 3150 in^3 array. Tow depth is 7 m. The labels indicate the firing volume (in cubic inches) for each airgun. Also see Table C-2.

Table C-2. Layout of the modelled 3150 in^3 array. Tow depth is 7 m. Firing pressure for all guns is 2000 psi. Also see Figure C-5.

String	Gun	*x* (m)	*y* (m)	*z* (m)	Vol (in^3)	String	Gun	*x* (m)	*y* (m)	*z* (m)	Vol (in^3)
	1	7.5	−5.4	7	150		12	7.5	4.6	7	100
	2	7.5	−4.6	7	150		13	7.5	5.4	7	100
	3	4.5	−5.4	7	100		14	4.5	4.6	7	150
	4	4.5	−4.6	7	100		15	4.5	5.4	7	150
1	5	2.5	−5.4	7	250	2	16	2.5	4.6	7	250
	6	2.5	−4.6	7	250		17	2.5	5.4	7	250
	8	−1.5	−5	7	250		18	0.5	4.6	7	250
	10	−6.5	−5.4	7	150		19	0.5	5.4	7	250
	11	−6.5	−4.6	7	150		20	−1.5	5	7	100

C.5.1. Array Source Levels and Directivity

Figure C-6 shows the broadside (perpendicular to the tow direction), endfire (parallel to the tow direction) and vertical overpressure signature and corresponding power spectrum levels for the 3150 in^3 array. Horizontal decidecade-band source levels are shown as a function of band centre frequency and azimuth (Figure C-7).

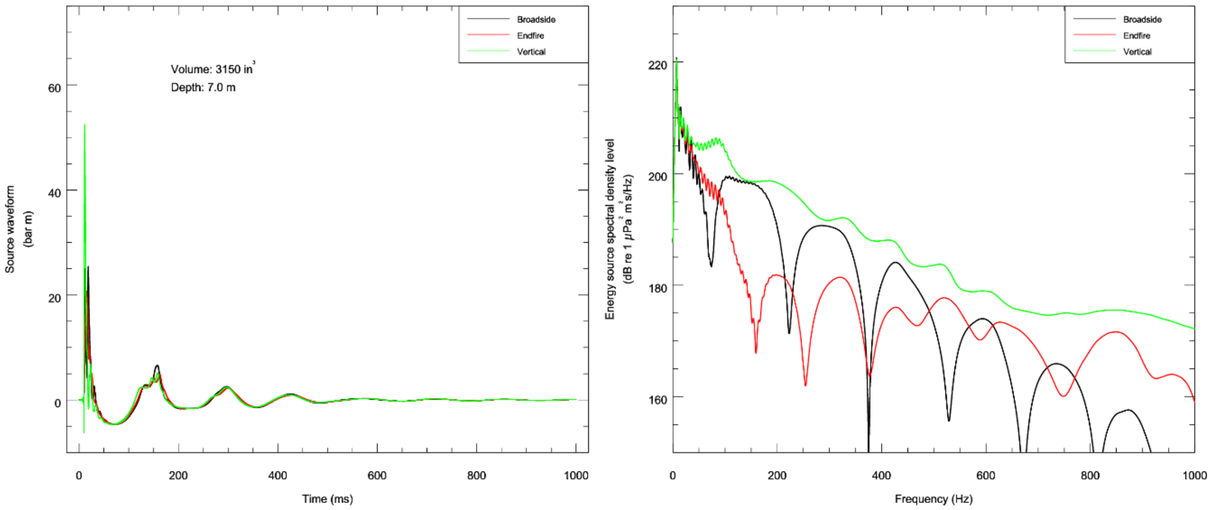

Figure C-6. Predicted source level details for the 3150 in^3 array at 7 m towed depth. (Left) the overpressure signature and (right) the power spectrum for in-plane horizontal (broadside), perpendicular (endfire), and vertical directions (no surface ghost).

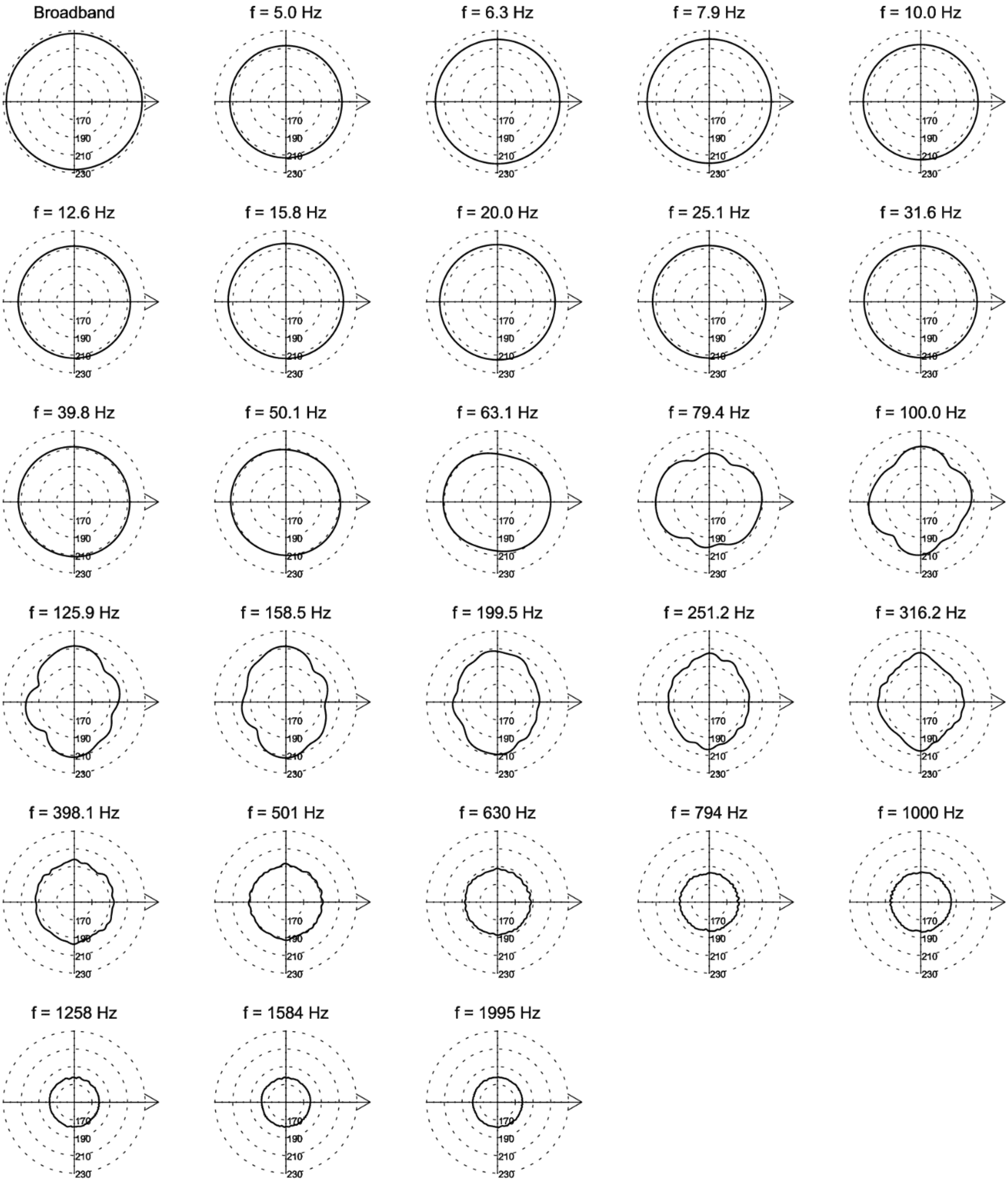

Figure C-7. Directionality of the predicted horizontal source levels for the 3150 in^3 seismic source, 5 Hz to 2 kHz. Source levels (in dB re 1 $\mu Pa^2 \cdot s\ m^2$) are shown as a function of azimuth for the centre frequencies of the decidecade bands modelled; frequencies are shown above the plots. The perpendicular direction to the frame is to the right. Tow depth is 7 m (see Figure C-6).

Appendix D. Per-Pulse SEL Sound Field Maps

Per-pulse SEL maps for both modelled sites are provided in Figures D-1 through D-4.

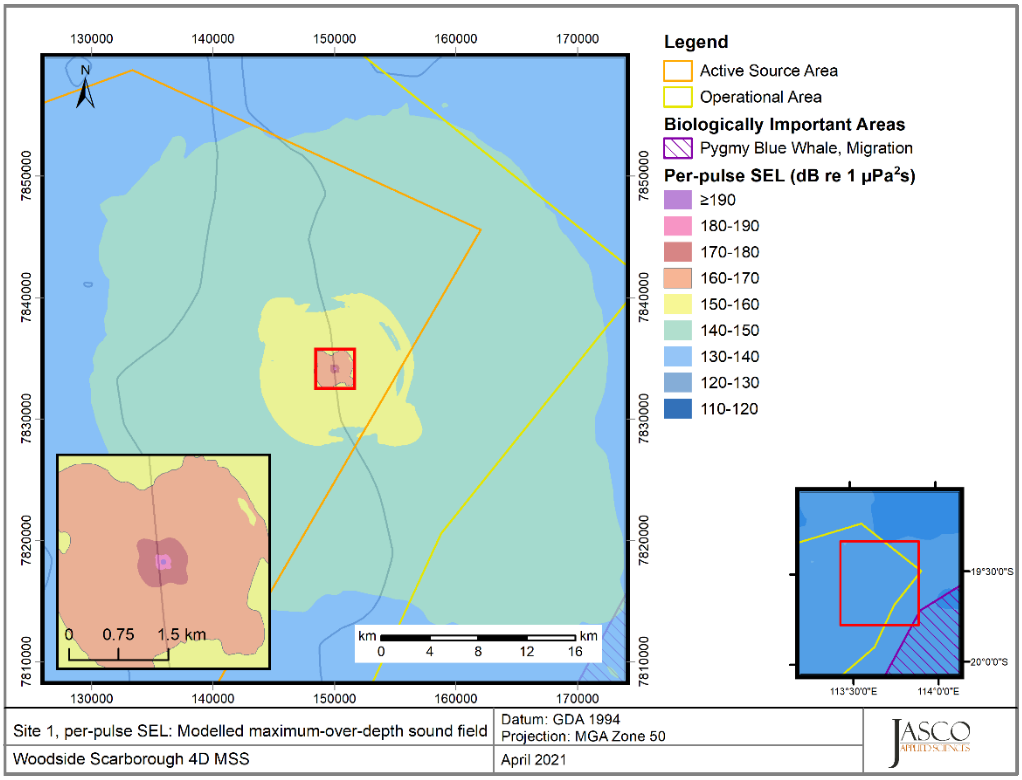

Figure D-1. *Site 1, tow azimuth 40°, per-pulse SEL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps.

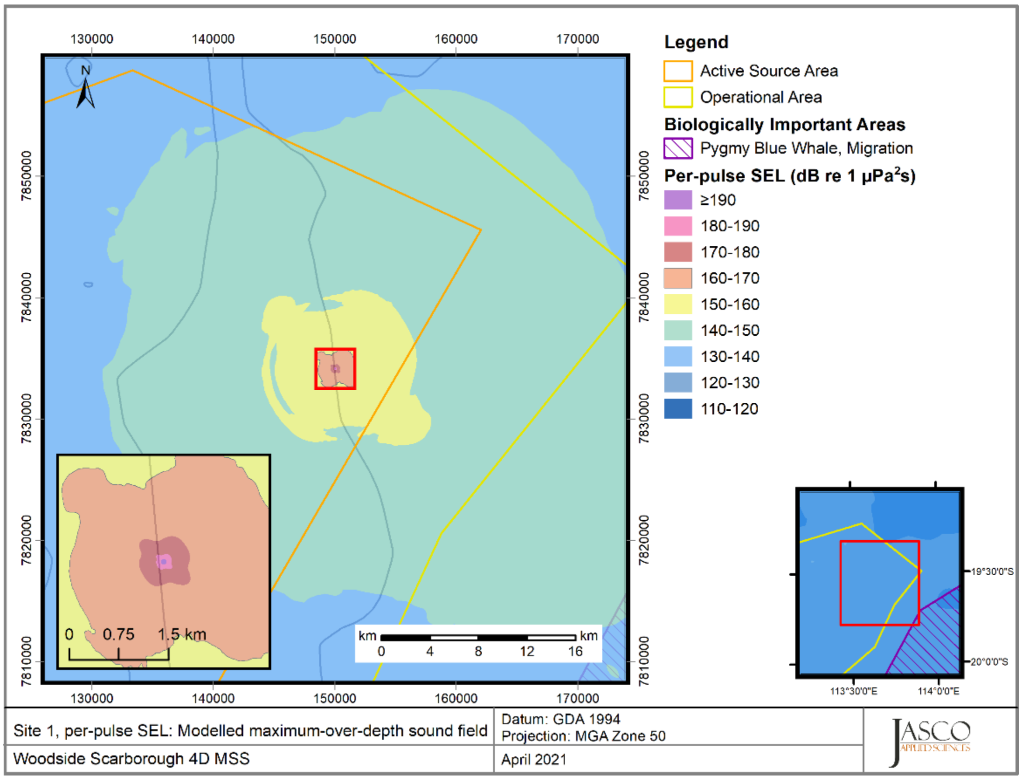

Figure D-2. *Site 1, tow azimuth 220°, per-pulse SEL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps.

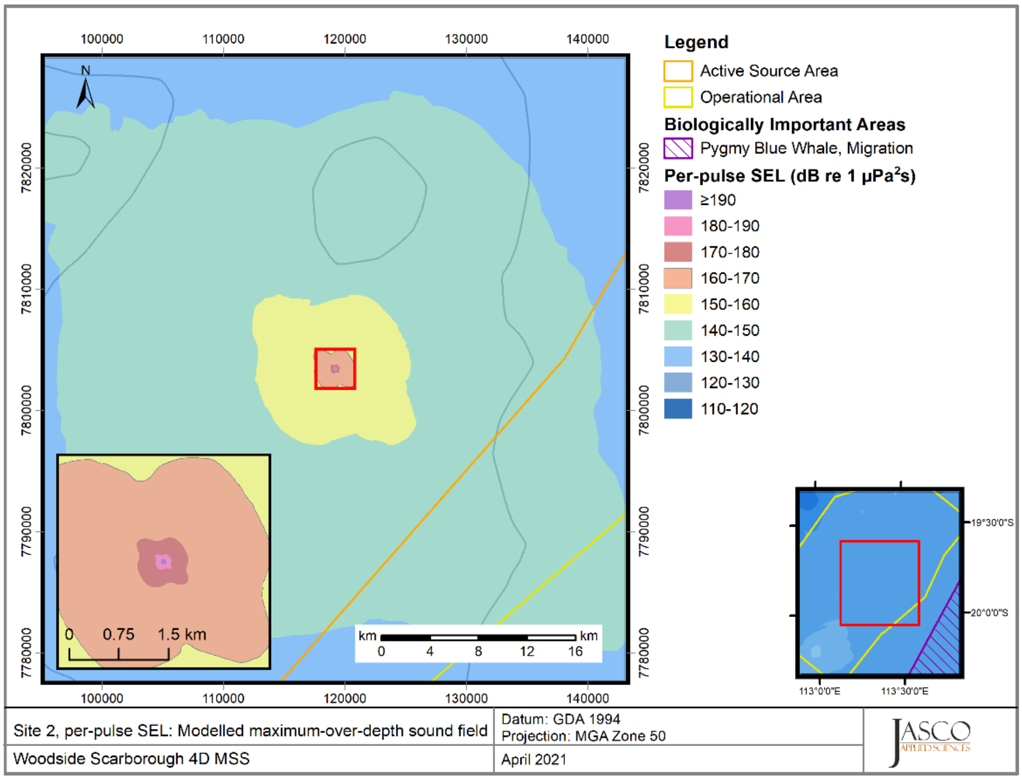

Figure D-3. *Site 2, tow azimuth 40°, per-pulse SEL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps.

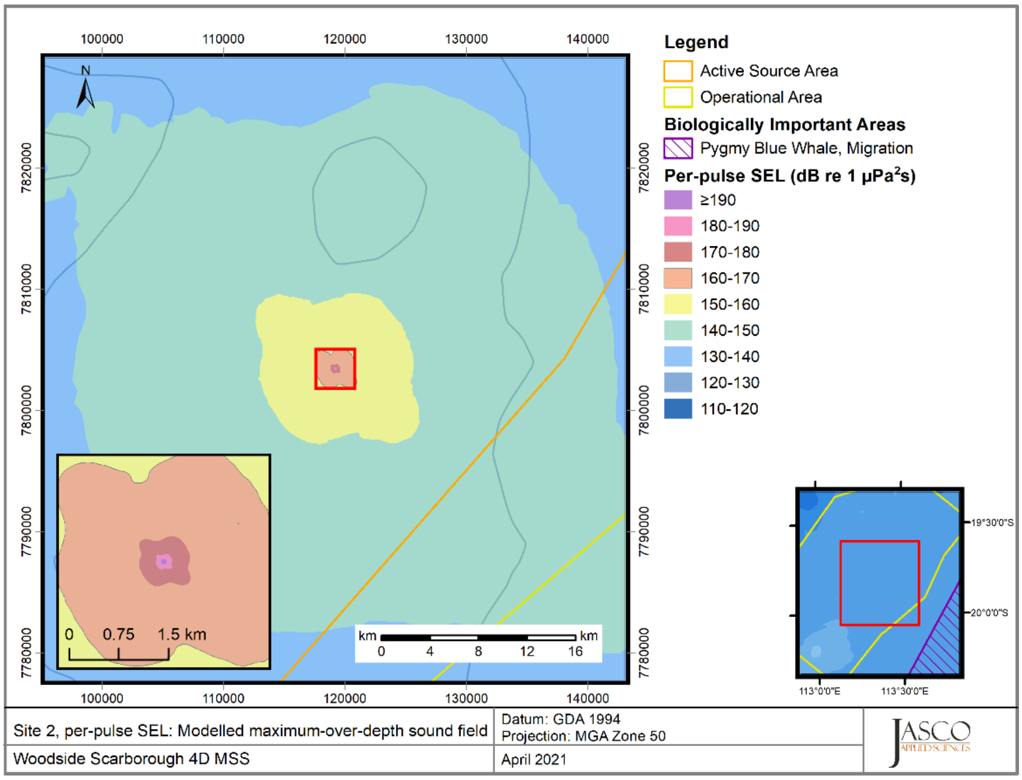

Figure D-4. *Site 2, tow azimuth 220°, per-pulse SEL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps.

Appendix E. Animal Movement Exposure Radial Distances

The JASMINE simulation restricted the spatial distribution of animats to the adjacent migration BIA, which resulted in zero exposures above threshold for any of the assessed criteria (see Section 5.4). To provide context, a second simulation was run that did not limit the distribution of the animats to the BIA. A summary of the resulting exposure ranges is included in Table E-1. Results include $ER_{95\%}$ and ER_{max} exposure ranges calculated for the 160 dB behavioural response threshold and PK and SEL thresholds for both TTS and PTS. Figures E-1 through E-5 show histograms of animat CPA ranges for each of the assessed threshold criteria.

Table E-1. Summary of animat simulation results for migrating pygmy blue whales. The 95th percentile exposure ranges ($ER_{95\%}$) and maximum exposure ranges (ER_{max}) in km and probability of animats being exposed above threshold within the $ER_{95\%}$ and ER_{max} are provided.

Threshold			**Maximum acoustic radial distance to threshold (km)**	**$ER_{95\%}$**		**ER_{max}**	
Description		Threshold level (dB)		Distance (km)	Probability of exposure (%)	Distance (km)	Probability of exposure (%)
TTS	PK	213[a]	0.06	0.05	88	0.06	84
	SEL_{24h}	168[b]	60.7	15.02	42	21.73	32
PTS	PK	219[a]	0.03	0.04	73	0.04	71
	SEL_{24h}	183[c]	0.38	0.06	80	0.13	65
Behavioural response		160[c]	7.28	6.54	71	7.33	67

[a] PK (L_{pk}; dB re 1 µPa)
[b] LF-weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^2·s)
[c] SPL (L_p; dB re 1 µPa)

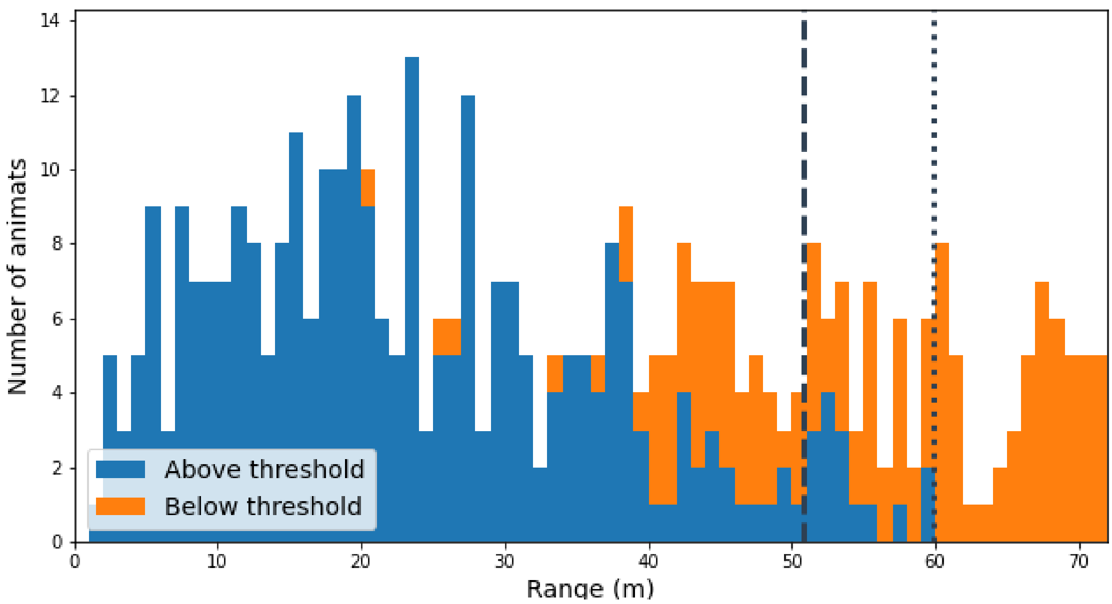

Figure E-1. Histograms of the distribution of CPA ranges for animats exposed above and below TTS PK threshold criteria for migrating pygmy blue whales. The TTS PK $ER_{95\%}$ and ER_{max} are indicated by vertical dashed lines.

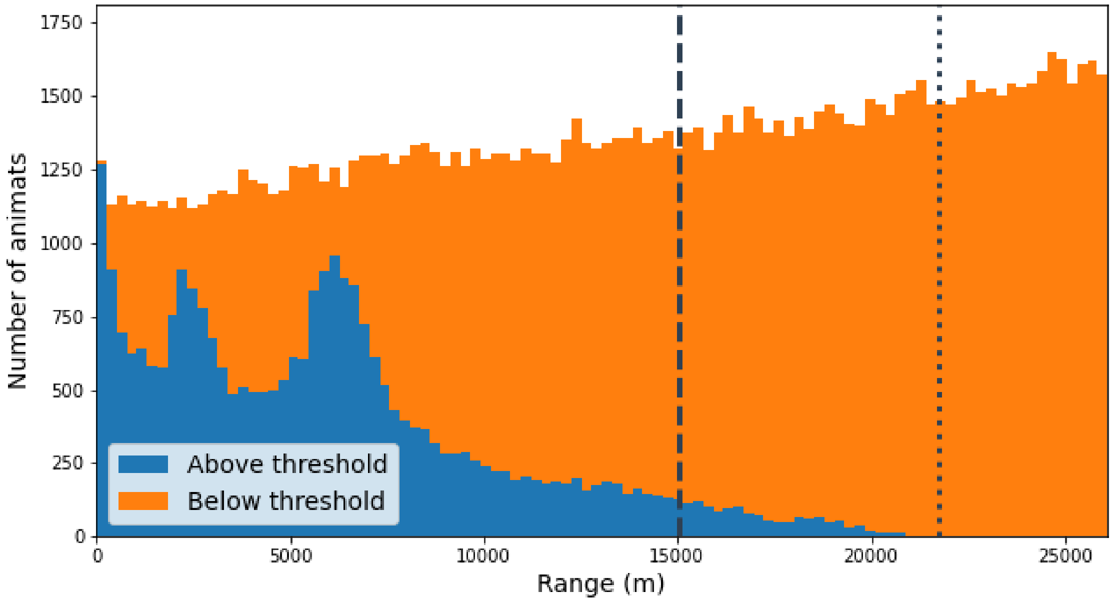

Figure E-2. Histograms of the distribution of CPA ranges for animats exposed above and below TTS SEL_{24h} threshold criteria for migrating pygmy blue whales. The TTS SEL_{24h} $ER_{95\%}$ and ER_{max} are indicated by vertical dashed lines.

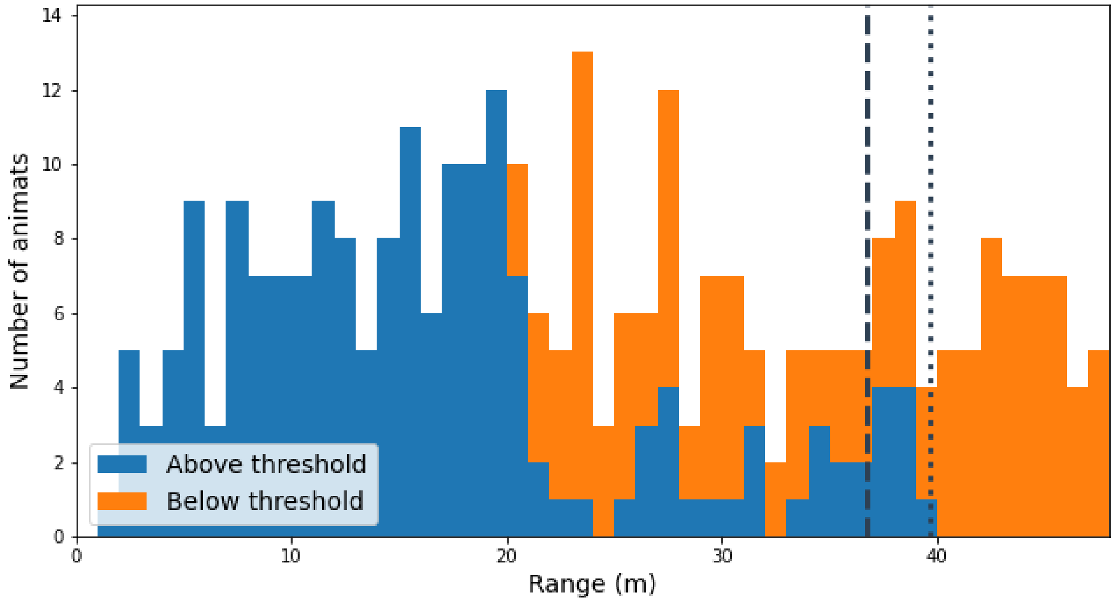

Figure E-3. Histograms of the distribution of CPA ranges for animats exposed above and below PTS PK threshold criteria for migrating pygmy blue whales. The PTS PK $ER_{95\%}$ and ER_{max} are indicated by vertical dashed lines.

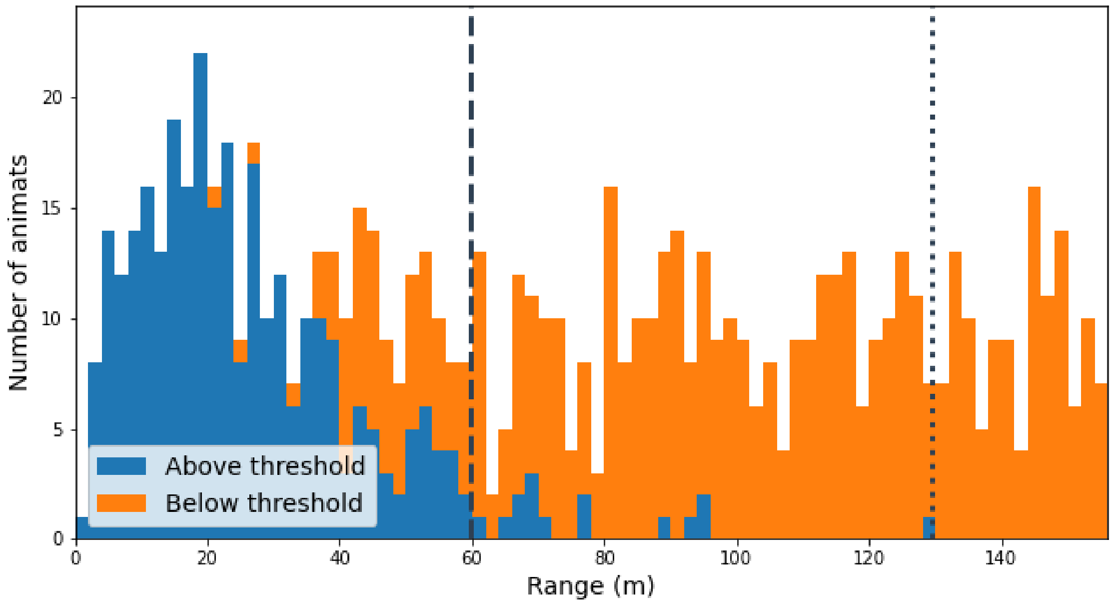

Figure E-4. Histograms of the distribution of CPA ranges for animats exposed above and below PTS SEL_{24h} threshold criteria for migrating pygmy blue whales. The PTS SEL_{24h} $ER_{95\%}$ and ER_{max} are indicated by vertical dashed lines.

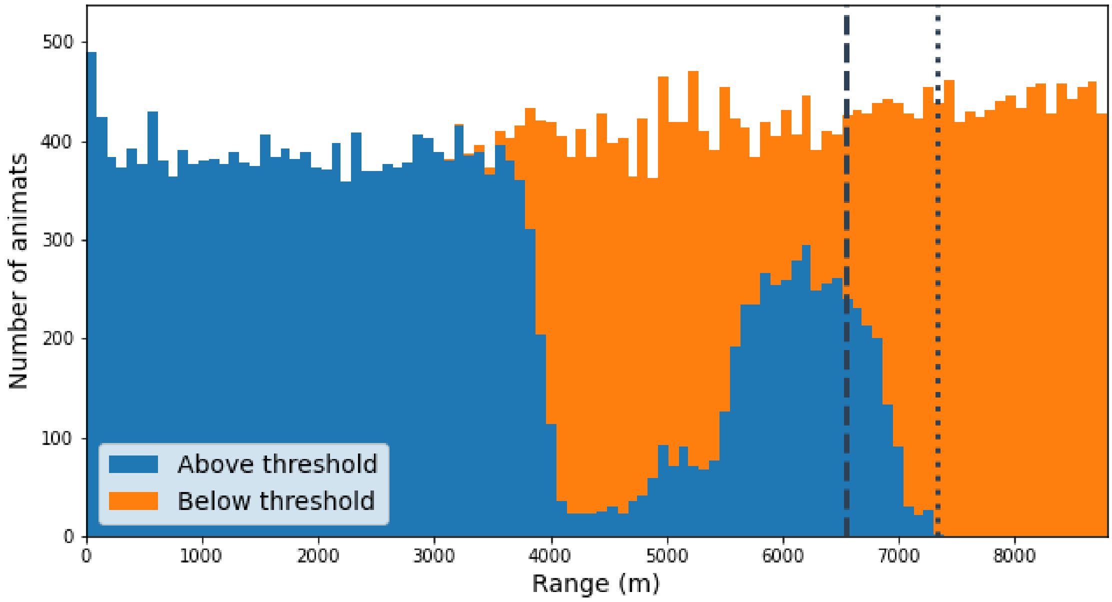

Figure E-5. Histograms of the distribution of CPA ranges for animats exposed above and below the behavioural response threshold criteria for migrating pygmy blue whales. The behavioural response $ER_{95\%}$ and ER_{max} are indicated by vertical dashed lines.

Figures E-6 and E-7 demonstrate the accumulation of SEL for TTS and PTS criteria when both the sources and the receivers are moving relative to each other. SEL criteria are assessed over a 24-hour duration, which is reflected in the SEL resets shown in the lower panels of both figures. In Figure E-6, an animat moves in a north-easterly direction and the cumulative SEL increases with proximity to the seismic survey. At approximately 55,000 seconds, the TTS threshold is exceeded. As the animat moves away from the seismic survey area and to the northeast, the SEL accumulation becomes negligible. Figures E-6 and E-7 shows an animat that exceeds both TTS and PTS thresholds within the first 24-hour period. Since the animats are modelled as migrating, they spend less time accumulating energy near the source, and instead follow a relatively direct path into and through the ensonified area. To accumulate levels that exceed PTS or TTS threshold criteria, they need to pass close to the source. Conversely, those animats that were restricted to the BIA were never exposed to levels for long enough to exceed any of the cumulative thresholds.

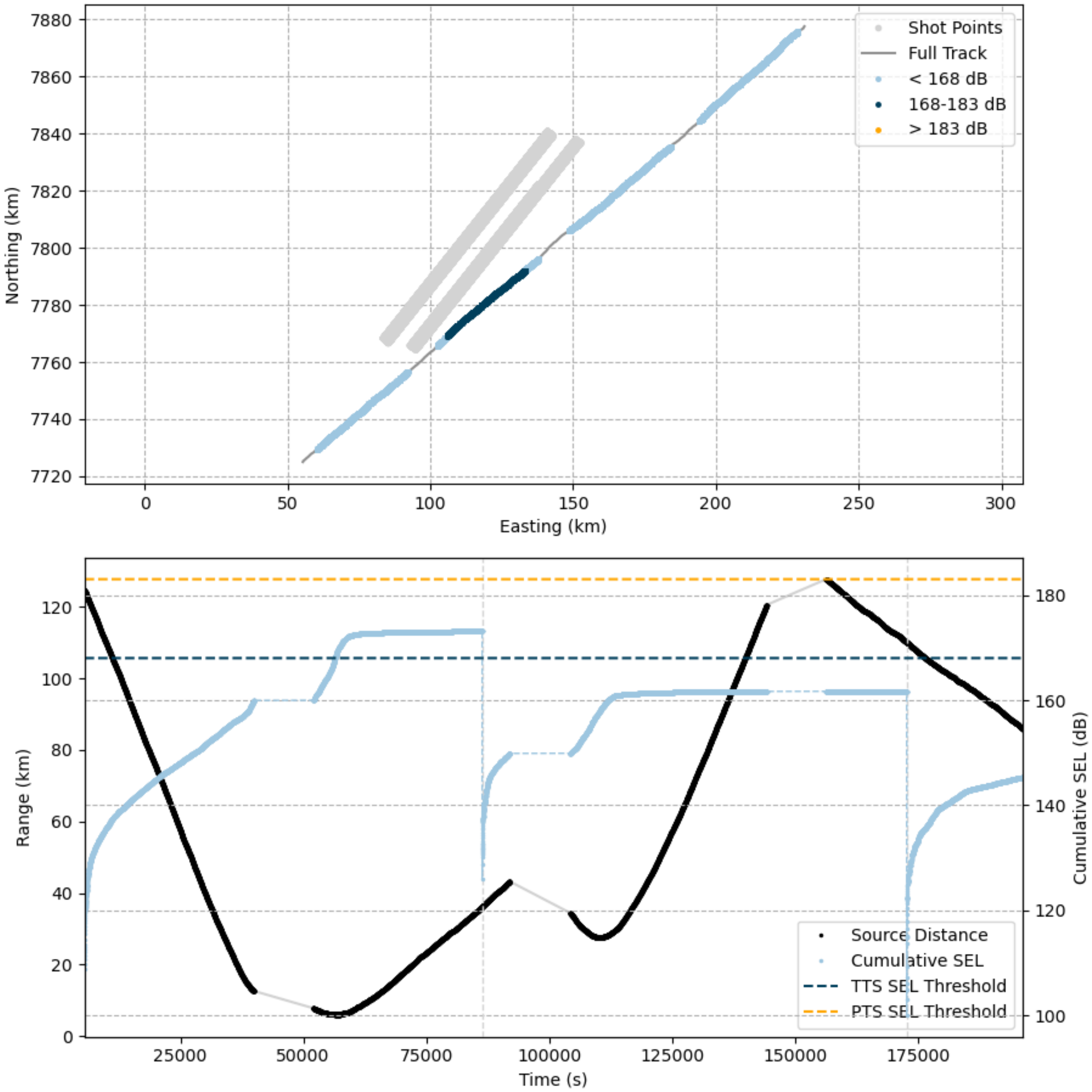

Figure E-6. Plots showing animat an animat track over a duration of approximately 2.2 days. The upper panel shows a plan view of both the source tracks and the migrating animat. Animat steps are coloured to indicate whether the accumulated sound energy at that point has exceeded either TTS or PTS threshold criteria. The lower panel shows horizontal distance in kilometres to the seismic source (black dots; left y-axis), and cumulative 24-h SEL ($L_{E,24h}$, dB re 1 µPa²·s; right y-axis).

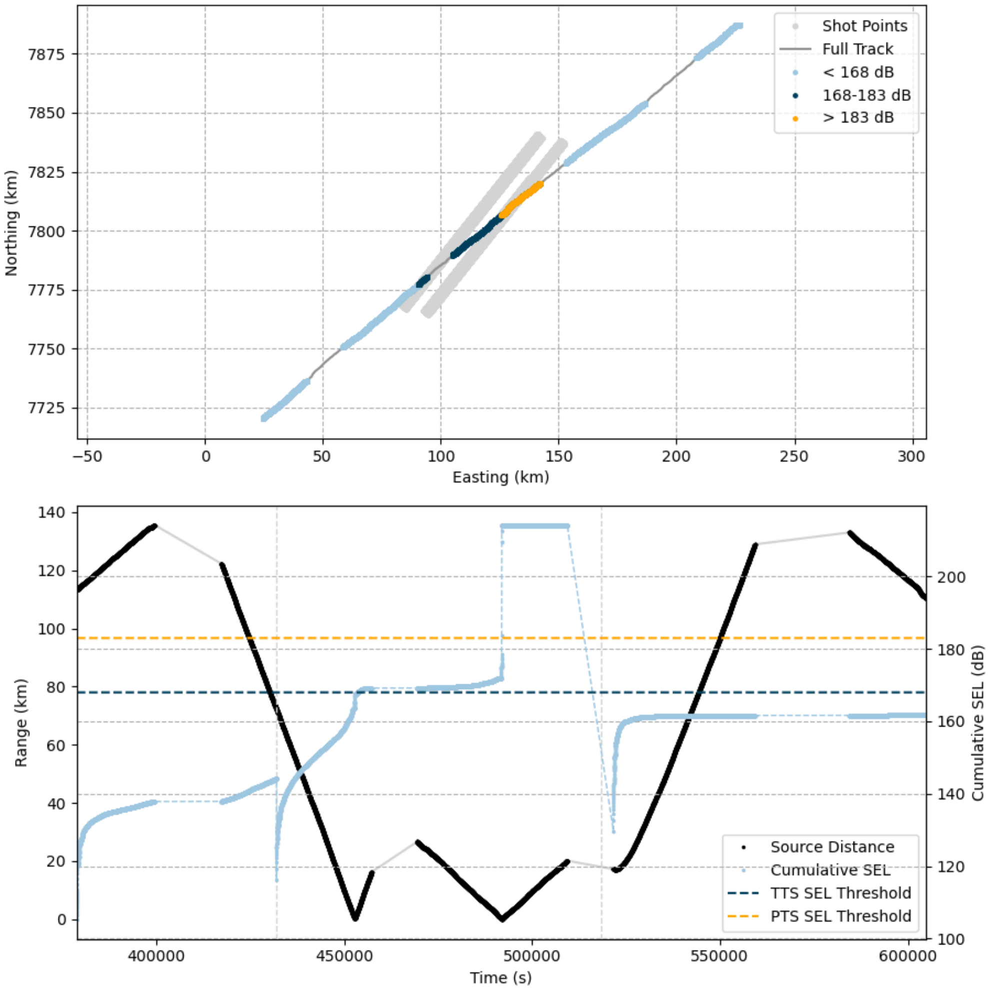

Figure E-7. Plots showing animat an animat track over a duration of approximately 2.5 days. The upper panel shows a plan view of both the source tracks and the migrating animat. Animat steps are coloured to indicate whether the accumulated sound energy at that point has exceeded either TTS or PTS threshold criteria. The lower panel shows horizontal distance in kilometres to the seismic source (black dots; left y-axis), and cumulative 24-h SEL ($L_{E,24h}$, dB re 1 µPa²·s; right y-axis).

APPENDIX H MASTER WOODSIDE EXISTING ENVIRONMENT

Description of the Existing Environment

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TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

1. INTRODUCTION

1.1 Purpose

This document applies, where indicated in the relevant Environment Plan, to Woodside Energy Ltd. (Woodside) activities and operations.

1.2 Scope

This document describes the existing environment within the Woodside areas of activity located in Commonwealth waters off north-western Western Australia (WA), with a focus on the North-west Marine Region (NWMR) (**Figure 1-1**). This document includes details of the particular and relevant values and sensitivities of the environment as required by the Commonwealth Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 in order to inform the impact and risk evaluation of Woodside's activities within the NWMR. Furthermore, the key values of the South-west Marine Region (SWMR) and the North Marine Region (NMR) are summarised to encompass areas outside the NWMR. This is with reference to the environment that may be affected (EMBA), as defined and described in individual EPs, for unplanned hydrocarbon spill risks. Additional information appropriate to the nature and scale of the impacts and risks of activities that may interact with the environment will be used to further inform impact and risk assessments and included in the Description of the Existing Environment of individual EPs.

This document is informed by a variety of resources that includes: a search of the Department of Agriculture, Water and the Environment (DAWE) Protected Matters Search Tool (PMST) for the marine bioregions (NWMR, SWMR and NMR) and the three PMST reports provided in **Appendix A**; State (WA)/Commonwealth Marine Park Management Plans, the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Species Profile and Threats Database (SPRAT), Part 13 statutory instruments (recovery plans, conservation advices and wildlife conservation plans for listed threatened and migratory species); and peer reviewed scientific publications, as well as Woodside and Joint Venture (JV) funded studies and other titleholder funded study findings available in the public domain.

1.3 Review and Revision

The information presented in this document is reviewed and updated, where relevant, on at least an annual basis to address any relevant changes, which includes but is not limited to the status of EPBC Act listed species, Part 13 Instruments, policies and guidelines and recently published scientific literature.

1.4 Regional Context

Where relevant, the physical, biological and social environments within the areas of interest are discussed with reference to the three marine bioregions of Australia—NWMR, SWMR and NMR (**Table 1-1)**. The NWMR is the focal marine bioregion for the Description of the Existing Environment as this is currently the location of most of Woodside's activities.

Table 1-1. Description of the Marine Bioregions

Marine Bioregion	Description
North-west	The NWMR includes all Commonwealth waters (from 3 nautical mile [nm] from the Territorial Sea Baseline [TSB] to the 200 nm Exclusive Economic Zone [EEZ] boundary) extending from the WA/Northern Territory (NT) border to Kalbarri, south of Shark Bay in WA, covering an area of approximately 1.07 million square kilometres and includes extensive areas of shallower waters on the continental shelf, as well as deep areas of abyssal plain where water depths are 5000 m or greater.
South-west	The SWMR comprises Commonwealth waters from the eastern end of Kangaroo Island in SA to Shark Bay in WA. The region spans approximately 1.3 million square kilometres of temperate and subtropical waters and abuts the coastal waters of SA and WA.
North	The NMR comprises Commonwealth waters from west Cape York Peninsula to the NT/WA border). The region covers approximately 625,689 square kilometres of tropical waters in the Gulf of Carpentaria and Arafura and Timor seas, and abuts the coastal waters of Queensland and the NT.

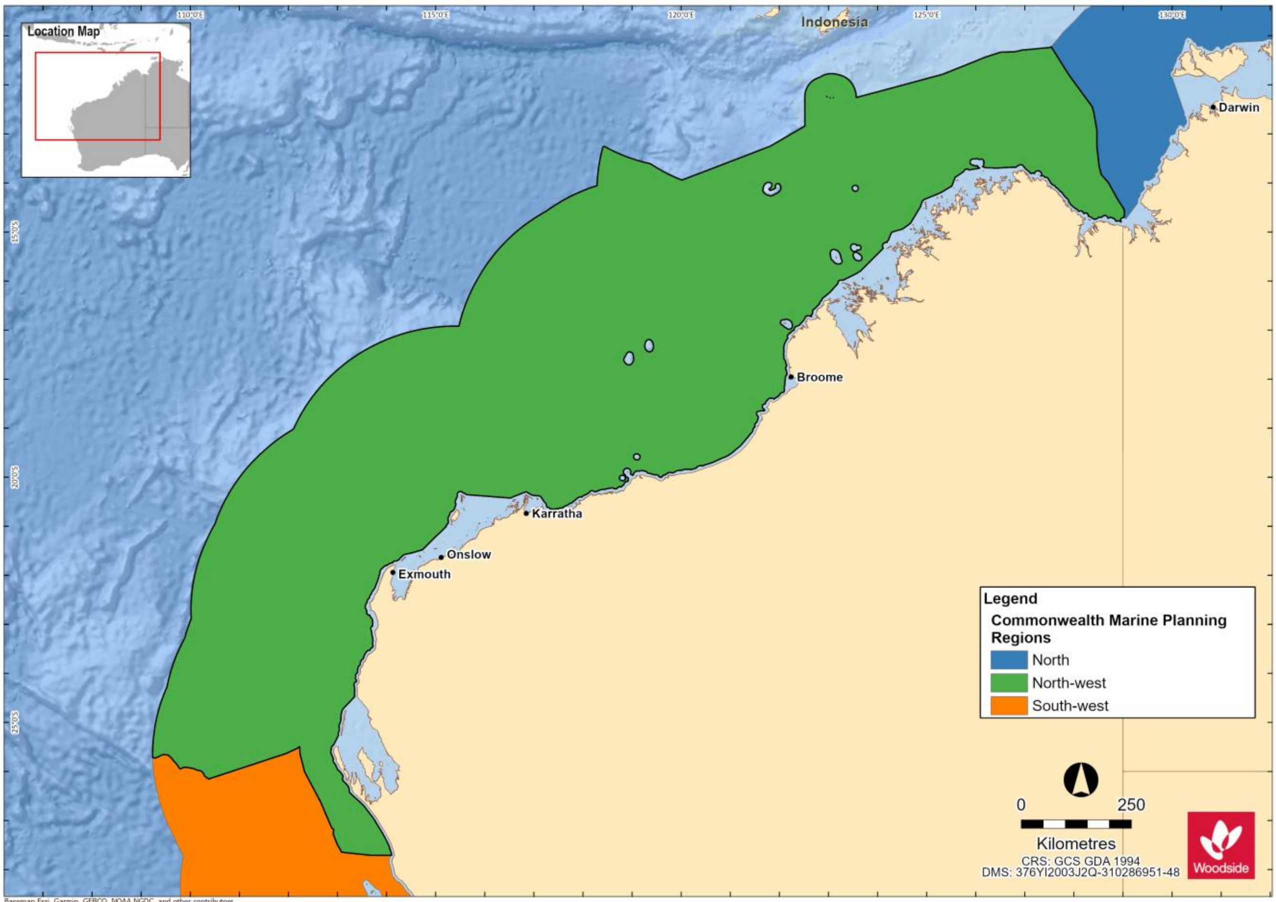

Figure 1-1. Marine Bioregions: North-west (NWMR), South-west (SWMR) and North (NMR)

2. PHYSICAL ENVIRONMENT

2.1 Regional Context

The key physical characteristics of the NWMR, SWMR and NMR are presented in **Table 2-1**.

Table 2-1 Key physical characteristics of the NWMR, SWMR and NMR

Bioregion	Key Characteristics
North-west Marine Region	The NWMR experiences a tropical monsoonal climate towards the northern extent of the region, transitioning to tropical arid and subtropical arid within the central and southern areas of the region (DSEWPAC, 2012a).
	The NWMR is part of the Indo-Australian Basin, the ocean region between the north-west coast of Australia and the Indonesian islands of Java and Sumatra. Dominant currents in the Region include: the South Equatorial Current, the Indonesian Throughflow; the Eastern Gyral Current, and the Leeuwin Current (DEWHA, 2007a).
	The seafloor of the NWMR consists of four general feature types: continental shelf; continental slope; continental rise; and abyssal plain and is distinguished by a range of topographic features including canyons, plateaus, terraces, ridges, reefs, and banks and shoals.
South-west Marine Region	The SWMR contains both subtropical and temperate climates, with overall light climatic cycles.
	The SWMR experiences complex and unusual oceanographic patterns, driven largely by the Leeuwin Current and its associated currents that have a significant influence on biodiversity distribution and abundance.
	The major seafloor features of the SWMR include a narrow continental shelf on the west coast to the waters off south-west WA, and a wide continental shelf dominated by sandy carbonate sediments of marine origin in the Great Australian Bight, the region also contains a steep, muddy continental slope, many canyons and large tracts of abyssal plains (DSEWPAC, 2012b).
North Marine Region	The NMR experiences a tropical monsoonal climate with complex weather cycles, including high temperatures and heavy seasonal yet variable rainfall and cyclones, which can be both destructive (loss of seagrass and mangroves) and constructive (mobilisation of sediment into coastal habitats).
	The NMR comprises Commonwealth waters from west Cape York Peninsula to the NT–WA border, covering tropical waters in the Gulf of Carpentaria and Arafura and Timor seas. Currents in the NMR are driven largely by strong winds and tides, with only minor influences from oceanographic currents such as the Indonesian Throughflow and the South Equatorial Current (DSEWPAC, 2012c).
	The seafloor of the NMR consists mainly of a wide continental shelf, as well as other geomorphological features such as shoals, banks, terraces, valleys, shallow canyons and limestone pinnacles.

2.2 Marine Systems of the North-west Marine Region.

The NWMR can be divided into three large scale ecological marine systems on the basis of the influence of major ocean currents, seafloor features and eco-physical processes (e.g. climate, tides, freshwater inflow) upon the Region (DSEWPAC, 2012a). The three large scale marine systems approximate the Woodside activity areas within the NWMR (**Figure 2-1**). The key characteristics of each marine system are outlined below in **Table 2-2**.

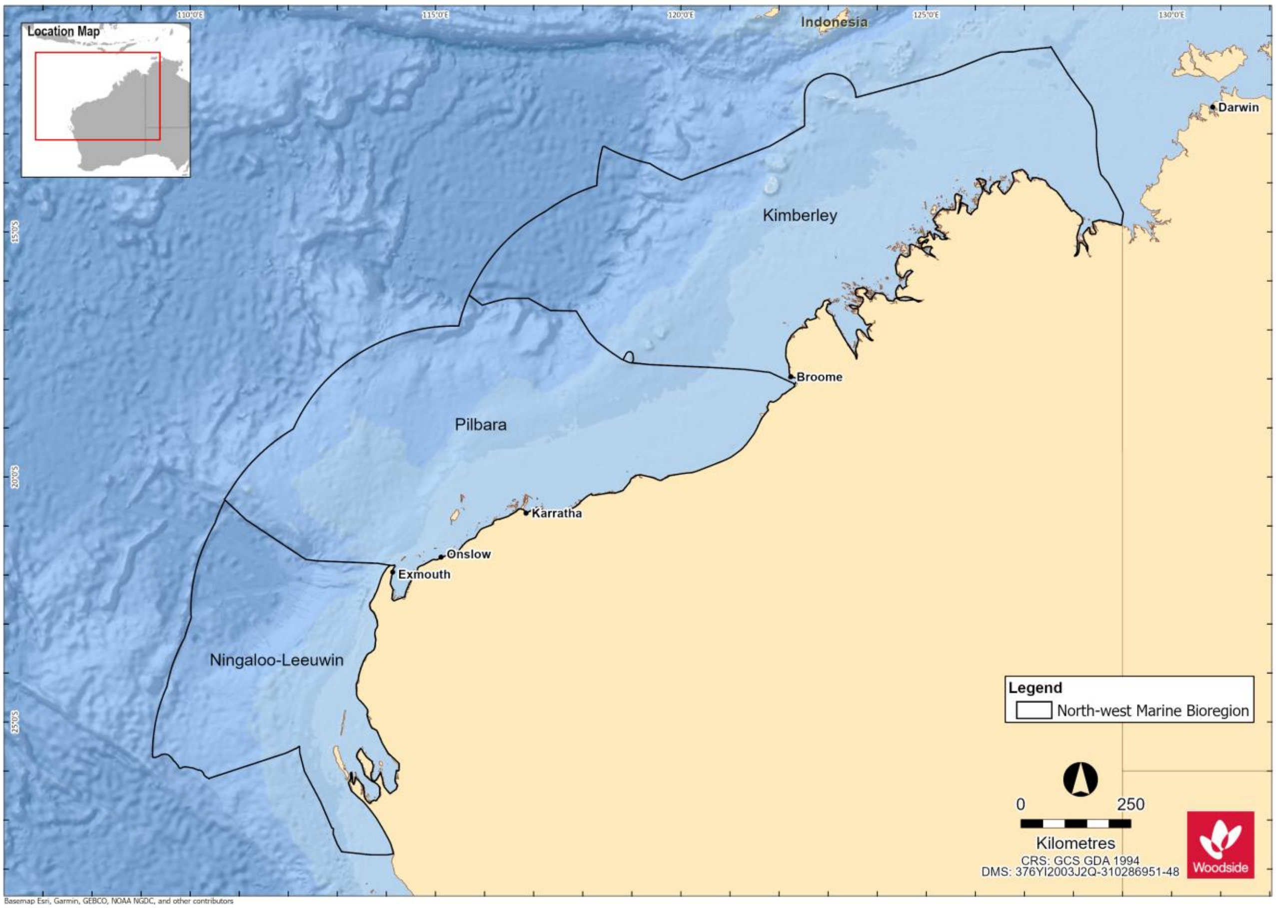

Figure 2-1. The marine systems of the North-west Marine Region (NWMR)

Table 2-2. Key characteristics of the Marine Systems of the NWMR

Note: Woodside areas align with the marine systems as described in DEWHA (2007a)

Marine System	Woodside Activity Area	Key Characteristics
Kimberley	Browse	Tropical monsoonal climate Strong influence from Indonesian Throughflow Predominantly tropical Indo-Pacific species Subject to episodic offshore cyclonic activity, rarely crossing the coast Large tidal regimes Freshwater input from terrestrial monsoonal run-off Turbid coastal waters (i.e. light limited systems) Dominated by shelf environments Predominantly hard substrates in inner to mid-shelf environments Includes a number of shelf-edge atolls (i.e. Scott Reef, Rowley Shoals)
Pilbara	North-west Shelf (NWS) / Scarborough	Tropical arid climate Transition between Indonesian Throughflow and Leeuwin Current dominated areas Predominantly tropical species High cyclone activity with frequent crossing of the coast Transitional tidal zone Internal tide activity Large areas of shelf and slope Dry coast with ephemeral freshwater inputs
Ningaloo-Leeuwin	North-west Cape	Subtropical arid climate Leeuwin Current consolidates Transitional tropical/temperate faunal area Higher water clarity in near-shore and offshore environments Narrow shelf and slope Marginal tidal range Seasonal wind forcing more dominant influence on marine environment

2.3 Meteorology and Oceanography

This section describes the general meteorological conditions and oceanography for the NWMR and provides further detail for the three Woodside activity areas. The NWMR is influenced by a complex system of ocean currents that change between seasons and between years, which generally result in its surface waters being warm and nutrient-poor, and of low salinity (DEWHA, 2007a). The mix of bathymetric features, complex topography and oceanography across the whole north-west marine environment has created and supports a globally important marine biodiversity hotspot (Wilson, 2013).

Table 2-3 NWMR climate and oceanography summary

Receptor	Description
Meteorology	
Seasonal patterns	The NWMR associated land mass of the Australian continent is characterised as a hot and humid summer climate zone. The broader NWMR experiences variations of a tropical or monsoon climate. In the far north-west (Kimberley), there is a hot summer season from December to March and a milder winter season between April and November. The Pilbara area is described as having a tropical arid climate with high cyclone activity (DEWHA, 2007a). The Pilbara and North-west Cape has a hot summer season from October to April and a milder winter season between May and September with transition periods between the summer and winter regimes.
Air temperature and rainfall	In summer (between September and March), maximum daily temperatures range from 31ºC to 33ºC. During winter (May to July), mean daily temperatures range from 18ºC to 31ºC (BOM[1]), refer to **Figure 2-2a** and **b**. Rainfall in the region typically occurs during the summer, with highest falls observed late in the season. This is often associated with the passage of tropical low-pressure systems and cyclones.
Wind	Wind patterns in north-west WA are dictated by the seasonal movement of atmospheric pressure systems. During summer, high-pressure cells produce prevailing winds from the north-west and south-west, which vary between 10 and 13 ms^{-1}. During winter, high-pressure cells over central Australia produce north-easterly to south-easterly winds with average speeds of between 6 and 8 ms^{-1}. Refer to **Figure 2-3a** and **b**.
Tropical cyclones	The NWS and Pilbara coast (within the NWMR) experiences more cyclonic activity than any other region of the Australian mainland coast (BOM, 2021a). Tropical cyclone activity typically occurs between November and April and is most frequent in the region during December to March (i.e. considered the peak period), with an average of about one cyclone per month (BOM, 2021a). Refer to **Figure 2-4**.
Oceanography	
Ocean temperature	Waters in NWMR are tropical year-round, with sea surface temperature in open shelf waters reaching ~26°C in summer and dropping to ~22°C in winter. Nearshore temperatures (as recorded for the NWS area) fluctuate more widely on an annual basis from ~17°C in winter to ~31°C in summer (Chevron Australia, 2010). Refer to **Figure 2-5a** and **b**.
Currents	The major surface currents influencing north-west WA flow towards the poles and include the Indonesian Throughflow, the Leeuwin Current, the South Equatorial Current, and the Eastern Gyral Current. The Ningaloo Current, the Holloway Current, the Shark Bay Outflow, and the Capes Current are seasonal surface currents in the region. Below these surface currents are several subsurface currents, the most important of which are the Leeuwin Undercurrent and the West Australian Current. These subsurface currents flow towards the equator in the opposite direction to surface currents (DEWHA, 2007a). Refer to **Figure 2-6**. The offshore waters of the NWMR are characterised by surface and subsurface boundary currents that flow along the continental shelf/slope and are enhanced through inflows from the ocean basins and are an important conduit for the poleward heat and mass transport along the west coast (Wijeratne *et al.*, 2018). Local physical oceanography is strongly influenced by the large-scale water movements of the Indonesian Throughflow (Liu *et al*. 2015; Sutton *et al*. 2019). Typically, a warm and well-mixed oligotrophic surface layer and a cooler and more nutrient rich, deeper water layer (Menezes *et al*. 2013).
Waves	Sea surface waves within the NWMR, generally reflect the direction of the synoptic winds and flow predominately from the south-west in the summer and east in winter (Pearce *et al.*, 2003). The NWS within the NWMR is a known area of internal wave generation. Both internal tides and internal waves are thought to be more prevalent during summer months due to the increased stratification of the water column (DEWHA, 2007a). Along the continental slope of the NWMR, strong internal waves and interaction between semi-diurnal tidal currents and seabed topographic features facilitates upwelling events and localised productivity events (Holloway, 2001).
Tides	Tides on the NWS (NWMR) increase as the water moves from deep towards the shallower coast. The highest offshore tides are experienced at the border of the Browse and Canning basins. The smallest tides are experienced at the Exmouth Plateau, near the coast. Tides of NWS (NWMR) are predominantly semi-diurnal (two highs and two lows each day), but with increasing importance of the diurnal (once per day) inequality at the southern and northern extremities of the NWS.

[1] http://www.bom.gov.au/jsp/ncc/climate_averages/temperature/index.jsp, accessed 21 January 2021.

Receptor	Description
	The tide range—represented by the Mean Spring Range (MSR)—increases northwards along the coast from 1.4 m at North-west Cape (Point Murat) to 7.7 m at Broome, before decreasing again (apart from local amplification in King Sound and Collier Bay) to about 5 m off Cape Londonderry. The MSR then increases again through Joseph Bonaparte Gulf and on up 5.5 m at Darwin (RPS, 2016).

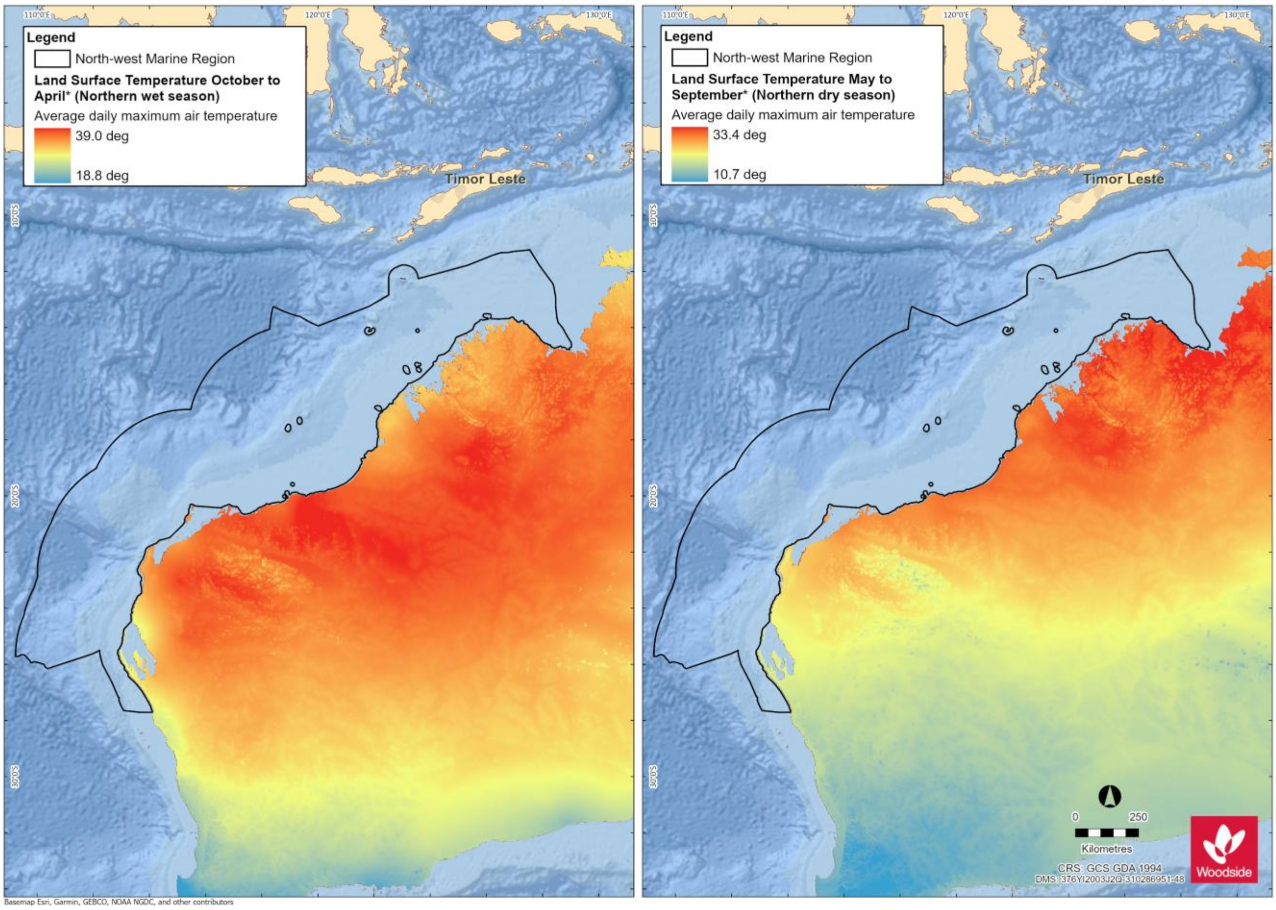

Figure 2-2. Average daily maximum air temperature for land surface adjacent to NWMR: (a) summer (northern wet season) and (b) winter (northern dry season)

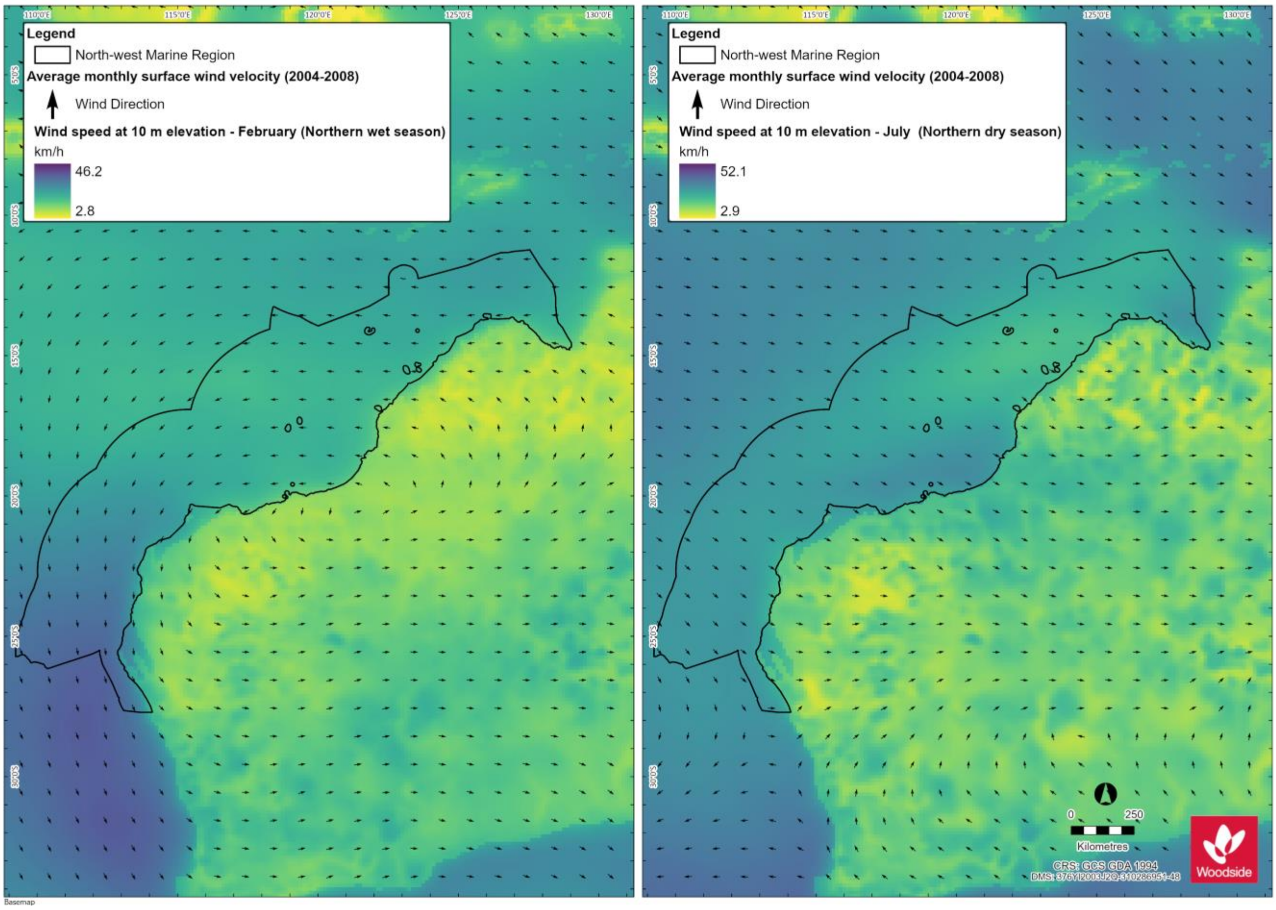

Figure 2-3. Average monthly surface wind direction and velocity for NWMR: (a) summer (February, northern wet season) and (b) winter (July, northern dry season)

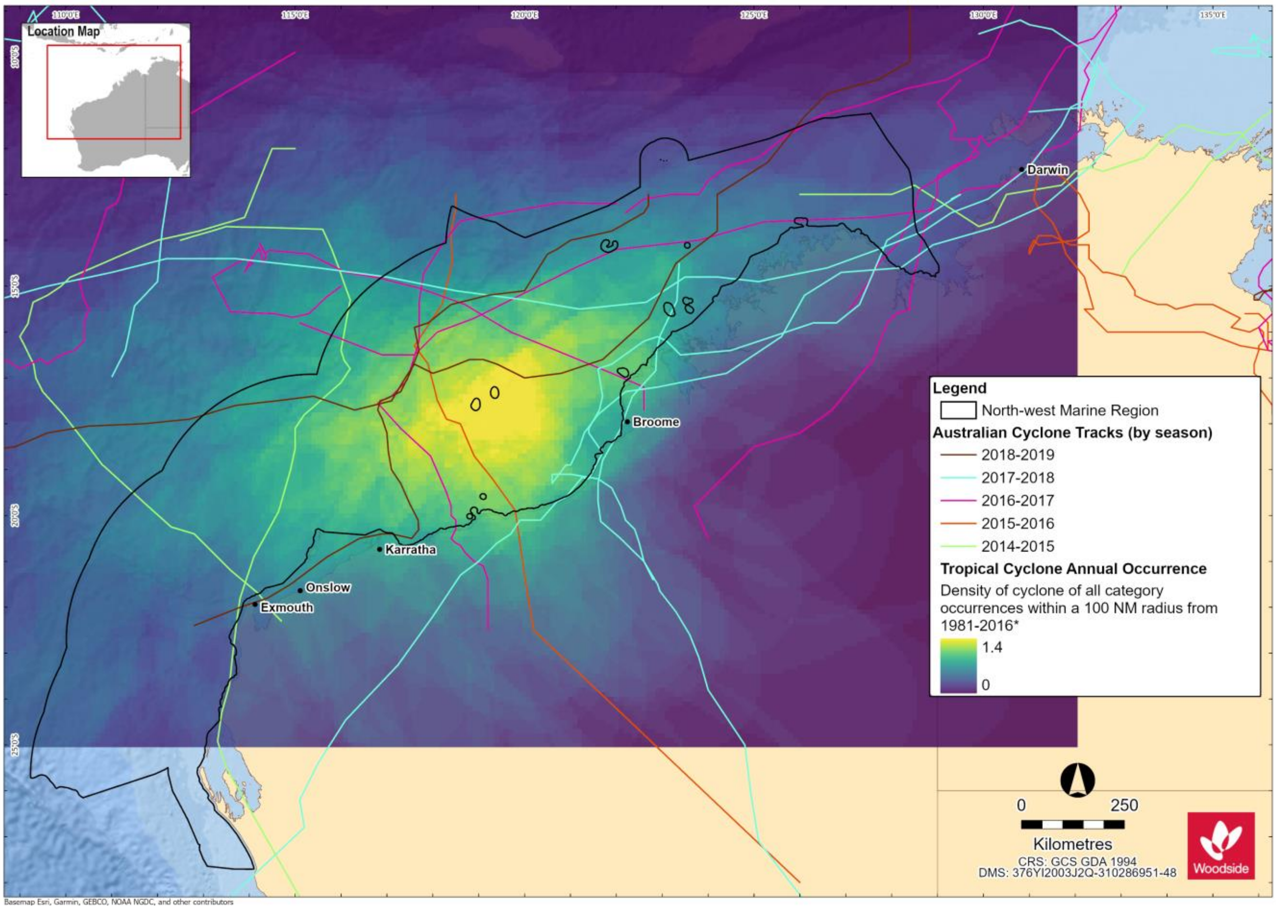

Figure 2-4. Tropical cyclone annual occurrence and cyclone tracks for NWMR

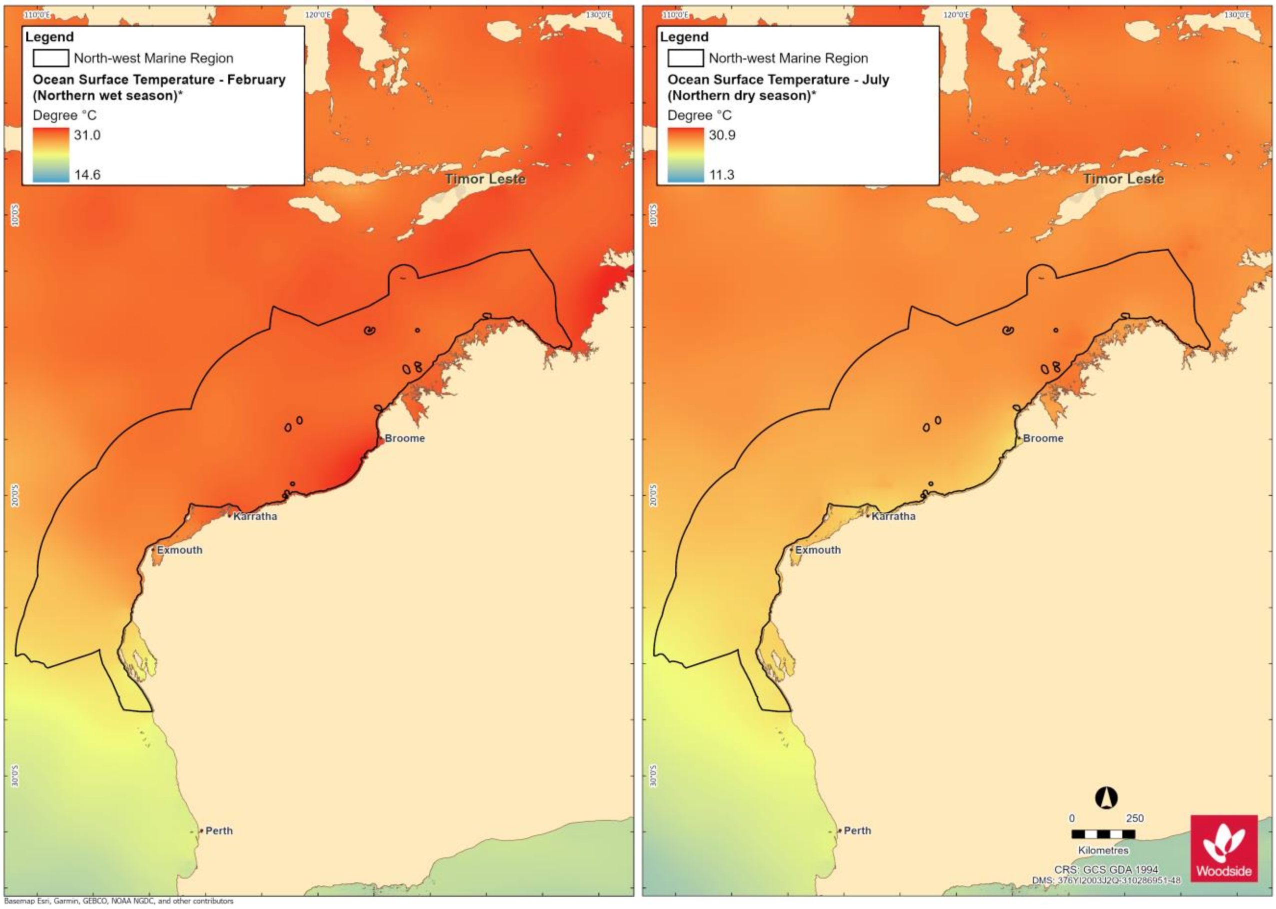

Figure 2-5. Ocean surface temperature for NWMR: (a) summer (February, northern wet season) and (b) winter (July, northern dry season)

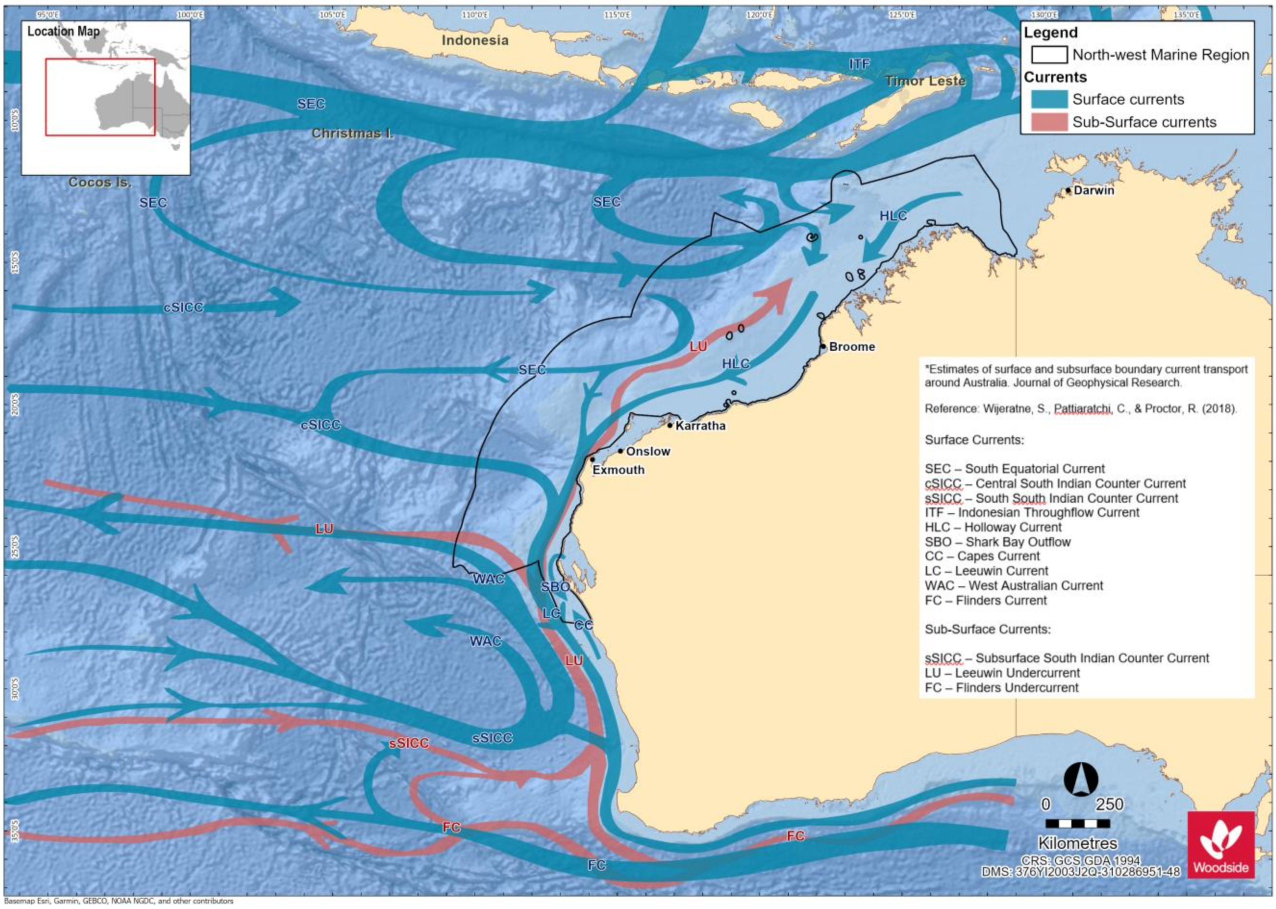

Figure 2-6. Ocean surface and sub-surface currents of the NWMR and wider region

2.3.1 Browse

Table 2-4 Summary meteorology and oceanography for Browse (refer to Appendix B for supporting metocean figures)

Receptor	Description
Meteorology	
Seasonal patterns	The Browse area overlapping the Kimberley marine system experiences tropical monsoon climate with two distinct seasons: the wet season from December to March and dry season from April to November.
Air temperature	The mean annual air temperature recorded at Troughton Island between 2010 and 2020 ranged from 30.1ºC in 2011 to 32.6ºC in 2016 and highest mean monthly air temperatures were recorded for the months of November and December (BOM, 2021b).
Rainfall	Rainfall recorded from Troughton Island in the Browse basin ranged from barely detectable (<1 mm) mean monthly level to >100 mm in December to March, with the highest rainfall recorded for January. Reflecting the wet monsoon season of the Kimberley marine system (BOM, 2021c).
Wind	The dry season experiences high pressure systems that bring east to south-easterly winds with average wind speeds during the season of approximately 16.6 km/hr and maximum wind gusts of 65 km/hr. In contrast the wet season brings predominately westerly winds with average wind speeds approximately 17 km/hr and maximum gusts exceeding 100 km/hr (generally associated with tropical cyclones (MetOcean Engineers, 2005).
Oceanography	
Currents	Surface currents exhibit seasonal directionality, with flow to the south-west during March to June and more variable outside this period (Woodside, 2019). This is consistent with the stronger Leeuwin Current flow during winter months, with more variable currents driven by local wind stress during periods of weaker Leeuwin Current flow.

2.3.2 North West Shelf / Scarborough

Table 2-5 Summary meteorology and oceanography for the North West Shelf and Scarborough (refer to Appendix B for supporting metocean figures)

Receptor	Description
Meteorology	
Seasonal patterns	The NWS and Scarborough areas experience the monsoonal climate of the wider NWMR with a distinct wet and dry seasonal regime and transitions periods between seasons.
Air temperature	Air temperatures as measured at the North Rankin A platform on NWS ranged from a maximum average of 39.5ºC in summer to a minimum average temperature of 15.6ºC in winter (Woodside, 2012).
Rainfall	Rainfall patterns annually reveal the wet season with highest rainfalls during the late summer, often associated with the passage of tropical low-pressure systems and cyclones. Rainfall in the dry season is typically extremely low. (Pearce *et al.* 2003).
Wind	Winds are typically from the southwest during the wet season (summer) and tending from the south-east during the dry season (winter). The summer south-westerly winds are driven by high pressure cells that pass from west to east over the Australian continent. During the winter period, the relative position of the high-pressure cells shifts further north, leading to prevailing south-easterly winds from the mainland (Pearce *et al.* 2003).
Oceanography	
Currents	The large-scale ocean currents of the NWMR, primarily the Indonesian Throughflow and Leeuwin Current (and Holloway Current), are the primary influence on the NWS and Scarborough areas. The ITF and Leeuwin Current are strongest during the late summer and winter and flow reversals to the north-east, typically short-lived and weak, when there are strong south-westerly winds can generate localised upwelling on the shelf edge (Holloway and Nye, 1985; James *et al.* 2004 and Condie *et al.* 2006).

2.3.3 North-west Cape

Table 2-6 Summary meteorology and oceanography for the North-west Cape (refer to Appendix B for supporting metocean figures)

Receptor	Description
Meteorology	
Seasonal patterns	The climate of the NWMR is dry tropical exhibiting a hot summer season and a mild winter season. There are often distinct transition periods between the summer and winter regimes, characterised by periods of relatively low winds.
Air temperature	Air temperatures in the North-west Cape area range from high summer temperatures (maximum average of 37.5ºC) and mild winter temperatures (minimum average of 12.2ºC).
Rainfall	Rainfall typically occurs during the summer, with highest rainfall during later summer and autumn, often associated with the passage of tropical low-pressure systems and cyclones. Rainfall is typically low in winter.
Wind	Winds vary seasonally, generally from the south-west quadrant during summer months and the south, south-east quadrant during the autumn and winter months. The summer south-westerly winds are driven by high pressure cells that pass from west to east over the Australian continent. Winds typically weaken and are more variable during the transitional period between the summer and winter seasons, generally between April to August.
Oceanography	
Currents	Surface currents exhibit seasonal directionality, with flow to the south-west during March to June and more variable outside this period (Woodside, 2016). This is consistent with the stronger Leeuwin Current flow during winter months, with more variable currents driven by local wind stress during periods of weaker Leeuwin Current flow.

2.4 Physical Environment of NWMR

Based on the Integrated Marine and Coastal Regionalisation of Australia (IMCRA) Version 4.0, there are eight provincial bioregions that occur within the NWMR, which are based on patterns of demersal fish diversity, benthic habitat and oceanographic data (Commonwealth of Australia, 2006), **Figure 2-7**. Of the eight provincial bioregions that occur within the NWMR, these include four offshore (~65% of total NWMR area) and four shelf (~35% of total NWMR area) bioregions (Baker *et al.,* 2008).

The NWMR is a tropical carbonate margin that comprises an extensive area of shelf, slope and abyssal plain/deep ocean floor, as well as complex areas of bathymetry such as plateau, terraces and major canyons (Harris *et al.*, 2005). A series of reefs are located on the outer shelf/slope of the NWMR, including Ashmore, Cartier, Scott and Seringapatam reefs (Baker *et al*., 2008). The distribution of seafloor geomorphic features has been systematically mapped over much of the Australian margin and adjacent seafloor. The mapped area can be divided into 10 geomorphic regions, of which the NWMR overlays two; the Western Margin and Northern Margin (Harris *et al.*, 2005). Most of the region consists of either continental slope (61%) or continental shelf (28%) (DEWHA, 2007a) with more than 40% of the NWMR having a water depth less than 200 m. The shallow shelf is contrasted by features such as the Cuvier and Argo abyssal plains, which reach depths more than five kilometres. A unique feature of the region is the significant narrowing of the continental shelf around North-west Cape (approximately 7 km wide) from the broad continental shelf in the north of the region (approximately 400 km wide at Joseph Bonaparte Gulf) (DEWHA, 2007a), **Figure 2-8.**

The geological history of the region, as well as its geomorphology and oceanography, has influenced the composition and distribution of sediments (DEWHA, 2007a). The sedimentology of the NWMR is dominated by marine carbonates, which show a broad zoning and fining with water depth. Main trends of the NWMR sediments include a tropical carbonate shelf that is dominated by sand and gravel, an outer shelf/slope zone that is dominated by mud and a relatively homogenous rise and abyssal plain/deep ocean floor that is dominated by non-carbonate mud (Baker *et al.,* 2008), **Figure 2-9**.

The distribution and resuspension of sediments on the inner shelf is strongly influenced by the strength of tides across the continental shelf as well as episodic events such as cyclones. Further offshore, on the mid to outer shelf and on the slope itself, sediment movement is primarily influenced by ocean currents and internal tides (DEWHA, 2007a).

This variation in bathymetry and interactions with oceanographic processes provides a diversity of habitats to marine fauna and flora within the NWMR.

2.5 Air quality

The ambient air quality of all three marine regions is largely unpolluted due to the extent of the open ocean area, the activities currently carried out in each and the relative remoteness of each region.

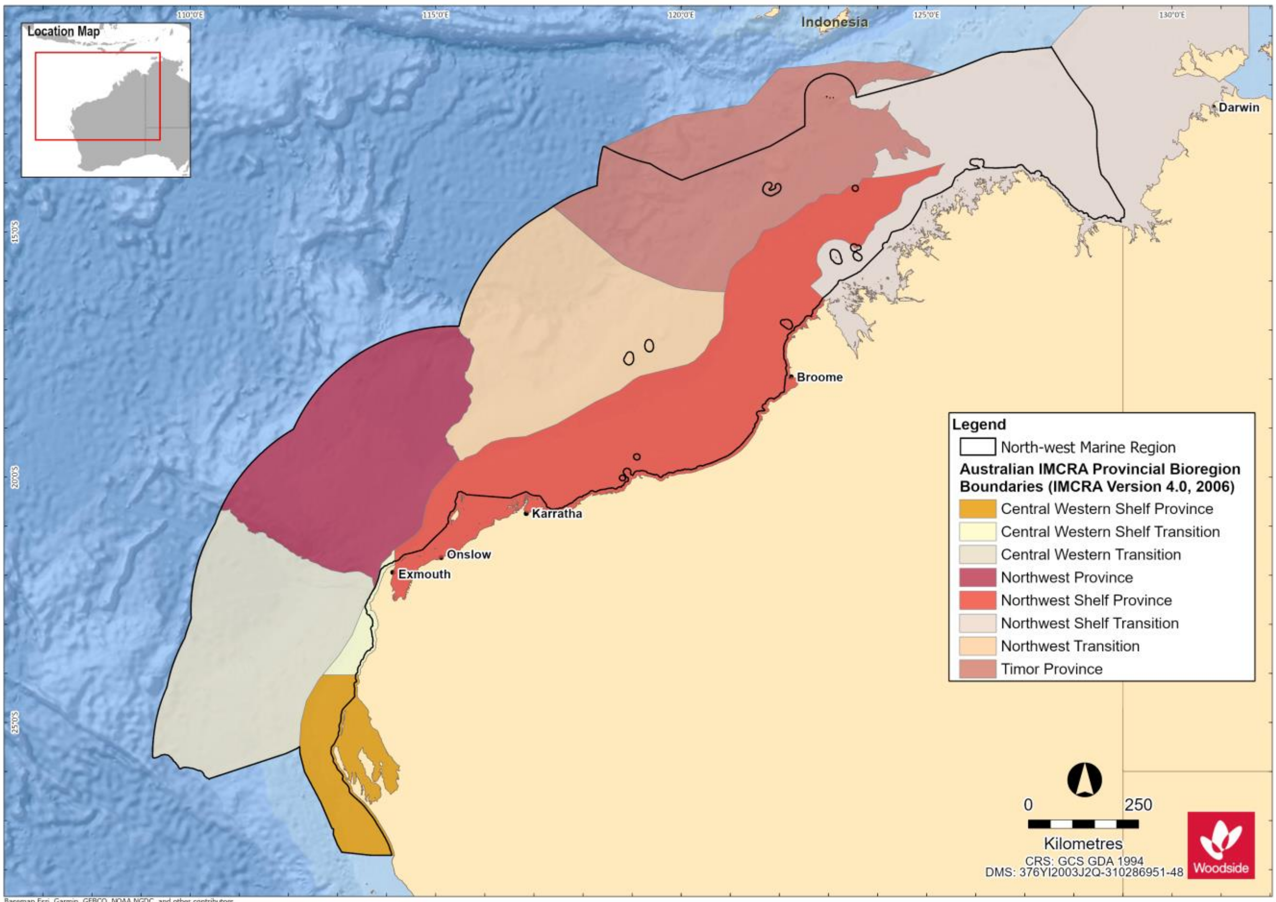

Figure 2-7. The eight provincial bioregions of the NWMR (Commonwealth of Australia, 2006)

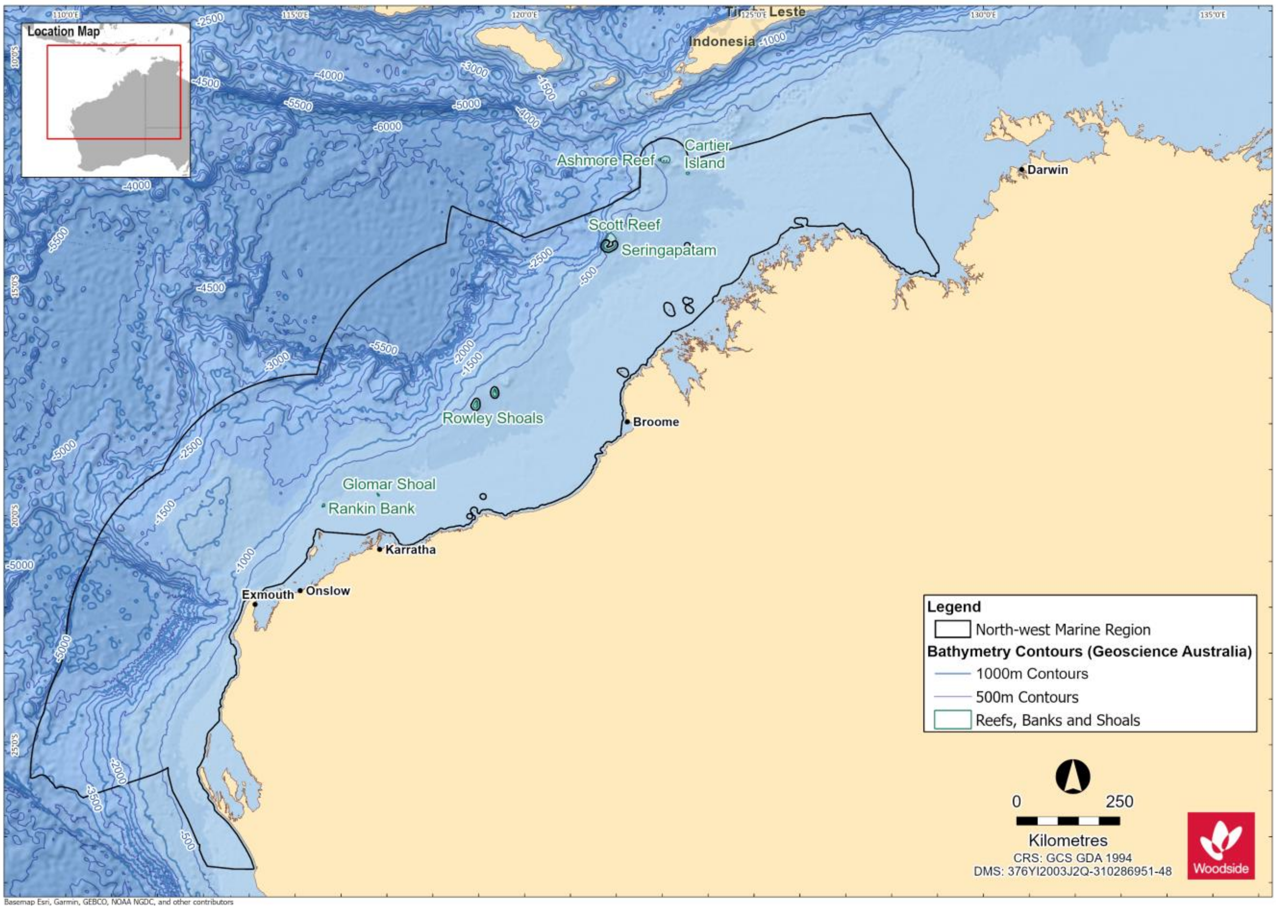

Figure 2-8. Bathymetry of the NWMR

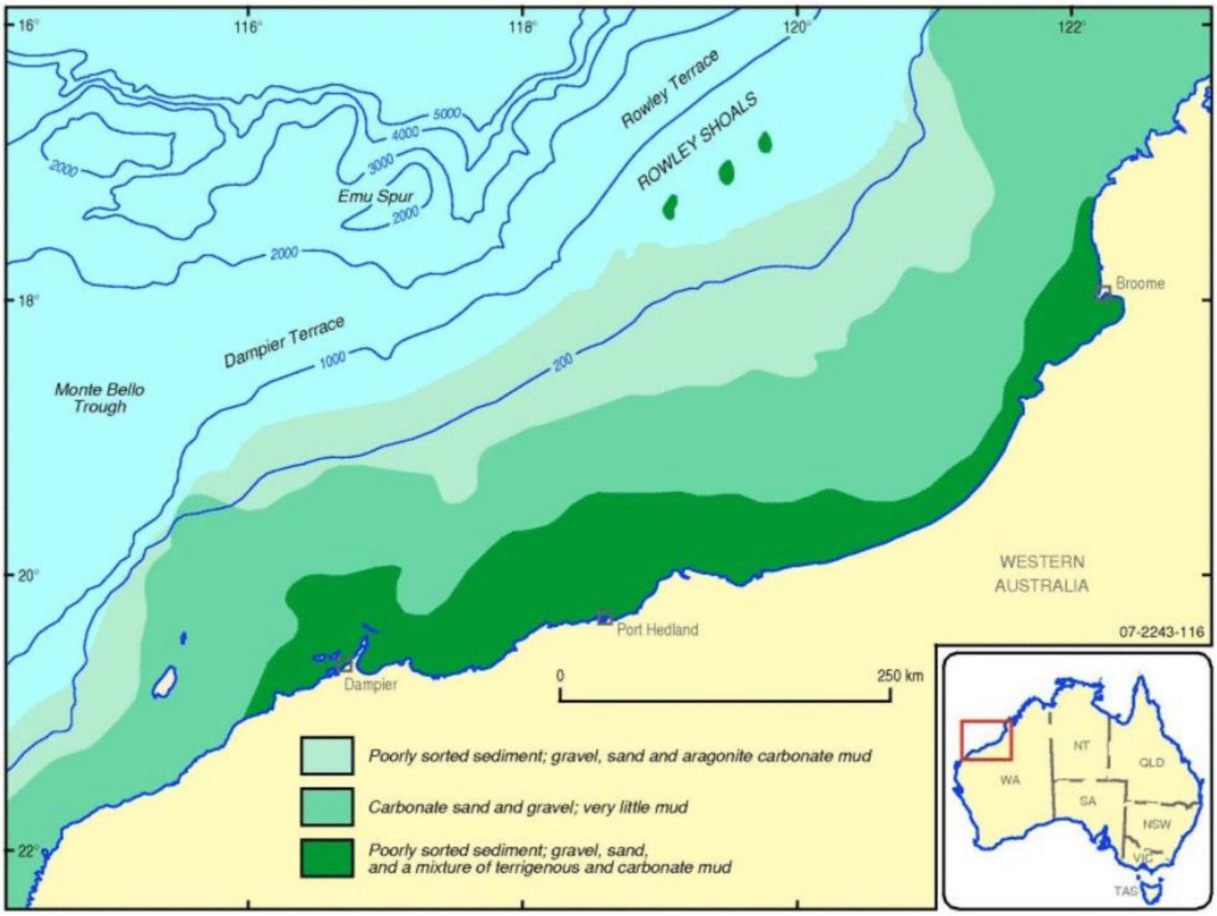

Figure 2-9. Overview of the seabed sediments of the NWMR (Baker *et al*., 2008)

3. MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE (EPBC ACT)

3.1 Summary of Matters of National Environmental Significance (MNES)

This section summarises the matters of national environmental significance (MNES) reported for the three bioregions; NWMR **(Table 3-1), ** SWMR (**Table 3-2**) and NMR (**Table 3-3**), based on the Protected Matters search reports (**Appendix A**).

Additional information on these MNES are provided in subsequent sections (referenced below).

Table 3-1 Summary of MNES identified by the EPBC Act Protected Matters Search Tool (PMST) as potentially occurring within the NWMR

MNES	Number	Description	Section of this Document
World Heritage Properties	2	Shark Bay The Ningaloo Coast	**Section 10**
National Heritage Places	5	Shark Bay The Ningaloo Coast The West Kimberley The Dampier Archipelago (including Burrup Peninsula) Dirk Hartog Landing Site 1616	**Section 10**
Wetlands of International Importance (Ramsar)	3	Ashmore Reef National Nature Reserve Eighty Mile Beach Roebuck Bay[1]	**Section 10**
Commonwealth Marine Area	2	EEZ and Territorial Sea Key Ecological Features (KEFs) Australian Marine Parks (AMPs) Australian Whale Sanctuary Extended Continental Shelf	**Section 9** **Section 10**
Listed Threatened Ecological Communities	1	Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula	Terrestrial community and not considered further
Listed Threatened Species	70	Refer NWMR PMST report (**Appendix A**)	**Section 5 – Section 8**
Listed Migratory Species	84	Refer NWMR PMST report (**Appendix A**)	**Section 5 – Section 8**

[1] *Roebuck Bay is a designated Wetland of International Importance (Ramsar site), which was not included in the PMST Report (**Appendix A**).*

Table 3-2 Summary of MNES identified by the EPBC Act Protected Matters Search Tool (PMST) as potentially occurring within the SWMR

MNES	Number	Description	Section of this Document
World Heritage Properties	0	N/A	N/A
National Heritage Places	3	Cheetup Rock Shelter Batavia Shipwreck Site and Survivor Camps Area 1629 – Houtman Abrolhos HMAS Sydney II and HSK Kormoran Shipwreck Sites	**Section 10**
Wetlands of International Importance (Ramsar)	4	Becher Point Wetlands Forrestdale and Thomsons Lakes Peel-Yalgorup System Vasse-Wonnerup System	**Section 10**
Commonwealth Marine Area	2	EEZ and Territorial Sea KEFs AMPs Australian Whale Sanctuary Extended Continental Shelf	**Section 9** **Section 10**
Listed Threatened Ecological Communities	3	Banksia Woodlands of the Swan Coastal Plain ecological community Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of Western Australia Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain ecological community	Terrestrial communities and not considered further
Listed Threatened Species	65	Refer SWMR PMST report (**Appendix A**)	N/A
Listed Migratory Species	67	Refer SWMR PMST report (**Appendix A**)	N/A

Table 3-3 Summary of MNES identified by the EPBC Act Protected Matters Search Tool (PMST) as potentially occurring within the NMR

MNES	Number	Description	Section of this Document
World Heritage Properties	0	N/A	N/A
National Heritage Places	0	N/A	N/A
Wetlands of International Importance (Ramsar)	0	N/A	N/A
Commonwealth Marine Area	2	EEZ and Territorial Sea KEFs AMPs Australian Whale Sanctuary Extended Continental Shelf	**Section 9** **Section 10**
Listed Threatened Ecological Communities	0	N/A	N/A
Listed Threatened Species	33	Refer NMR PMST report (**Appendix A**)	N/A
Listed Migratory Species	70	Refer NMR PMST report (**Appendix A**)	N/A

3.2 Part 13 Statutory Instruments for EPBC Act Listed Threatened and Migratory Species in the NWMR, SWMR and NMR

A screening process was conducted to identify which EPBC Act listed threatened and migratory species, and associated Part 13 statutory instruments, are relevant in the context of the assessment of impacts and risks associated with petroleum activities in each of the Woodside activity areas, using the following criteria:

- overlap between the Woodside activity areas with habitat critical for the survival of marine turtles, and with BIAs (overlapping the marine environment) for any listed threatened species as reported in the PMST searches;
- published literature, unpublished reports and/or credible anecdotal information (e.g. feedback from stakeholders) indicating species presence/occurrence within the Woodside activity areas;
- temporal overlap between the likely timing of petroleum activities and peak periods for key behaviours (e.g. breeding, nesting, calving, resting, foraging, migration); and
- environmental aspects associated with petroleum activities have been identified as a key threat to a species in a Part 13 statutory instrument (e.g. anthropogenic noise, light emissions, marine debris).

Relevant EPBC Act threatened and migratory species and their Part 13 statutory instruments are listed in **Table 3-4**. For the full list of EPBCA Act listed species for each marine bioregion refer to the PMST reports (**Appendix A**).

Table 3-4 Summary of MNES identified by the EPBC Act Protected Matters Search Tool (PMST) to be considered for impact or risk evaluation for Woodside operations

Species	EPBC Act Part 13 Statutory Instrument
All vertebrate marine fauna	Threat Abatement Plan for the impacts of marine debris on vertebrate marine life (Commonwealth of Australia, 2018)
Marine Mammals	
Blue whale	Conservation Management Plan for the Blue Whale: A Recovery Plan under the *Environment Protection and Biodiversity Conservation Act 1999* 2015–2025 (Commonwealth of Australia, 2015a)
Southern right whale	Conservation Management Plan for the Southern Right Whale: A Recovery Plan under the *Environment Protection and Biodiversity Conservation Act 1999* 2011–2021 (DSEWPAC, 2012d)
Sei whale	Conservation Advice *Balaenoptera borealis* sei whale (Threatened Species Scientific Committee, 2015a)
Humpback whale	Conservation Advice *Megaptera novaeangliae* humpback whale (Threatened Species Scientific Committee, 2015b)
Fin whale	Conservation Advice *Balaenoptera physalus* fin whale (Threatened Species Scientific Committee, 2015c)
Australian sea lion	Recovery Plan for the Australian Sea Lion (*Neophoca cinerea*) 2013 (DSEWPAC, 2013a) (due to expire in October 2023) Conservation Advice *Neophoca cinerea* Australian Sea Lion (Threatened Species Scientific Committee, 2020a) (in effect under the EPBC Act from 23-Dec-2020)
Marine Reptiles	
All marine turtle species (loggerhead, green, leatherback, hawksbill, flatback, olive ridley)	Recovery Plan for Marine Turtles in Australia 2017-2027 (Commonwealth of Australia, 2017)
Short-nosed sea snake	Approved Conservation Advice for *Aipysurus apraefrontalis* (Short-nosed Sea Snake) (DSEWPAC, 2011a)
Leaf-scaled sea snake	Approved Conservation Advice for *Aipysurus foliosquama* (Leaf-scaled Sea Snake) (DSEWPAC, 2011b)
Fishes, Sharks, Rays and Sawfishes	
Grey nurse shark (west coast population)	Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) 2014 (DOE, 2014)
White shark	Recovery Plan for the White Shark (*Carcharodon carcharias*) 2013 (DSEWPAC, 2013b)
Whale shark	Conservation Advice *Rhincodon typus* whale shark (Threatened Species Scientific Committee, 2015d)
All sawfishes (largetooth, green, dwarf, speartooth, narrow)	Sawfish and River Sharks Multispecies Recovery Plan (Commonwealth of Australia, 2015b)

Species	EPBC Act Part 13 Statutory Instrument
Seabirds	
Migratory seabird species	Draft Wildlife Conservation Plan for Migratory Seabirds (Commonwealth of Australia, 2019)
Southern giant petrel	National recovery plan for threatened albatrosses and giant petrels 2011–2016 (DSEWPAC, 2011c)
Indian yellow-nosed albatross	National recovery plan for threatened albatrosses and giant petrels 2011–2016 (DSEWPAC, 2011c)
Abbott's booby	Conservation Advice for the Abbott's booby - *Papasula abbotti* (Threatened Species Scientific Committee, 2020b)
Australian fairy tern	Approved Conservation Advice for *Sterna nereis nereis* (Fairy Tern) (DSEWPAC, 2011d)
Australian lesser noddy	Conservation Advice *Anous tenuirostris melanops* Australian lesser noddy (Threatened Species Scientific Committee, 2015e)
Soft-plumaged petrel	Conservation Advice *Pterodroma mollis* soft-plumaged petrel (Threatened Species Scientific Committee, 2015f)
Shorebirds	
Migratory shorebird species	Wildlife Conservation Plan for Migratory Shorebirds (Commonwealth of Australia, 2015c)
Eastern curlew, far eastern curlew	Conservation Advice *Numenius madagascariensis* eastern curlew (DOE, 2015a)
Curlew sandpiper	Conservation Advice *Calidris ferruginea* curlew sandpiper (DOE, 2015b)
Great knot	Conservation Advice *Calidris tenuirostris* Great knot (Threatened Species Scientific Committee, 2016a)
Red knot, knot	Conservation Advice *Calidris canutus* Red knot (Threatened Species Scientific Committee, 2016b)
Bar-tailed godwit (*menzbieri*)	Conservation Advice *Limosa lapponica menzbieri* Bar-tailed godwit (northern Siberia) (Threatened Species Scientific Committee, 2016c)
Greater sand plover	Conservation Advice *Charadrius leschenaultii* Greater sand plover (Threatened Species Scientific Committee, 2016d)
Lesser sand plover	Conservation Advice *Charadrius mongolus* Lesser sand plover (Threatened Species Scientific Committee, 2016e)

4. HABITAT AND BIOLOGICAL COMMUNITIES

4.1 Regional context

The NWMR habitats range from nearshore benthic primary producer habitats such as seagrass beds, coral communities and mangrove forests, to offshore soft sediment seabed habitats and submerged and emergent reef systems. These habitats support biological communities that range from low density sessile and mobile benthos, such as sponges, molluscs and echinoids (with noted areas of sponge hotspot diversity) in offshore soft sediment habitat (DSEWPAC, 2012a) to complex, diverse, remote coral reef systems.

Benthic primary producer habitats, such as seagrass beds, coral communities and mangrove forests within the SWMR, are described as a mixture of tropical and temperate species, due to the seasonal influences of the tropical waters carried south by the Leeuwin Current and the temperate waters carried north by the Capes Current (DSEWPAC, 2012b).

The NMR shares similar habitat types to the NWMR. The predominant habitat of the region includes soft muddy sediments on relatively flat terrain. Other habitat types include seagrasses, reefs, shoals and coastal habitats such as mangroves and coastal wetlands (Rochester *et al.*, 2007).

The summary of key habitats and biological communities provided in the following sub-sections is focused on the primary features of relevance to the activity areas within the NWMR – primarily the offshore habitats of the continental shelf and slope, submerged shoals and banks, and remote oceanic reef systems of recognised conservation value.

4.2 Biological Productivity of NWMR

Primary productivity of the NWMR 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. Seasonal weather patterns also influence the delivery of nutrients from deep-water to shallow water. Cyclones and north-westerly winds during the North-west monsoon (approximately November–March) and the strong offshore winds of the South-east monsoon (approximately April–September) facilitate the upwelling and mixing of nutrients from deep-water to shallow water environments (Brewer *et al.*, 2007).

The Indonesian Throughflow (ITF) has an important effect on productivity in the northern areas of the Region. Generally, its deep, warm and low nutrient waters suppress upwelling of deeper comparatively nutrient-rich waters, thereby forcing the highest rates of primary productivity to occur at depths associated with the thermocline. When the ITF is weaker, the thermocline lifts bringing deeper, more nutrient-rich waters into the photic zone and hence resulting in conditions favourable to increased productivity (DEWHA, 2007a). Similarly, the Leeuwin Current has a significant role in determining primary productivity in the southern areas of the NWMR. As with the ITF, the overlying warm oligotrophic waters of the Leeuwin Current suppress upwelling. A subsurface chlorophyll maximum is therefore formed at a depth in the water column where nutrients and light are sufficient for photosynthesis to proceed. Seasonal changes in the strength of the Leeuwin Current influence primary productivity levels and seasonal interactions between the Leeuwin and Ningaloo currents in the south of the NWMR are believed to be particularly important (DEWHA, 2007a).

Internal tides (defined as internal waves generated by the barotropic tide) are a striking characteristic of many parts of the NWMR and are associated with highly stratified water columns. Internal waves (solitons), which can raise cooler, generally more nutrient rich water higher in the water column, are generated between water depths of 400 m and 1000 m where bottom topography results in a significant change in water depth over a relatively short distance. Cyclones are episodic events in the NWMR that contribute to spikes in productivity through enrichment of surface water layers due to enhanced vertical mixing of the water column. Temporary increases in primary productivity as a result of cyclones generally last between one and two weeks, and it is believed that the impacts of cyclones are generally limited to waters less than 100 m deep and affect benthic communities more substantially than pelagic systems (DEWHA, 2007a).

Water depth also has a significant overriding influence over productivity in the marine environment, due to its influence on light availability. This is reflected by distinct onshore and offshore assemblages of major pelagic groups of phytoplankton, microzooplankton, mesoplankton and ichthyoplankton. Productivity booms are thought to be triggered by seasonal changes to physical drivers or episodic events, as detailed above, which result in rapid increases in primary production over short periods, followed by extended periods of lower primary production. The trophic systems in the NWMR are able to take advantage of blooms in primary production, enabling nutrients generated to be used by different groups of consumers over long periods (DEWHA, 2007a).

Little detailed information is available about the trophic systems in the NWMR. The utilisation of available nutrients is thought to differ between pelagic and benthic environments, influenced by water depth and vertical migration of some species groups in the water column. In the pelagic system, it is thought that approximately half of the nutrients available are utilised by microzooplankton (e.g. protozoa) with the remainder going to macro/meso-zooplankton (e.g. copepods). As primary and secondary consumers, gelatinous zooplankton (e.g. salps, coelenterates) and jellyfish are thought to play an important role in the food web, contributing a significant proportion of biomass in the marine system during and for periods after booms in primary productivity. Salps are semi-transparent, barrel-shaped marine animals that can reproduce quickly in response to bursts in primary productivity and provide a food source for many pelagic fish species (DEWHA, 2007a).

4.3 Planktonic Communities in the NWMR

The NWMR has two distinct phytoplankton assemblages; a tropical oceanic community in offshore waters and a tropical shelf community confined to the NWS (Hallegraeff, 1995). MODIS (Moderate Resolution Imaging Spectrometer) satellite datasets from the NWMR indicates that chlorophyll (and thus phytoplankton) levels are low in summer months (December to March) and higher in the winter months (Schroeder *et al.*, 2009). Low chlorophyll levels during summer months may be a result of lower plankton productivity during the wet season or lower nutrient inputs from warm surface waters dominant during summer. However, it is likely that much of the primary production is taking place below the surface, where the MODIS imagery does not penetrate (Schroeder *et al.*, 2009). The winter months are relatively cloud free and surface chlorophyll is high throughout most of the region.

Zooplankton and may include organisms that complete their lifecycle as plankton (e.g. copepods, euphausiids) as well as larval stages of other taxa such as fishes, corals and molluscs. Peaks in zooplankton such as mass coral spawning events (typically in March and April) (Rosser and Gilmour, 2008) and fish larvae abundance (CALM, 2005a) can occur throughout the year. Spatial and temporal patterns in the distribution and abundance of macro-zooplankton on the North-west Shelf are influenced by sporadic climatic and oceanographic events, with large inter-annual changes in assemblages (Wilson *et al.*, 2003). Amphipods, euphausiids, copepods, mysids and cumaceans are among the most common components of the zooplankton in the region (Wilson *et al.*, 2003).

4.3.1 Browse

Phytoplankton within the Browse activity area is expected to reflect the conditions of the NWMR. There is a tendency for offshore phytoplankton communities in the NWMR to be characterised by smaller taxa (e.g. bacteria), whereas shelf waters are dominated by larger taxa such as diatoms (Hanson *et al.*, 2007).

Zooplankton within the activity area may include organisms that complete their lifecycle as plankton (e.g. copepods, euphausiids) as well as larval stages of other taxa such as fishes, corals and molluscs. Peaks in zooplankton such as mass coral spawning events (typically in March and April) (Rosser and Gilmour, 2008; Simpson *et al.*, 1993) and fish larvae abundance (CALM, 2005a) can occur throughout the year.

The influence of the Indonesian Throughflow restricts upwelling across the Kimberley System (approximately equates to the Browse activity area). However, small-scale topographically associated current movements and upwellings are thought to occur, which inject nutrients into specific locations within the system and result in ‘productivity hot-spots’. Similarly, internal waves, generated at the shelf break (e.g. west of Browse Island and around submerged cliffs) play a role in making nutrients available in the photic zone. Productivity within shallow nearshore waters is driven primarily by tidal movement and terrestrial runoff whereby nutrients are mixed by tidal action and new inputs of organic matter come from the land.

4.3.2 North-west Shelf / Scarborough

Plankton communities within the NWS / Scarborough activity area are expected to reflect conditions of the NWMR. Within the Pilbara system of the NWMR (approximately equates to the NWS / Scarborough activity area). Internal tides along the NWS and Exmouth Plateau result in the drawing of deeper cooler waters into the photic zone, stirring up nutrients and triggering primary productivity. Broadly the greatest productivity within this sub-system is found around the 200 m isobath associated with the shelf break.

4.3.3 North-west Cape

Waters of the North-west Cape experience a relatively high diversity of phytoplankton groups including diatoms, coccolithophorids and dinoflagellates. During the warmer months blooms of *Trichodesmium* occur in the region, these have been observed particularly on the frontal systems around Point Murat (Heyward *et al*., 2000).

Average Leeuwin Current phytoplankton biomass is characteristic of low productivity oceanic waters like the Indian, Pacific and Atlantic Oceans (Hanson *et al.*, 2005). However, the Canyons linking the Cuvier Abyssal Plain and Cape Range Peninsula KEF 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 (Brewer *et al.* 2007). These waters are cooler and richer in nutrients and strong internal tides may also aid upwelling at the canyon heads (Brewer *et al.* 2007). The narrow shelf width (about 10 kilometres) near the canyons facilitates nutrient upwelling and relatively high productivity. This high primary productivity leads to high densities of primary consumers, such as micro and macro-zooplankton, such as amphipods, copepods, mysids, cumaceans, euphausiids (Brewer *et al.*, 2007).

4.4 Habitats and Biological Communities in the NWMR

4.4.1 Offshore Habitats and Biological communities

The NWMR has a large area of continental shelf and continental slope, with a range of bathymetric features such as canyons, plateaus, terraces, ridges, reefs, banks and shoals. The marine environment in this region is typified by tropical to sub-tropical marine ecosystems with diverse habitats from soft sediments, canyons, remote coral reefs and limestone pavement.

The key habitats and biological communities representative of the broader NWMR are summarised in **Table 4-1**.

The key habitats and biological communities representative of the broader SWMR and NMR are summarised in **Table 4-2** and **Table 4-3**.

4.4.2 Shoreline habitats and biological communities

The NWMR encompasses offshore and coastal waters, islands and mainland shoreline habitats typified by mangroves, tidal flats, saltmarshes, sandy beaches, and smaller areas of rocky shores. Each of these shoreline types has the potential to support different flora and fauna assemblages due to the different physical factors (e.g. waves, tides, light, etc.) influencing the habitat.

The key shoreline habitats representative of the broader NWMR are summarised in **Table 4-1**.

The key shoreline habitats representative of the broader SWMR and NMR are summarised in **Table 4-2** and **Table 4-3**.

Table 4-1 Habitats and biological communities within the NWMR

Habitat/Community	Browse	NWS / Scarborough	North-west Cape	Reference
	Offshore habitats and biological communities			
Soft sediment with infauna	The offshore environment of the NWMR comprises predominately of seabed habitats dominated by soft sediments (sandy and muddy substrata with occasional patches of coarser sediments) and sparse benthic biota. The benthic communities inhabiting the predominantly soft, fine sediments of the offshore habitats are characterised by infauna such as polychaetes, and sessile and mobile epifauna such as crustacea (shrimp, crabs and squat lobsters) and echinoderms (starfish, cucumbers).The density of benthic fauna is typically lower in deep-sea sediment habitats (greater than 200 m) than in shallower coastal sediment habitats, but the diversity of communities may be similar.			
Soft sediment with hard substrate outcropping	A unique seafloor feature combining both soft sediment and hard substrates, including outcrops, terraces, continental slope, and escarpments. This habitat is found in offshore areas of the NWMR, often associated with key ecological features such as the Ancient coastline at 125 m depth contour KEF.			**Section 9**
	Ancient Coastline at 125 m Depth Contour KEF Continental Slope Demersal Fish Communities KEF	Ancient Coastline at 125 m Depth Contour KEF Continental Slope Demersal Fish Communities KEF	Ancient Coastline at 125 m Depth Contour KEF Continental Slope Demersal Fish Communities KEF	**Section 9**
Coral Reef	Coral reef habitats within the NWMR have a high species diversity that includes corals, and associated reef species such as fishes, crustaceans, invertebrates, and algae. Coral reef habitats of the offshore environment of the NWMR include remote oceanic reef systems, large platform reefs, submerged banks and shoals.			
	Browse Island Scott Reef Seringapatam Reef Ashmore Reef Cartier Island Hibernia Reef	Rowley Shoals (including Mermaid Reef, Clerke Reef, Imperieuse Reef) Glomar Shoal Rankin Bank	-	**Section 10**
Seagrass and Macroalgae communities	Seagrass beds and benthic macroalgae reefs are a main food source for many marine species and also provide key habitats and nursery grounds (Heck Jr. *et al.*, 2003; Wilson *et al.*, 2010). In the northern half of Western Australia, these habitats are restricted to sheltered and shallow waters, including around offshore reef systems, due to large tidal movement, high turbidity, large seasonal freshwater run-off and cyclones.			
	Scott Reef Seringapatam Reef Ashmore Reef	Rowley Shoals (including; Mermaid Reef, Clerke Reef, Imperieuse Reef)		**Section 10**
Filter Feeders/ heterotrophic	Filter feeder epifauna such as sponges, ascidians, soft corals and gorgonians are animals that feed by actively filtering suspended matter and food particles from water, by passing the water over specialised filtration structures (DEWHA, 2008). Filter feeders generally live in areas that have strong currents and hard substratum, often associated with deeper environments of the shoals and banks in the offshore NWMR.			
	Lower outer reef slopes of the oceanic reef	Glomar Shoal Rankin Bank	Cape Range canyon system	**Section 10**

Habitat/Community	Browse	NWS / Scarborough	North-west Cape	Reference
	systems such as Scott Reef	Ancient coastline at 125 m depth contour KEF		
Sandy Beaches	Sandy beaches are dynamic environments, naturally fluctuating in response to external forcing factors (e.g. waves, currents, etc). Sandy beaches vary in length, width and gradient, and in sediment type, composition, and grain size throughout the NWMR, being found around islands and reefs in the offshore areas of the region.			
	Browse Island Scott Reef (Sandy Islet) Ashmore Reef Cartier Island	Montebello Islands Lowendal Islands Barrow Island	Muiron Islands	**Section 10**
Nearshore/coastal habitats and biological communities				
Coral Reef	Coral reef habitats typically found in nearshore regions of the NWMR include the fringing reefs around coastal islands and the mainland shore.			
	Kimberley East Holothuria and Long reefs Bonaparte and Buccaneer Archipelagos Montgomery Reef Adele complex (Beagle, Mavis, Albert, Churchill reefs, Adele Island)	Dampier Archipelago Montebello, Lowendal and Barrow Island Groups	Ningaloo Reef Exmouth Gulf Shark Bay	**Section 10**
Seagrass and Macroalgae communities	Seagrass beds and benthic macroalgae reefs are a main food source for many marine species and also provide key habitats and nursery grounds (Heck Jr. *et al.*, 2003; Wilson *et al.*, 2010). In the nearshore areas of the NWMR, these habitats are restricted to sheltered and shallow waters due to large tidal movement, high turbidity, large seasonal freshwater run-off and cyclones. These areas include in bays and sounds and around reef and island groups.			
	King Sound	Roebuck Bay Dampier Archipelago Montebello, Lowendal and Barrow Island Groups	Ningaloo Reef Exmouth Gulf Shark Bay	**Section 10**
Filter Feeders/ heterotrophic	Filter feeder epifauna such as sponges, ascidians, soft corals and gorgonians are animals that feed by actively filtering suspended matter and food particles from water, by passing the water over specialised filtration structures (DEWHA, 2007a). Filter feeders generally live in areas that have strong currents and hard substratum. Conversely, higher diversity infauna are mainly associated with soft unconsolidated sediment and infauna communities are considered widespread and well represented along the continental shelf and upper slopes of the NWMR. In nearshore areas of the NWMR, these species are generally found around reef systems.			
	-	Deeper habitats of Rankin Bank and Glomar Shoal	Deeper habitats of Ningaloo Reef and the protected sponge zone in the south	

Habitat/Community	Browse	NWS / Scarborough	North-west Cape	Reference
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). Mangroves are confined to shoreline habitats, in nearshore areas of the NWMR.			
	Dampier Peninsula (including Carnot Bay, Beagle Bay and Pender Bay)	Pilbara Coastline (including; Ashburton River Delta, Coolgra Point, Robe River Delta, Yardie Landing, Yammadery Island and the Mangrove Islands) Montebello, Lowendal and Barrow Island Groups Roebuck Bay	Shark Bay Mangrove Bay, Cape Range Peninsula Exmouth Gulf	
Saltmarshes	Saltmarshes communities are confined to shoreline habitats and 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.			
	-	Eighty Mile Beach Roebuck Bay	Shark Bay	
Sandy Beaches	Sandy beaches are dynamic environments, naturally fluctuating in response to external forcing factors (e.g. waves, currents, etc). Sandy beaches vary in length, width and gradient, and in sediment type, composition, and grain size throughout the NWMR. Sandy beaches are important for both resident and migratory seabirds and shorebirds and can also provide an important habitat for turtle nesting and breeding. They are located along many coastlines of the nearshore environments of the NWMR.			
	Cape Domett Lacrosse Island	Eighty Mile Beach Eco Beach Dampier Archipelago Inshore Pilbara Islands (Northern, Middle, and Southern)	Ningaloo coast Muiron Islands Exmouth Gulf	

Table 4-2 Habitats within the SWMR

Habitat/Community	Location
Offshore	
Soft sediment with infauna	Most of the SWMR seafloor is composed of soft unconsolidated sediments, but due to large variations in bathymetry there are marked differences in sedimentary composition and benthic assemblage structure across the region. Despite the prevalence of these habitats in the SWMR, very little is known about the composition or distribution of the region's sedimentary infauna (DEWHA, 2008b)
Soft sediment with hard substrate outcropping	A unique seafloor feature combining both soft sediment and hard substrates, including outcrops, terraces, continental slope, and escarpments.
	Perth Canyon Marine Park Ancient coastline at 90-120 m depth contour KEF Diamantina Fracture Zone Naturaliste Plateau
Coral Reef	To date, studies and understanding of the corals within the SWMR have concentrated on the shallow water areas in State Waters. Within the deeper Commonwealth waters of the SWMR little is known of the distribution of corals.
Filter Feeders/ heterotrophic	Filter feeder epifauna such as sponges, ascidians, soft corals and gorgonians are animals that feed by actively filtering suspended matter and food particles from water, by passing the water over specialised filtration structures (DEWR, 2007). Filter feeders generally inhabit deeper habitat (below the photic zone) that have strong currents and hard substratum
	Ancient coastline at 90-120 m depth Diamantina Fracture Zone Naturaliste Plateau Perth Canyon Marine Park South-west Corner Marine Park
Nearshore	
Coral Reef	The northern extent of the SWMR coincides loosely with the disappearance of abundant and diverse coral from coastal habitats. To the south of Shark Bay, abundant corals occur predominantly around offshore islands, with corals at inshore sites occurring in very isolated patches of non-reef coral communities, usually of reduced species richness.
	Houtman Abrolhos Islands Rottnest Island
Seagrass and Macroalgae communities	Within the SWMR, macroalgae and seagrass communities are noted for their extent, species richness and endemism. The clear waters of the region allow light to reach greater depths, with some species found at much greater depths than usual (down to 120 m) (DEWR, 2007). Of the known species there are more than 1000 species of macro-algae and 22 species of seagrass consisting of tropical and temperate species. Seagrass and macro-algae occur in areas with sheltered bays and in the inter-reef lagoons along exposed sections of the coast.
	Houtman Abrolhos Islands Jurien Marine Park Shoalwater Islands Marine Park Geographe Marine Park Cockburn Sound Rottnest Island

Habitat/Community	Location
	Commonwealth marine environment within and adjacent to the west-coast inshore lagoons KEF Commonwealth marine environment within and adjacent to Geographe Bay KEF Commonwealth marine environment surrounding the Recherche Archipelago KEF
Filter Feeders/ heterotrophic	Filter feeder epifauna such as sponges, ascidians, soft corals and gorgonians are animals that feed by actively filtering suspended matter and food particles from water, by passing the water over specialised filtration structures (DEWR, 2007). Filter feeders generally live in areas that have strong currents and hard substratum.
	Houtman Abrolhos Islands Recherche Archipelago
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). Mangroves are confined to shoreline habitats, in nearshore areas of the SWMR.
	Houtman Abrolhos Islands
Sandy Beaches	Sandy beaches within the SWMR are important for both resident and migratory seabirds and shorebirds and can also host breeding populations of the Australian sea lion. They are found along many coastlines of the nearshore environments of the SWMR. In addition to this, beaches in the SWMR provide a variety of socio-economic values including tourism, commercial and recreational fishing, and support other recreational activities.
	Houtman Abrolhos Islands Marmion Marine Park Ngari Capes Marine Park Walpole and Nornalup Inlets Marine Park

Table 4-3 Habitats and Biological Communities within the NMR

Habitat/Community	Location
	Offshore habitats and biological communities
Soft sediment with infauna	Most of the offshore environment of the NMR is characterised by relatively flat expanses of soft sediment seabed. The soft sediments of the region are characterised by moderately abundant and diverse communities of infauna and mobile epifauna dominated by polychaetes, crustaceans, molluscs, and echinoderms.
Soft sediment with hard substrate outcropping	A unique seafloor feature combining both soft sediment and hard substrates, including outcrops, terraces, continental slope, and escarpments. The variability in substrate composition may contribute to the presence of unique ecosystems. Species present include sponges, soft corals and other sessile filter feeders associated with hard substrate sediments.
	Carbonate bank and terrace system of the Van Diemen Rise KEF Pinnacles of the Bonaparte Basin KEF
Coral Reef	Offshore coral reefs within the NMR is generally associated with a series of submerged shoals and banks. The shoals/banks in the region support tropical marine biota consistent with that found on emergent reef systems of the Indo West Pacific region such as Ashmore Reef, Cartier Island, Seringapatam Reef and Scott Reef (Heyward *et al.,* 1997)
	Pinnacles of the Bonaparte Basin KEF Evans Shoal Tassie Shoal Blackwood Shoal
Filter Feeders/ heterotrophic	Filter feeder epifauna such as sponges, ascidians, soft corals and gorgonians are animals that feed by actively filtering suspended matter and food particles from water, by passing the water over specialised filtration structures (DEWHA, 2007b). Filter feeders generally live in areas that have strong currents and hard substratum and typically associated with the deeper habitats of the submerged shoals and banks, and canyon features.
	Carbonate bank and terrace system of the Van Diemen Rise KEF Pinnacles of the Bonaparte Basin KEF Tributary Canyons of the Arafura Depression KEF Evans Shoal Tassie Shoal Goodrich Bank
	Nearshore
Coral Reef	Within the NMR corals occur both as reefs and in non-reef coral communities. Nearshore reefs include patch reefs and fringing reefs sparsely distributed within the region. Coral reefs within the NMR provides breeding and aggregation areas for many fish species including mackerel and snapper and offer refuges for sea snakes and apex predators such as sharks.
	Submerged coral reefs of the Gulf of Carpentaria KEF Darwin Harbour
Seagrass and Macroalgae communities	Seagrasses provide key habitats in the NMR. They stabilise coastal sediments and trap and recycle nutrients. They provide nursery grounds for commercially harvested fish and prawns and provide feeding grounds for dugongs and green turtles. Seagrass distribution in the region is largely associated with sheltered small bays and inlets including shallow waters surrounding inshore islands.
	Field Island The mainland coastline adjacent to Kakadu National Park

Habitat/Community	Location
Filter Feeders/ heterotrophic	Filter feeder epifauna such as sponges, ascidians, soft corals, and gorgonians are animals that feed by actively filtering suspended matter and food particles from water, by passing the water over specialised filtration structures (DEWHA, 2007b). Filter feeders generally live in areas that have strong currents and hard substratum.
	Cape Helveticus
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). Mangroves provide habitat for waterbirds and support many commercially and recreationally important fish and crustacean species for parts of their life cycles. They buffer the coast from large tidal movements, storm surges and flooding.
	Tiwi Islands Darwin Harbour The mainland coastline adjacent to the Daly River
Sandy Beaches	Sandy beaches vary in length, width and gradient, and in sediment type, composition, and grain size throughout the NMR and are important for both resident and migratory seabirds and shorebirds. Sandy beaches can also provide an important habitat for turtle nesting. They are located along many coastlines of the nearshore environments of the islands and mainland shores of the NMR.
	Tiwi Islands Cobourg Peninsula Joseph Bonaparte Gulf

5. FISHES, SHARKS AND RAYS

5.1 Regional Context

Western Australian waters provide important habitat for listed fishes, sharks, and rays including areas that support key life stages such as breeding, foraging, and migration routes for fish species. Pelagic and demersal fishes occupy a range of habitats throughout each of the regions, from coral reefs to open offshore waters, and are an extremely important component of ecosystems, providing a link between primary production and higher predators, with many species being of conservation value and important for commercial and recreational fishing.

The fish fauna in the NWMR is diverse. Of the approximately 500 shark species found worldwide, 94 are found in the region (DEWHA, 2008). Approximately 54 species of syngnathids (seahorses, seadragons, pipehorses and pipefishes) and one species of solenostomids (ghostpipefishes) are also known to occur in the NWMR or adjacent State waters (DSEWPAC, 2012a).

The fish fauna of the SWMR includes more than 900 species occupying a large variety of habitats. However, only three species of bony fishes known to occur in the region are listed under the EPBC Act as threatened or marine species, and seven listed species of shark (DSEWPAC, 2012b).

The NMR is considered an important area for the sawfish and river shark species group, with five species of sawfishes and river sharks listed under the EPBC Act known to occur in the region (DSEWPAC, 2012c). Approximately 28 species of syngnathids and two species of solenostomids are listed marine and known to occur in the NMR, however there is a paucity of knowledge on the distribution, relative abundance and habitats of these species in the region (DEWHA, 2008).

The following sections focus on the fish species (including sharks and rays) listed as threatened or migratory that are known to occur within the NWMR. In addition, listed, conservation dependent fish and shark species for the NWMR are described. A detailed account of commercial and recreational fisheries that operate in the region is provided in **Section 11**.

Table 5-1 outlines the threatened and migratory fish species that may occur within the NWMR, with their conservation status and relevant recovery plans and/or conservation advice. **Table 5-2** provides information for species of fish that are listed as conservation dependent that may occur within the NWMR, NMR and SWMR. Note that currently there are no approved Conservation Advices in place for any of these five species.

Table 5-1 Fish species (including sharks and rays) identified by the EPBC Act PMST for the NWMR

Species Name	Common Name	*Environment Protection and Biodiversity Conservation Act 1999*			WA *Biodiversity Conservation Act 2016*	EPBC Act Part 13 Statutory Instrument
		Threatened Status	Migratory Status	Listed	Conservation Status	
Rhincodon typus	Whale shark	Vulnerable	Migratory	Marine	Other specially protected fauna	Conservation Advice *Rhincodon typus* whale shark. (Threatened Species Scientific Committee, 2015d)
Carcharias taurus	Grey nurse shark (west coast population)	Vulnerable	N/A	Marine	Vulnerable	Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) (DOE, 2014a)
Carcharodon carcharias	White shark	Vulnerable	Migratory	Marine	Vulnerable	Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPAC, 2013b)
Isurus oxyrinchus	Shortfin mako	N/A	Migratory	Marine	N/A	N/A
Isurus paucus	Longfin mako	N/A	Migratory	Marine	N/A	N/A
Lamna nasus	Porbeagle shark Mackerel shark	N/A	Migratory	Marine	N/A	N/A
Carcharhinus longimanus	Oceanic whitetip shark	N/A	Migratory	Marine	N/A	N/A
Anoxypristis cuspidata	Narrow sawfish	N/A	Migratory	Marine	N/A	N/A
Pristis clavata	Dwarf sawfish	Vulnerable	Migratory	Marine	Priority	Sawfish and River Sharks Multispecies Recovery Plan (Commonwealth of Australia, 2015b)
Pristis pristis	Largetooth (Freshwater) sawfish	Vulnerable	Migratory	Marine	Priority	
Pristis zijsron	Green sawfish	Vulnerable	Migratory	Marine	Vulnerable	
Glyphis garricki	Northern river shark	Endangered	N/A	Marine	Priority	
Manta alfredi	Reef manta ray	N/A	Migratory	Marine	N/A	N/A
Manta birostris	Giant manta ray	N/A	Migratory	Marine	N/A	N/A

Table 5-2 EPBC Act listed Conservation Dependent species of fishes and sharks that may occur in the NWMR, NMR and SWMR

Species Name	Common Name	Likely Occurrence / Distribution	Listing Advice
Hoplostethus atlanticus	Orange roughy, Deep-sea perch, Red roughy	SWMR	No conservation listing advice for this species. Refer to the Marine bioregional plan for the SWMR (DSEWPAC, 2012b) for further information
Thunnus maccoyii	Southern bluefin tuna	NWMR and SWMR	Threatened Species Scientific Committee (2010)
Sphyrna lewini	Scalloped hammerhead	NWMR, NMR and SWMR	Threatened Species Scientific Committee (2018)
Centrophorus zeehaani	Southern dogfish, Endeavour dogfish, Little gulper shark	SWMR	Threatened Species Scientific Committee (2013)
Galeorhinus galeus	School shark, Eastern school shark, Snapper shark, Tope, Soupfin shark	SWMR	Threatened Species Scientific Committee (2009)

5.2 Protected Sharks, Sawfishes and Rays in the NWMR

The EPBC Act Protected Matters search (**Appendix A**) identified seven species of shark and five species of river shark or sawfish listed as threatened and/or migratory within the NWMR. In addition, two species of ray (the reef manta ray and giant manta ray) are listed as migratory within the region (refer **Table 5-2**).

5.2.1 Sharks and Sawfishes

The shark species known to occur within the NWMR include: the whale shark, grey nurse shark, white shark, shortfin mako, and longfin mako (**Table 5-2**).

Five species of river shark or sawfish known to occur in the NWMR and include: the narrow sawfish, northern river shark, freshwater sawfish, green sawfish and dwarf sawfish (**Table 5-2**).

There are identified BIAs within the NWMR for the whale shark, freshwater sawfish, green sawfish, and dwarf sawfish (refer **Section 5.3.2**).

Table 5-2 Information on the threatened shark and sawfish species within the NWMR

Species	Preferred Habitat and Diet	Habitat Location
Whale shark	Preferred habitat: They have a widespread distribution in tropical and warm temperate seas, both oceanic and coastal (Last and Stevens, 2009). The species is widely distributed in Australian waters. Diet: Whale sharks are planktivorous sharks and feed on a variety of planktonic organisms including krill, jellyfish, and crab larvae (Last and Stevens, 2009).	Ningaloo Reef is the main known aggregation site for whale sharks in Australian waters and has the largest density of whale sharks per kilometre in the world (Martin, 2007). Refer **Table 5-3** for the BIA summary for the whale shark.
Grey nurse shark (west coast population)	Preferred habitat: Most commonly found in temperate waters on, or close to, the bottom of the continental shelf, from close inshore to depths of about 200 m (McAuley, 2004). Diet: A variety of teleost and elasmobranch fishes and some cephalopods (Gelsleichter *et al.*, 1999; Smale, 2005).	Details of movement patterns of the western sub-population are unclear (McAuley, 2004) and key aggregation sites have not been formally identified within the NWMR (Chidlow *et al.*, 2006). The NWMR represents the northern limit of the west coast population.

Species	Preferred Habitat and Diet	Habitat Location
White shark	Preferred habitat: The species typically occurs in temperate coastal waters between the shore and the 100 m depth contour; however, adults and juveniles have been recorded diving to depths of 1000 m (Bruce *et al.*, 2006; Bruce, 2008). Diet: Smaller white sharks (less than 3 m in length) feed primarily on teleost and elasmobranch fishes, broadening their diet as larger sharks to include marine mammals (Last and Stevens, 2009).	There are no known aggregation sites for white sharks in the NWMR, and this species is most often found south of North-west Cape, in low densities (DSEWPAC, 2012a). Given the migratory nature of the species, most likely has a broad distribution within the NWMR. No BIAs identified for NWMR.
Shortfin mako	Preferred habitat: The shortfin mako shark is a pelagic species with a circumglobal, wide-ranging oceanic distribution in tropical and temperate seas (Mollet *et al.*, 2000). Tagging studies indicate shortfin makos spend most of their time in water less than 50 m deep but with occasional dives up to 880 m (Abascal *et al.*, 2011; Stevens *et al.*, 2010). Diet: Feeds on a variety of prey, such as teleost fishes, other sharks, marine mammals, and marine turtles (Campana *et al.*, 2005).	Given the migratory nature of the species, most likely has a broad distribution within the NWMR. No BIAs identified for NWMR.
Longfin mako	Preferred habitat: A pelagic species with a wide-ranging oceanic distribution in tropical and temperate seas (Mollet *et al.*, 2000). Diet: Primarily teleost fishes and cephalopods (primarily squid) (Last and Stevens, 2009).	Records on longfin mako sharks are sporadic and their complete geographic range is not well known (Reardon *et al.*, 2006). Given the migratory nature of the species, most likely has a broad distribution within the NWMR. No BIAs identified for NWMR.
Mackerel/Porbeagle shark	Preferred habitat: The porbeagle shark primarily inhabits offshore waters around the edge of the continental shelf. They occasionally move into coastal waters, but these movements are temporary (Campana and Joyce, 2004; Francis *et al.*, 2002). The porbeagle shark is known to dive to depths exceeding 1300 m (Campana *et al.*, 2010; Saunders *et al.*, 2011). Diet: Primarily teleost fish, elasmobranchs, and cephalopods (primarily squid) (Joyce *et al.*, 2002; Last and Stevens, 2009).	In Australia, the species occurs in waters from southern Queensland to south-west Australia (Last and Stevens, 2009). Distribution within the NWMR is unknown, but there are several records for this species on the NWS in the Atlas of Living Australia (ALA).
Oceanic whitetip shark	Preferred habitat: The oceanic whitetip shark is globally distributed in warm-temperate and tropical oceans (Andrzejaczek *et al.*, 2018). The species may occur in tropical and sub-tropical offshore and coastal waters around Australia. They primarily occupy pelagic waters in the upper 200 m of the water column; however, they have been observed diving to depths of around 1000 m, potentially associated with foraging behaviour (Howey-Jordan *et al.*, 2013; D'Alberto *et al.*, 2017). The species is highly migratory, travelling large distances between shallow reef habitats in coastal waters and oceanic waters (Howey-Jordan *et al.*, 2013). The species does exhibit a strong preference for warm and shallow waters above 120 m. Diet: Opportunistic feeders and generally target a variety of finfishes and pelagic squid, depending on habitat. Target pelagics such as tuna in open ocean as noted by the large bycatch numbers in the long line fisheries.	Given the migratory nature of the species, most likely has a broad distribution within the NWMR. No BIAs identified for NWMR.

Species	Preferred Habitat and Diet	Habitat Location
Narrow sawfish	Preferred habitat[1]: Shallow coastal, estuarine, and riverine habitats, however it may occur in waters up to 40 m deep (D'Anastasi *et al.*, 2013). Diet: Shoaling fishes, such as mullet, as well as molluscs and small crustaceans (Cliff and Wilson, 1994).	Shallow coastal waters of the Pilbara and Kimberly coasts (Last and Stevens, 2009).
Northern river shark	Preferred habitat[1]: Rivers, tidal sections of large tropical estuarine systems and macrotidal embayments, as well as inshore and offshore marine habitats (Pillans *et al.*, 2009; Thorburn and Morgan, 2004). Adults have been recorded only in marine environments. Juveniles and sub-adults have been recorded in freshwater, estuarine and marine environments (Pillans *et al.*, 2009). Diet: Variety of fish and crustaceans (Stevens *et al.*, 2005)	Within the NWMR records have come from both the west and east Kimberley, including King Sound, the Ord and King rivers, West Arm of Cambridge Gulf and also from Joseph Bonaparte Gulf (Thorburn and Morgan, 2004; Stevens *et al.*, 2005; Thorburn, 2006; Field *et al.*, 2008; Pillans *et al.*, 2008, Whitty *et al.*, 2008; Wynen *et al.*, 2008).
Largetooth (Freshwater) sawfish	Preferred habitat: Sandy or muddy bottoms of shallow coastal waters, estuaries, river mouths and freshwater rivers, and isolated water holes. Diet: Shoaling fishes, such as mullet, as well as molluscs and small crustaceans (Cliff and Wilson, 1994).	Refer **Table 5-3** for the BIA summary for the freshwater sawfish.
Green sawfish	Preferred habitat[1]: Inshore coastal environments including estuaries, river mouths, embayments, and along sandy and muddy beaches, as well as offshore marine habitat (Stevens *et al.*, 2005; Thorburn *et al.*, 2003). Diet: Schools of baitfish and prawns (Poganoski *et al.*, 2002), molluscs and small crustaceans (Cliff and Wilson, 1994).	Refer **Table 5-3** for the BIA summary for the green sawfish.
Dwarf sawfish	Preferred habitat[1]: Shallow (2 to 3 m) silty coastal waters and estuarine habitats, occupying relatively restricted areas and moving only small distances (Stevens *et al.*, 2008) Diet: Shoaling fish such as mullet, molluscs, and small crustaceans (Cliff and Wilson, 1994).	Refer **Table 5-3** for the BIA summary for the dwarf sawfish.

1 Preferred habitat as described within the Sawfish and River Sharks Multispecies Recovery Plan (Commonwealth of Australia, 2015b).

5.2.2 Rays

Rays are commonly found in the NWMR. Two listed and migratory species of ray known to occur within the NWMR: the reef manta ray and giant manta ray.

No BIAs for either the reef or giant manta ray species have been identified in the NWMR.

Table 5-3 Information on migratory ray species within the NWMR

Species	Preferred Habitat and Diet	Habitat Location
Reef manta ray	Preferred habitat: The reef manta ray is commonly sighted within productive nearshore environments, such as island groups, atolls or continental coastlines. However, the species has also been recorded at offshore coral reefs, rocky reefs, and seamounts (Marshall *et al.*, 2009). Diet: Feed on planktonic organisms including krill and crab larvae.	A resident population of reef manta rays has been recorded at Ningaloo Reef. No BIAs identified for NWMR.
Giant manta ray	Preferred habitat: The species primarily inhabits near-shore environments along productive coastlines with regular upwelling, but they appear	The Ningaloo Coast is an important area for giant manta rays from March to August (Preen *et al.*, 1997).

Species	Preferred Habitat and Diet	Habitat Location
	to be seasonal visitors to coastal or offshore sites including offshore island groups, offshore pinnacles and seamounts (Marshall *et al.*, 2011). Diet: Feed on planktonic organisms including krill and crab larvae.	No BIAs identified for NWMR.

5.3 Fish, Shark and Sawfish Biological Important Areas in the NWMR

A review of the National Conservation Values Atlas identified Biologically Important Areas (BIAs) for four species of shark and sawfish (whale shark, freshwater sawfish, green sawfish and dwarf sawfish) within the NWMR. The BIAs for the whale shark and the sawfish species include foraging, nursing and pupping areas. These are described in **Table 5-4**.

Table 5-4 Fish, whale shark and sawfish BIAs within the NWMR

Species	Woodside Activity Area			BIAs		
	Browse	NWS/S	NWC	Pupping	Nursing	Foraging
Whale shark	✓	✓	✓	No pupping BIA identified within the NWMR	No nursing BIA identified within the NWMR	Foraging (high density) in Ningaloo Marine Park and adjacent Commonwealth waters (March–July) Foraging northward from Ningaloo along the 200 m isobath (July – Nov).
Green sawfish	✓	✓	-	Pupping in Cape Keraudren (pupping occurs in summer in a narrow area adjacent to shoreline) Pupping in Willie Creek Pupping in Roebuck Bay Pupping in Cape Leveque Pupping in waters adjacent to Eighty Mile Beach Pupping (likely) in Camden Sound.	Nursing in Cape Keraudren Nursing in waters adjacent to Eighty Mile Beach	Foraging in Cape Keraudren Foraging in Roebuck Bay Foraging in Cape Leveque Foraging in Camden Sound
Largetooth (freshwater) sawfish	✓	✓	-	Pupping in the mouth of the Fitzroy River (January to May) Roebuck Bay (Jan – May) Pupping likely in waters adjacent to Eighty Mile Beach	Nursing (likely) in King Sound Roebuck Bay (Jan – May)	Foraging in the mouth of the Fitzroy River (January to May) Foraging in King Sound Roebuck Bay (Jan – May) Foraging in waters adjacent to Eighty Mile Beach
Dwarf sawfish	✓	✓	-	Pupping in King Sound Pupping in waters adjacent to Eighty Mile Beach	Nursing in King Sound Nursing waters adjacent to Eighty Mile Beach	Foraging in King Sound Foraging in Camden Sound Foraging in waters adjacent to Eighty Mile Beach

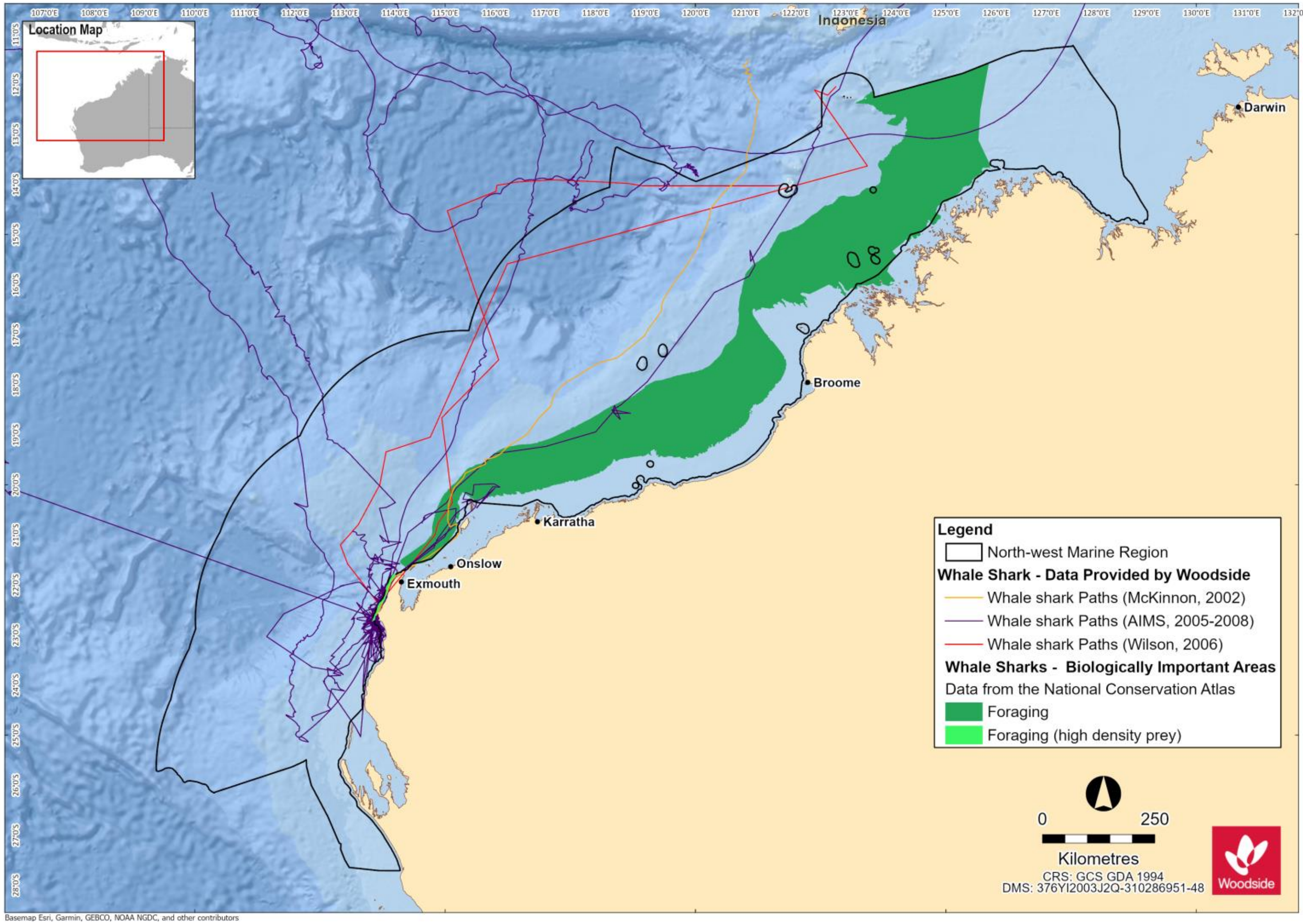

Figure 5-1 Whale shark BIAs for the NWMR and tagged whale shark tracks

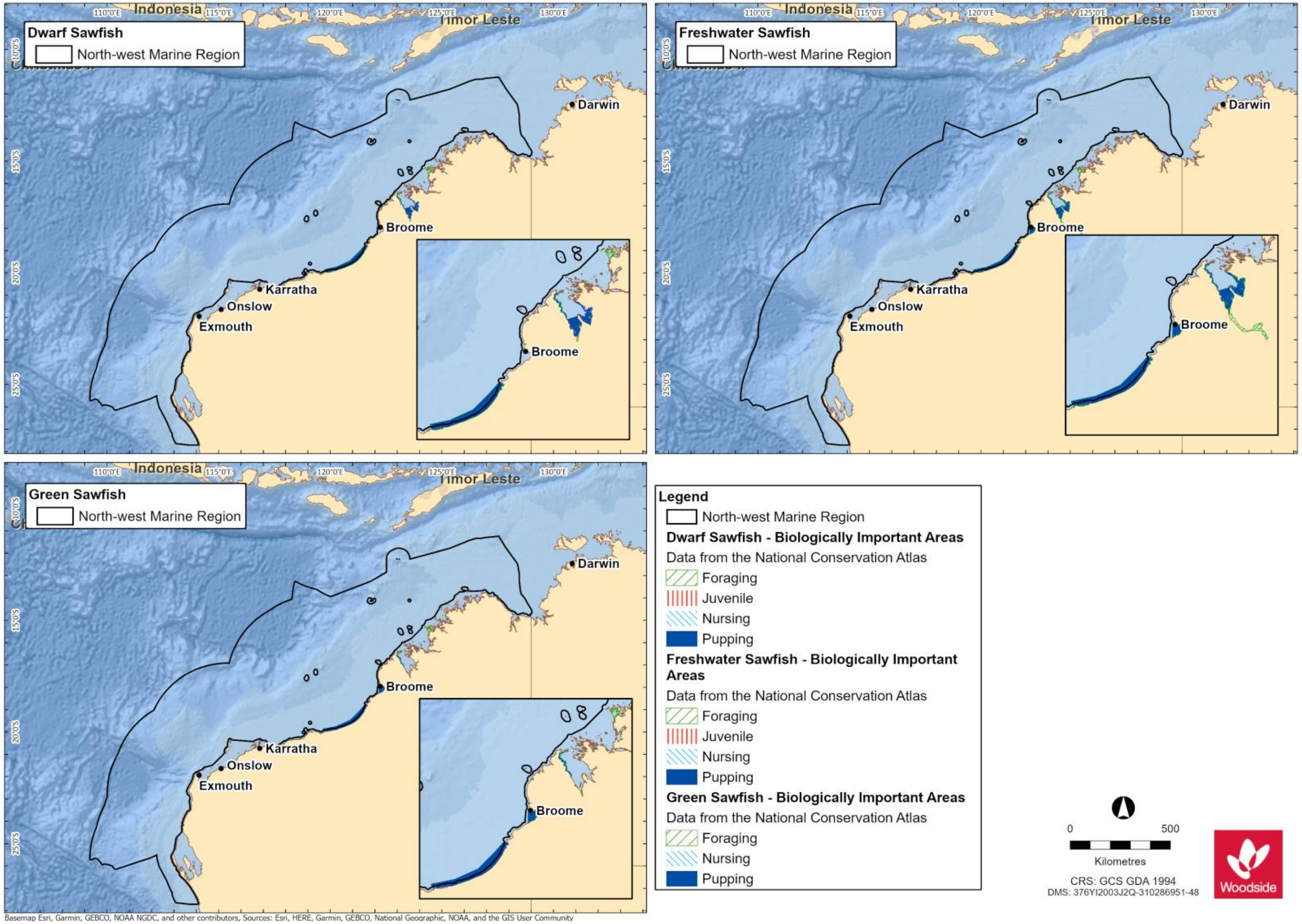

Figure 5-2 Sawfish BIAs for the NWMR

5.4 Fish Assemblages of the NWMR

5.4.1 Regional Context for Fish Assemblages of NWMR

The NWMR contains a diverse range of fishes of tropical Indo-west Pacific affinity (Allen *et al.*, 1988). The region is characterised by the highest level of endemism and species diversity compared with other areas of the Australian continental slope. Last *et al.* (2005) recorded 1431 species from the three bioregions encompassing the continental slope, whilst also acknowledging some information gaps.

The NWMR is known for its demersal slope fish assemblages; the continental slope of the Timor Province and the North-west Transition supports more than 418 and 505 species of demersal fishes respectively, of which 64 are considered to be endemic. This is the second richest area for demersal fish species across the entire Australian continental slope. Conversely, the broad Southern Province, which covers most of southern Australia, supports 463 species, only 26 possibly being endemic. The continental slope demersal fish assemblages of the NWMR have been identified as a KEF (DEWHA, 2008), as described in **Section 9**.

The NWMR also features a diversity of pelagic fishes (those living in the pelagic zone) and bentho-pelagic fishes, including tuna, billfish, bramids, lutjanids, serranids and some sharks (DEWHA, 2007a). These species feed on salps and jellyfish, and more often on secondary consumers such as squid and bait fish. Water depth provides an indication of the level of interaction between pelagic and benthic communities within the NWMR; in waters deeper than 1000 m, for instance, the trophic system is pelagically-driven and benthic communities rely on particulates that fall to the seafloor (DEWHA, 2007a).

Pelagic fishes play an important ecological role within the NWMR; small pelagic fishes, such as lantern fish, inhabit a range of marine environments, including inshore and continental shelf waters and form a vital link in and between many of the region’s trophic systems, feeding on pelagic phytoplankton and zooplankton and providing a food source for a wide variety of predators including large pelagic fishes, sharks, seabirds and marine mammals (Bulman, 2006; Mackie *et al.*, 2007). Large pelagic fishes, such as tuna, mackerel, swordfish, sailfish and marlin, are found mainly in oceanic waters and occasionally on the continental shelf (Brewer *et al.*, 2007). Both juvenile and adult phases of the large pelagic species are highly mobile and have a wide geographic distribution, although the juveniles more frequently inhabit warmer or coastal waters (DEWHA, 2008).

5.4.2 Listed Fish Species in the NWMR

The family Syngnathidae is a group of bony fishes that includes seahorses, pipefishes, pipehorses and seadragons. Along with syngnathids, members of the related Solenostomidae family (ghost pipefishes) are also found in the NWMR (DSEWPAC, 2012a).

There are 44 solenostomid and syngnathid species that are listed marine species that may occur within the NWMR, although no species is currently listed as threatened or migratory, according to the PMST report (**Appendix A**).

Syngnathids live in nearshore and inner shelf habitats, usually in shallow coastal waters, among seagrasses, mangroves, coral reefs, macroalgae dominated reefs, and sand or rubble habitats (Dawson, 1985; Lourie *et al.*, 1999, Lourie *et al.*, 2004; Vincent, 1996). Two species, the winged seahorse (*Hippocampus alatus*) and western pipehorse (*Solegnathus sp. 2*) have been identified in deeper waters of the NWMR (up to 200 m) (DSEWPAC, 2012a), however, these species were not identified by the Protected Matters search of the NWMR.

Knowledge about the distribution, abundance and ecology of both syngnathids and solenostomids in the NWMR is limited. No BIAs for syngnathids and solenostomids have been identified in the NWMR.

5.4.3 Browse

The proposed Browse activity area includes biologically important habitat for the whale shark and three sawfish species:

- whale shark (foraging northward from Ningaloo along the 200 m isobath (July – Nov),
- freshwater sawfish (pupping, nursing and foraging areas),
- green sawfish (pupping, nursing and foraging areas); and
- dwarf sawfish (pupping, nursing and foraging areas).

BIAs for the shark and sawfish species are outlined in **Table 5-4** and **Figure 5-1**.

The proposed Browse activity area has partial overlap with the Continental slope demersal fish communities KEF.

5.4.4 NWS / Scarborough

The NWS / Scarborough activity area includes biologically important habitat for the whale shark and three sawfish species:

- whale shark (foraging northward from Ningaloo along the 200 m isobath (July – Nov),
- freshwater sawfish (pupping, nursing and foraging areas),
- green sawfish (pupping, nursing and foraging areas); and
- dwarf sawfish (pupping, nursing and foraging areas).

BIAs for the whale shark and sawfish species are outlined in **Table 5-4** and **Figure 5-1**.

The NWS / Scarborough activity area has partial overlap with the Continental slope demersal fish communities KEF. The continental slope between North-west Cape and the Montebello Trough has more than 500 fish species, 76 of which are endemic, which makes it the most diverse slope bioregion in Australia (Last *et al.*, 2005).

5.4.5 North-west Cape

The North-west Cape activity area includes biologically important foraging habitat for the whale shark:

- whale shark, including:
  - Foraging (high density) in Ningaloo Marine Park and adjacent Commonwealth waters (March–July); and
  - Foraging northward from Ningaloo along the 200 m isobath (July – Nov).

BIAs for the whale shark are outlined in **Table 5-4** and **Figure 5-1**.

The North-west Cape activity area coincides with part of the Continental slope demersal fish communities KEF.

6. MARINE REPTILES

6.1 Regional Context for Marine Reptiles

The NWMR contains important habitat for listed marine reptiles, including areas that support key life stages such as nesting, internesting, migration and foraging for marine turtle species, and habitats supporting resident sea snake and crocodile populations.

Six of the seven marine turtle species occur in Australian waters, and all six (the green turtle, hawksbill turtle, loggerhead turtle, flatback turtle, leatherback turtle and olive ridley turtle) occur in the NWMR and NMR.

There are 25 listed species of sea snake reported within or adjacent to the NWMR (Guinea, 2007a; Udyawer *et al*., 2016), of which four are endemic to reef habitats in the remote parts of the region. Nineteen (19) listed sea snake species are known to occur in the NMR, as reported in the Protected Matters search (**Appendix A**).

There are significantly fewer marine reptile species that frequently occur within the SWMR and presently include three species of listed marine turtle and one sea snake species. Other species of sea snake may occur because of the southward-flowing Leeuwin Current, as vagrants in the region (DSEWPAC, 2012b).

The following sections focus on the listed marine reptile species known to occur within the NWMR.

Table 6-1 outlines the threatened and migratory marine reptile species that occur within the NWMR, with their conservation status and relevant recovery plans and/or conservation advice.

Table 6-1 Marine reptile species identified by the EPBC Act PMST as potentially occurring within or utilising habitats in the NWMR for key life cycle stages

Species Name	Common Name	*Environment Protection and Biodiversity Conservation Act 1999*			WA *Biodiversity Conservation Act 2016*	EPBC Act Part 13 Statutory Instrument
		Threatened Status	Migratory Status	Listed	Conservation Status	
Caretta caretta	Loggerhead turtle	Endangered	Migratory	Marine	Endangered	Recovery Plan for Marine Turtles in Australia 2017-2027 (Commonwealth of Australia, 2017)
Chelonia mydas	Green turtle	Vulnerable	Migratory	Marine	Vulnerable	
Dermochelys coriacea	Leatherback turtle	Endangered	Migratory	Marine	Vulnerable	
Eretmochelys imbricata	Hawksbill turtle	Vulnerable	Migratory	Marine	Vulnerable	
Natator depressus	Flatback turtle	Vulnerable	Migratory	Marine	Vulnerable	
Lepidochelys olivacea	Olive ridley turtle	Endangered	Migratory	Marine	Vulnerable	
Aipysurus apraefrontalis	Short-nosed sea snake	Critically endangered	N/A	Marine	Critically endangered	Approved Conservation Advice for *Aipysurus apraefrontalis* (Short-nosed Sea Snake) (DSEWPAC, 2011a)
Aipysurus foliosquama	Leaf-scaled sea snake	Critically endangered	N/A	Marine	Critically endangered	Approved Conservation Advice for *Aipysurus foliosquama* (Leaf-scaled Sea Snake) (DSEWPAC, 2011b)
Crocodylus porosus	Salt-water crocodile	N/A	Migratory	Marine	Other protected fauna	N/A

6.2 Marine Turtles in the NWMR

According to the Protected Matters search (**Appendix A**) six species of marine turtle known to occur within the NWMR are listed as threatened and migratory (three Vulnerable and three Endangered) under the EPBC Act—the green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), flatback (*Natator depressus*), loggerhead (*Caretta caretta*), leatherback (*Dermochelys coriacea*) and olive ridley (*Lepidochelys olivacea*) turtle (DSEWPAC, 2012a) (refer **Table 6-1**).

The NWMR supports globally significant breeding populations of four marine turtle species: the green, hawksbill, flatback and loggerhead turtle. Olive ridley turtles are known to forage within the NWMR, but there are only occasional records of the species nesting in the region. Leatherback turtles regularly forage over Australian continental shelf waters within the NWMR but there are also no records of the species nesting in the region (DSEWPAC, 2012a).

The six marine turtle species reported for the NWMR also occur within the NMR.

Three marine turtle species; the green, loggerhead, and leatherback turtle, have presumed feeding areas within the SWMR; however, no known nesting areas exist within the region (DSEWPAC, 2012b).

Discrete genetic stocks have evolved within each marine turtle species. This is the result of marine turtles returning to the location where they hatched. These genetically distinct stocks are defined by the presence of regional breeding aggregations. Stocks are composed of multiple rookeries in a region and are delineated by where there is little or no migration of individuals between nesting areas. Turtles from different stocks typically overlap at feeding grounds (Commonwealth of Australia, 2017). There are 17 genetic stocks across both the NWMR and NMR (nine in the NWMR, six in the NMR, and two overlapping both regions). Of these 17 genetic stocks, nine are known to occur within Woodside’s three areas of activity (**Table 6-2**).

6.2.1 Life Cycle Stages

Marine turtles are highly migratory during non-reproductive life phases and have high site fidelity during breeding and nesting life phases. Majority of their lives are spent in the ocean, but the adult female marine turtles will come ashore to lay eggs in the sand above the high water mark on natal beaches (Commonwealth of Australia, 2017). **Figure 6-1** summarises the generalised life cycle of marine turtles. Species-specific life cycle information is outlined within the Recovery Plan for Marine Turtles of Australia (Commonwealth of Australia, 2017).

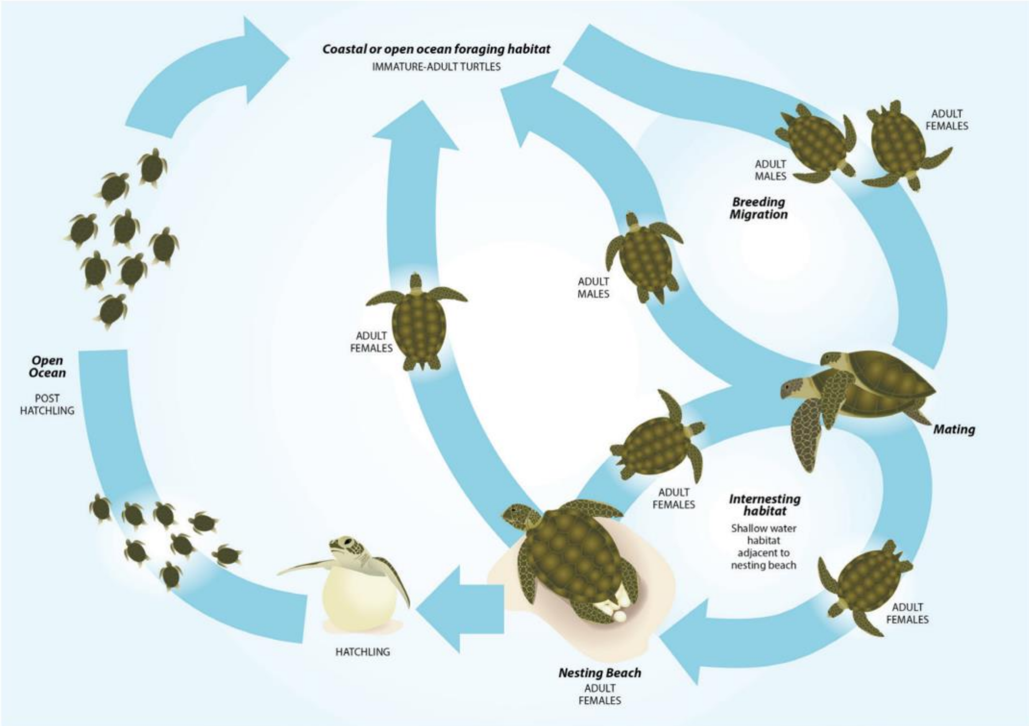

Figure 6-1 Generalised life cycle of marine turtles (Commonwealth of Australia, 2017)

6.2.2 Habitat Critical to Survival for Marine Turtles in the NWMR

The Recovery Plan for Marine Turtles of Australia (Commonwealth of Australia, 2017) identifies habitat critical to the survival of a species for marine turtle stocks under the EPBC Act. Habitat critical to survival is defined by the EPBC Act *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance* as areas necessary:

- for activities such as foraging, breeding or dispersal;
- for the long-term maintenance of the species (including the maintenance of species essential to the survival of the species);
- to maintain genetic diversity and long term evolutionary development; and
- for the reintroduction of populations or recovery of the species.

The Recovery Plan for Marine Turtles of Australia (Commonwealth of Australia, 2017) has identified nesting locations and associated internesting areas as habitat critical to survival for four marine turtle species within the NWMR and these are identified, described and mapped in **Table 6-2** and **Figure 6-2**. No habitat critical to survival has been identified within the NWMR for olive ridley or leatherback turtles.

Table 6-2 outlines the relevant genetic stock, habitat critical to survival and key life cycle stage seasonality of the four species of marine turtles within the NWMR.

Table 6-2 Genetic stock, habitat critical to survival and key life cycle stage seasonality of the four species of marine turtles within the NWMR

Species	Woodside Activity Area			Habitat Critical to Survival			
	Browse	NWS/S	NWC	Nesting (* Major Rookery[1])	Internesting Buffer	Seasonality-Nesting	Preferred Habitat[2]
Green Turtle							
NWS Stock (G-NWS)	✓	✓	✓	Adele Island Maret Island Cassini Island Lacepede Islands* Barrow Island* Montebello Islands (all with sandy beaches)* Serrurier Island Dampier Archipelago Thevenard Island Northwest Cape* Ningaloo coast	20 km radius	Nov-Mar	Nearshore reef habitats in the photic zone.
Ashmore Reef Stock (G-AR)	✓	-	-	Ashmore Reef* Cartier Reef*		All year (peak: Dec-Jan)	
Scott Reef-Browse Island Stock (G-ScBr)	✓	-	-	Scott Reef (Sandy Islet)* Browse Island*		Nov-Mar	
Hawksbill Turtle							
Western Australia Stock (H-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 radius	Oct-Feb	Nearshore and offshore reef habitats.

Species	Woodside Activity Area			Habitat Critical to Survival			
	Browse	NWS/S	NWC	Nesting (* Major Rookery[1])	Internesting Buffer	Seasonality- Nesting	Preferred Habitat[2]
Flatback Turtle							
Cape Domett Stock (F-CD)	✓	-	-	Cape Domett* Lacrosse Island	60 km radius	All year (peak: Jul-Sep)	Nearshore and offshore sub-tidal and soft bottomed habitats of offshore islands.
South-west Kimberley Stock (F-swKim)	-	✓	-	Eighty Mile Beach* Eco Beach* Lacepede Islands		Oct-Mar	
Pilbara Stock (F-Pil)	-	✓	-	Montebello Islands Mundabullangana Beach* Barrow Island* Cemetery Beach Dampier Archipelago (including Delambre Island* and Huay Island) Coastal islands from Cape Preston to Locker Island		Oct-Mar	
Unknown genetic stock Kimberley, Western Australia	✓	✓	-	Maret Islands Montilivet Islands Cassini Island Coronation Islands (includes Lamarck Island) Napier-Broome Bay Islands (West Governor Island, Sir Graham Moore Island – near Kalumbaru) Champagny, Darcy and Augustus Islands (Camden Sound)		May-July	

Species	Woodside Activity Area			Habitat Critical to Survival			
	Browse	NWS/S	NWC	Nesting (* Major Rookery[1])	Internesting Buffer	Seasonality-Nesting	Preferred Habitat[2]
Loggerhead Turtle							
Western Australia Stock (LH-WA)	-	-	✓	Dirk Hartog Island* Muiron Islands* Gnaraloo Bay* Ningaloo coast	20 km radius	Nov-May	Nearshore and island coral reefs, bays and estuaries in tropical and warm temperate latitudes.

[1] Major rookeries as outlined in the Recovery Plan (Commonwealth of Australia, 2017)

[2] Preferred habitat as outlined in the Recovery Plan (Commonwealth of Australia, 2017)

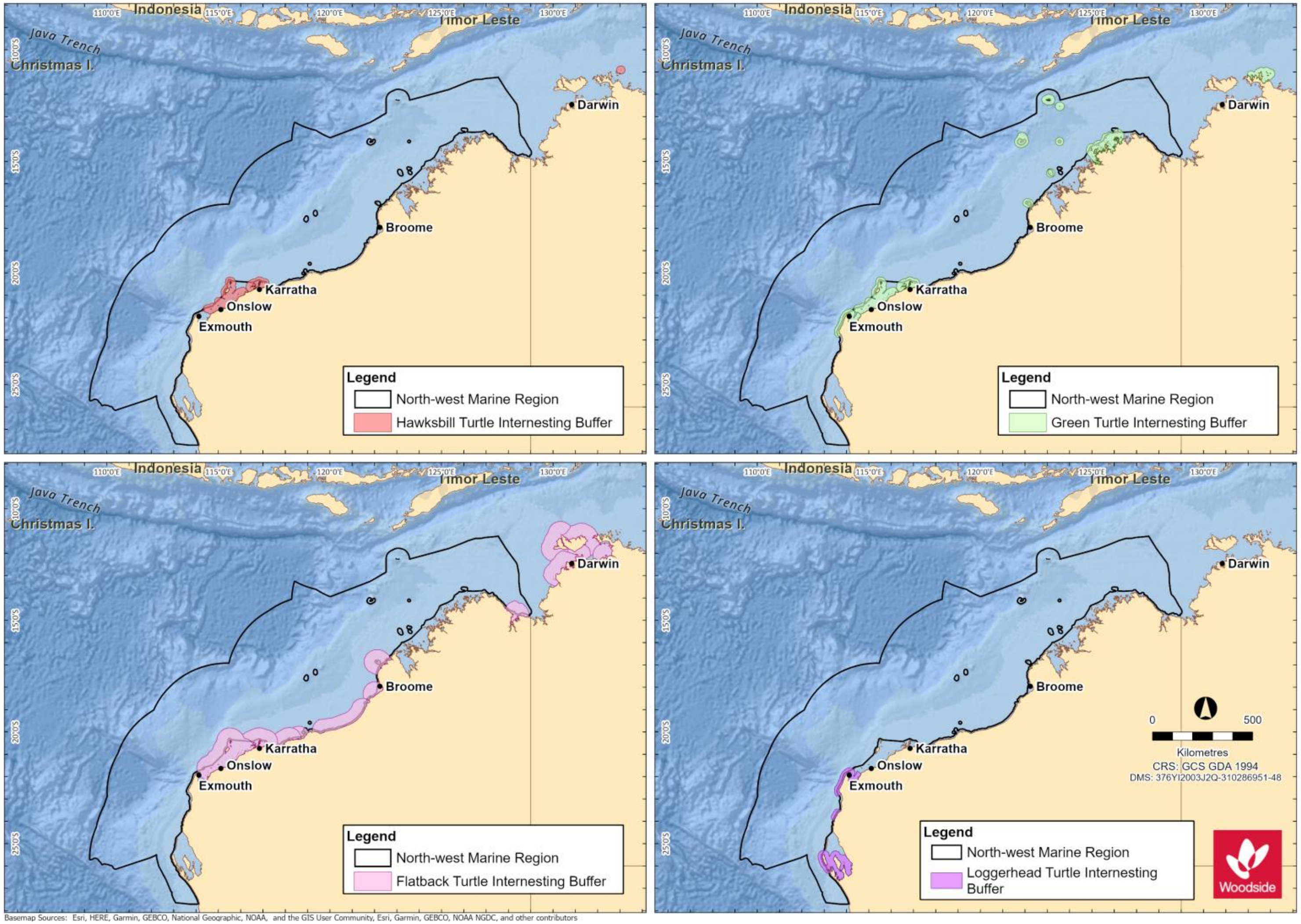

Figure 6-2 Marine turtle species habitat critical to survival (nesting beaches and internesting buffers) for the NWMR

6.3 Marine Turtle Biological Important Areas in the NWMR

A review of the National Conservation Values Atlas (DAWE, 2020[2]) identified BIAs for the four marine turtle species that occur within the NWMR. These are described in **Table 6-3**. Note that nesting and internesting BIAs are not listed in **Table 6-3** as they are defined as in the Recovery Plan as habitat critical to survival for marine turtles nesting beaches and internesting areas (refer **Table 6-2**).

[2] http://www.environment.gov.au/webgis-framework/apps/ncva/ncva.jsf

Table 6-3 Marine turtle BIAs within the NWMR

Species	Woodside Activity Area			BIAs		
	Browse	NWS/S	NWC	Mating	Foraging	Migration[3]
Green turtle	✓	✓	✓	No mating BIA identified within the NWMR.	Foraging inshore areas of Barrow Island Foraging at Montgomery Reef Foraging at Montebello Islands Foraging at Dixon Island Foraging around Ashmore Reef Foraging at Seringapatam Reef and Scott Reef Foraging in the De Grey River area to Bedout Island Foraging around the Islands between Cape Preston and Onslow and inshore of Barrow Island Foraging around Dampier Archipelago (islands to the west of the Burrup Peninsula) Foraging at Legendre Island and Huay Island Foraging around Delambre Island Foraging in the Joseph Bonaparte Gulf Foraging in waters adjacent to James Price Point	Green turtles can migrate more than 2600 km between their feeding and nesting grounds. Individual turtles foraging in the same area do not necessarily take the same migration route (Limpus *et al.*, 1992). Ferreira et al. (2021) broadly identified two migratory corridors, one used by the NWS stock-Pilbara and another used by the NWS stock-Kimberley and the Scott-Browse stock with some overlap at the northern and southern extents respectively. This study showed that the foraging distribution of green turtles from two stocks in WA expands throughout north-west and northern Australian coastal waters, including the NT and Queensland.
Hawksbill turtle	✓	✓	✓	No mating BIA identified within the NWMR.	Foraging around the Lowendal Island group Foraging at Delambre Island Foraging around Dixon Island Foraging in the De Grey River area to Bedout Island Foraging around the islands between Cape Preston and	Individuals may migrate up to 2400 km between their nesting and foraging grounds (DSEWPAC, 2012a).

[3] Migration BIA does not exist for Marine Turtles – general information provided.

Species	Woodside Activity Area			BIAs		
	Browse	NWS/S	NWC	Mating	Foraging	Migration[3]
					Onslow and inshore of Barrow Island Foraging around the islands of the Dampier Archipelago (to the west of the Burrup Peninsula) Foraging at Ashmore Reef	
Flatback turtle	✓	✓	-	Lacepede Islands Mating at Montebello Islands Mating at Dampier Archipelago (islands to the west of the Burrup Peninsula) Mating at Barrow Island A year-round internesting buffer biologically important area (BIA) of 80 km is located north and north-west of the Montebello Islands, extending 20 km further than the habitat critical to survival. However, use level for this BIA has been defined as very low (Commonwealth of Australia, 2017) and the habitat critical to survival internesting buffer is the legally recognised area of protection under the EPBC Act *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance* Refer to the Marine Bioregional Plan for the North-west Marine Region (DSEWPAC, 2012a) for locations of seasonal 80 km internesting buffer BIAs for flatback turtles	Foraging at the islands between Cape Preston and Onslow and inshore of Barrow Island. Foraging at Montebello Islands Foraging at Dampier Archipelago (islands to the west of the Burrup Peninsula) Foraging at Legendre Island and Huay Island Foraging at Delambre Island Foraging in the Joseph Bonaparte Depression Foraging in waters adjacent to James Price Point	There is evidence that some flatback turtles undertake long-distance migrations between breeding and feeding grounds (Limpus *et al.*, 1983). However, flatback turtles generally do not have a pelagic phase to their lifecycle. Instead, hatchlings grow to maturity in shallow coastal waters thought to be close to their natal beaches (DSEWPAC, 2012a).

Species	Woodside Activity Area			BIAs		
	Browse	NWS/S	NWC	Mating	Foraging	Migration[3]
Loggerhead turtle	✓	✓	-	No mating BIA identified within the NWMR	Foraging in the De Grey River area to Bedout Island Foraging on the Western Joseph Bonaparte Depression Foraging in the waters adjacent to James Price Point	Adult loggerhead turtles dispersing from Dirk Hartog Island beaches (near Shark Bay) have remained within WA waters from southern WA to the Kimberley. Turtles dispersing from the North-west Cape–Muiron Islands nesting area have ranged north as far as the Java Sea and the north-western Gulf of Carpentaria, and to south-west WA (DSEWPAC, 2012).
Olive ridley turtle	✓	✓	-	No mating BIA identified within the NWMR	Foraging in the Western Joseph Bonaparte Depression and Gulf Foraging in the Dampier Archipelago (islands to the west of the Burrup Peninsula)	Migration routes and distances between nesting beaches and foraging areas are not known for Australian olive ridley turtles.

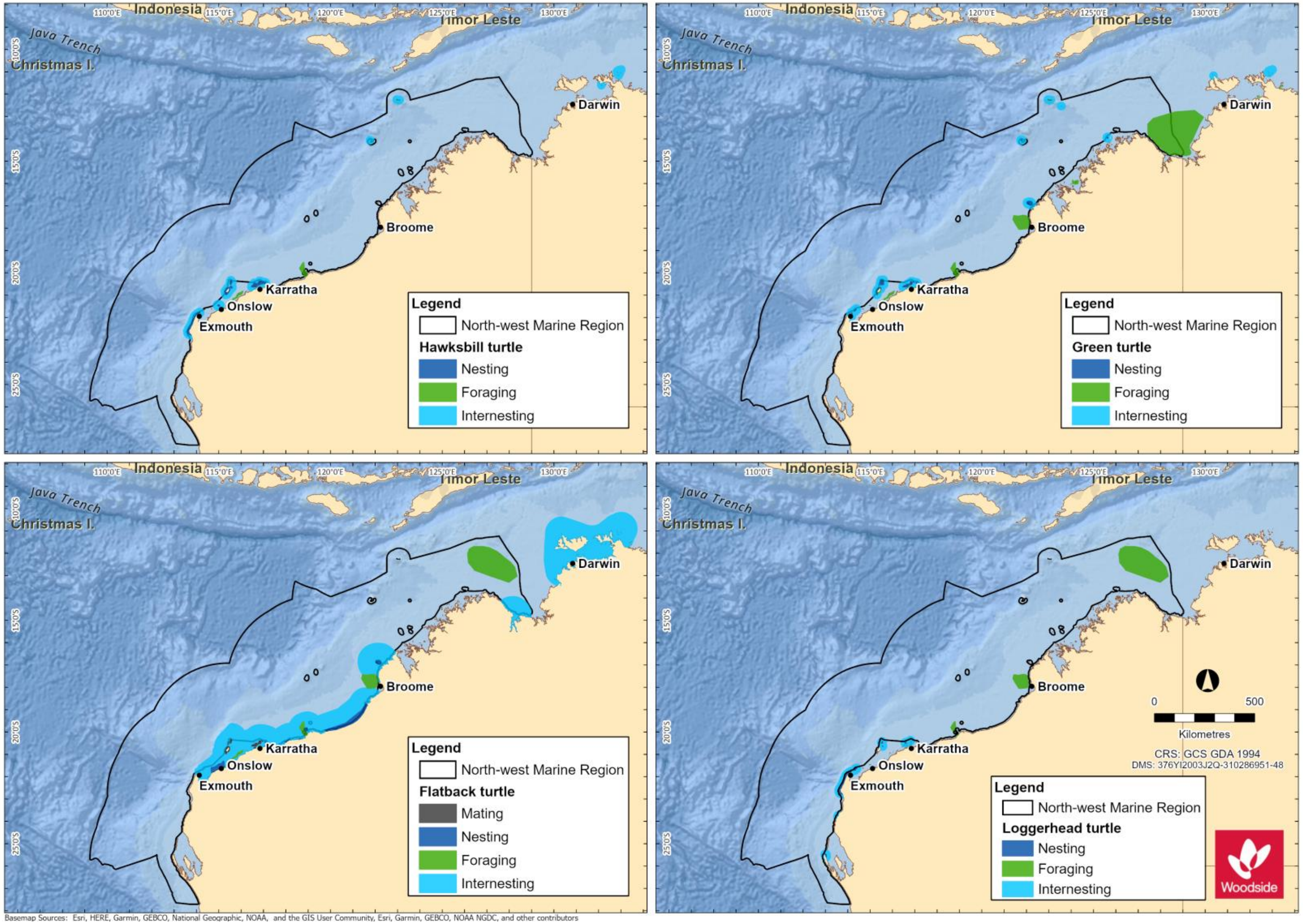

Figure 6-3 Marine turtle species BIAs within the NWMR

6.4 Marine Turtle Summary for NWMR

Six of the seven marine turtle species occur within the Woodside activity areas. Across all three areas, globally significant breeding populations of four marine turtle species; the green, hawksbill, flatback and loggerhead turtle, have been recorded.

However, offshore waters do not represent biologically important habitat for marine turtles in any of the three Woodside activity areas. Isolated records of transient individuals (on post-nesting migration) are expected, but there is no evidence of important habitat or behaviours for marine turtles in offshore, open water environment of the NWS, in general.

6.4.1 Browse

The proposed Browse activity area includes major nesting areas that support globally significant breeding populations of two marine turtle species:

- the green turtle, including two distinct genetic stocks (Ashmore Reef and Scott Reef-Browse Island); and
- the flatback turtle, Cape Domett genetic stock.

Locations of habitat critical for each of the two species are outlined in **Table 6-2** and **Figure 6-2**.

BIAs for the green and flatback turtle are outlined in **Table 6-3** and **Figure 6-3**.

Table 6-4 Marine turtle key information for Browse activity area

Species / Genetic Stock	Key Information
Green Turtle	
Ashmore Reef Stock (G-AR)	The G-AR stock nests in a localised area of the Indian Ocean in the Ashmore Reef and Cartier Island AMP areas. Population estimates are not available for Ashmore Reef, although annual breeding numbers are thought to be in the low hundreds (Whiting, 2000). Designated habitat critical for the G-AR stock are the nesting locations of Ashmore Reef and Cartier Reef, and an internesting buffer of 20 km radius around these rookeries, year-round with peak internesting activity occurring December to January (refer Table 6 of the Recovery Plan). Juvenile and adult turtles forage within the tidal/sub-tidal habitats of offshore islands and coastal waters with coral reef, mangrove, sand, rocky reefs, and mudflats where there are algal turfs or seagrass meadows present (Commonwealth of Australia, 2017).
Scott Reef-Browse Island Stock (G-ScBr)	The G-ScBr stock is a discrete unit known to nest at only two locations within the north-east Indian Ocean—Sandy Islet and Browse Island. There is currently very limited data available for the G-ScBr stock, therefore population numbers are not known. Designated habitat critical for the G-ScBr stock are the nesting locations of Sandy Islet and Browse Island, and an internesting buffer of 20 km radius around these rookeries, for the period November to March (refer Table 6 of the Recovery Plan). Surveys conducted at Scott Reef in 2006, 2008 and 2009 indicate that the summer months from late November to February are the preferred breeding season for green turtles at Sandy Islet (Guinea, 2009). Satellite tagging studies (Pendoley, 2005; Guinea, 2011) have provided an indication of the behaviour and migratory routes of adult green turtles leaving Scott Reef. Most animals appear to swim through South Reef lagoon and disperse toward the Western Australian mainland via two distinct post-nesting migration pathways; travelling east and north toward the Bonaparte Archipelago and then north along the coast to foraging areas in NT waters, or travelling south to Cape Leveque and then south along the coast to the Turtle Islands off the mouth of the De Grey River in the Pilbara region (Ferreira *et al*., 2021).

Species / Genetic Stock	Key Information
Flatback Turtle	
Cape Domett Stock (F-CD)	Cape Domett is an important high density nesting area. Combined with a smaller site at Lacrosse Island, the F-CD stock is one of the largest flatback turtle stocks in Australia. Average nesting abundance at Cape Domett is estimated at 3250 females per year (Whiting *et al.*, 2008). Designated habitat critical for the F-CD stock are the nesting locations of Cape Domett and Lacrosse Island, and an internesting buffer of 60 km radius around these rookeries, year-round with peak internesting activity occurring July to September. Extending further than the habitat critical internesting buffer, an internesting buffer BIA of 80 km is located at Cape Domett and Lacrosse Island.

6.4.2 North-west Shelf / Scarborough

The NWS / Scarborough activity area includes major nesting areas that support globally significant breeding populations of three marine turtle species, representing four discreet genetic stocks:

- the green turtle, NWS genetic stock;
- the hawksbill turtle, WA genetic stock; and
- the flatback turtle, South-west Kimberley stock and Pilbara genetic stocks.

Locations of habitat critical for each of the four species are outlined in **Table 6-2** and **Figure 6-2**.

BIAs for the green, hawksbill, and flatback are outlined in **Table 6-3** and **Figure 6-3**.

Table 6-5 Marine turtle key information for NWS / Scarborough activity area

Species / Genetic Stock	Key Information
Green Turtle	
NWS Stock (G-NWS)	The G-NWS stock is one of the largest green turtle stocks in the world and the largest in the Indian Ocean. The G-NWS stock is estimated at approximately 20,000 individuals (DSEWPAC, 2012a) and the trend for the stock is reported as stable (Commonwealth of Australia, 2017). Major rookeries of the G-NWS stock within the NWS / Scarborough activity area are located at Barrow Island and the Montebello Islands. These areas are designated habitat critical for the stock and include an internesting buffer of 20 km radius around these rookeries, November to March.
Hawksbill Turtle	
Western Australia Stock (H-WA)	The H-WA stock is the largest in the Indian Ocean. The majority of the nesting for this stock is located in the Pilbara. The Dampier Archipelago has the largest nesting aggregation recorded. In particular, Rosemary Island supports the most significant hawksbill turtle rookery in the WA region and one of the largest in the Indian Ocean; approximately 500-1000 females nest on the island annually, more than at any other WA rookery (Pendoley, 2005; Pendoley *et al*., 2016). Major rookeries of the H-WA stock within the NWS / Scarborough activity area are located at Rosemary Island, Delambre Island and the Montebello Islands. These areas are designated habitat critical for the stock and include an internesting buffer of 20 km radius around these rookeries, October to February.
Flatback Turtle	
South-west Kimberley Stock (F-swKim)	The genetic relationship between this nesting aggregation and the Cape Domett and Pilbara stocks is currently under review. Population numbers of the F-swKim stock are unknown. Major rookeries of the F-swKim stock are located at Eighty Mile Beach and Eco Beach. These areas are designated habitat critical for the stock and include an internesting buffer of 60 km radius around these rookeries, October to March.

Species / Genetic Stock	Key Information
Pilbara Stock (F-Pil)	The extent of genetic relatedness of flatback turtles along the WA coast is currently under review. Population numbers of the F-Pil stock are unknown. This stock nests on many islands in the Pilbara and southern Kimberley, with major rookeries at Mundabullangana Beach, Delambre Island and Barrow Island. These areas are designated habitat critical for the F-Pil stock and include an internesting buffer of 60 km radius around these rookeries, October to March. Extending further than the habitat critical internesting buffer, a year-round internesting buffer BIA of 80 km is located north and north-west of the Montebello Islands. However, use level for this BIA has been defined as very low (Commonwealth of Australia, 2017) and the habitat critical internesting buffer is the legally recognised area of protection under the EPBC Act *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance*. Post-nesting satellite tracking indicates foraging occurs along the WA coast in water shallower than 130 m and within 315 km of shore (Commonwealth of Australia, 2017).

6.4.3 North-west Cape

The North-west Cape activity area includes major nesting areas that support globally significant breeding populations of two marine turtle species, representing two discreet genetic stocks:

- the green turtle, NWS genetic stock; and
- the loggerhead turtle, Western Australia genetic stock.

Locations of habitat critical for each of the two species are outlined in **Table 6-2** and **Figure 6-2**.

BIAs for the green and loggerhead turtles are outlined in **Table 6-3** and **Figure 6-3**.

A 2018 survey, including on-beach monitoring of the Muiron Islands and Ningaloo Coast from North-west Cape to Bungelup (Rob *et al.*, 2019), supports the concept that North-west Cape and the Muiron Islands are major important nesting areas for green and loggerhead turtles, as identified in the Recovery Plan (Commonwealth of Australia, 2017).

Table 6-6 Marine turtle key information for North-west Cape activity area

Species / Genetic Stock	Key Information
Green Turtle	
NWS Stock (G-NWS)	The G-NWS stock is one of the largest green turtle stocks in the world and the largest in the Indian Ocean. The G-NWS stock is estimated at approximately 20,000 individuals (DSEWPAC, 2012a) and the trend for the stock is reported as stable (Commonwealth of Australia, 2017). There is one major rookery of the G-NWS stock located within the North-west Cape activity area. Located on the mainland coast of the North-west Cape, this area is designated habitat critical for the stock and includes an internesting buffer of 20 km radius around the rookery, November to March.
Loggerhead Turtle	
Western Australia Stock (LH-WA)	The LH-WA stock is one of the largest in the world (Limpus, 2009). The trend for the stock is reported as stable (Commonwealth of Australia, 2017). Major rookeries of the LH-WA stock are located at Dirk Hartog Island, Muiron Islands and Gnaraloo Bay. These areas are designated habitat critical for the stock and include an internesting buffer of 20 km radius around these rookeries, November to May. Dirk Hartog Island in the Shark Bay Marine Park, with an average of 122 nests per day over 2.1 km (Reinhold and Whiting, 2014), is recognised as the most important loggerhead turtle rookery in WA (Commonwealth of Australia, 2016; as cited in Rob *et al.*, 2019).

6.5 Sea Snakes

Sea snakes are commonly found in the NWMR and NMR, but less so in the SWMR, and occupy three broad habitat types: shallow water coral reef and seagrass habitats, deepwater soft bottom habitats away from reefs, and surface water pelagic habitats (Guinea, 2007a).

There are 25 listed species of sea snake reported within or adjacent to the NWMR (Guinea, 2007a; Udyawer *et al*., 2016), of which four are endemic to reef habitats in the remote parts of the region:

- dusky sea snake (*Aipysurus fuscus*);
- large headed sea snake (*Hydrophis pacificus*);
- short-nosed sea snake (*Aipysurus apraefrontalis*); and
- leaf-scaled sea snake (*Aipysurus foliosquama*).

The short-nosed sea snake and the leaf-scaled sea snake are listed threatened species (Critically Endangered) under the EPBC Act **(Table 6-7**).

There is currently limited knowledge about the ranges and distribution patterns of sea snake species in the NWMR, in addition to a lack of understanding of population status and threats. Recent findings of *A. apraefrontalis* and *A. foliosquama* in locations outside of their previously defined ranges have highlighted the lack of information on species distributions in the NWMR (Udyawer *et al.*, 2016). Udyawer *et al.* (2020) used a correlative modelling approach to understand habitat associations and identify suitable habitats for five sea snake species (*A. apraefrontalis, A. foliosquama, A. fuscus, A. l. pooleorum* and *A. tenuis*). Species-specific habitat suitability was modelled across 804,244 km^2 of coastal waters along the NWS, and the resulting habitat suitability maps enabled the identification of key locations of suitable habitat for these five species (refer **Table 6-6**).

No habitat critical to survival or BIAs for sea snake species have been identified in the NWMR. While the Ashmore Reef and Cartier Island AMPs have been recognised for their high diversity and density of sea snakes (DSEWPAC, 2012a), surveys have revealed a steep decline in sea snake numbers at Ashmore Reef (Guinea, 2007b; Lukoschek *et al.*, 2013). Leaf-scaled and short-nosed sea snakes have been absent from surveys at Ashmore Reef since 2001, despite an increase in survey intensity (Guinea, 2006, 2007b; Guinea and Whiting, 2005; Lukoschek *et al.*, 2013). The reason for the decline is unknown.

Table 6-7 Information on the two threatened sea snake species within the NWMR

Species	Preferred Habitat and Diet	Habitat Location
Short-nosed sea snake	Preferred habitat: Primarily on the reef flats or in shallow waters of the outer reef edges to depths of 10 m (Minton *et al*., 1975). Typically, movement is restricted to within 50 m of reef flat habitat (Guinea and Whiting, 2005). Diet: Primarily fishes and eels.	The short-nosed sea snake has been recorded from Exmouth Gulf to the reefs of the Sahul Shelf, although most records come from Ashmore and Hibernia reefs (Guinea and Whiting, 2005). Key locations of suitable habitat: Ashmore Reef, Exmouth Gulf, Muiron Islands, Montebello Islands (Udyawer *et al.*, 2020).
Leaf-scaled sea snake	Preferred habitat: The leaf-scaled sea snake occurs in shallow protected areas of reef flats, typically in water depth less than 10 m. Diet: Primarily shallow water coral-associated wrasse, gudgeons, clinids and eels (McCosker, 1975; Voris, 1972; Voris and Voris, 1983)	The leaf-scaled sea snake has only been recorded at Ashmore and Hibernia reefs (Guinea and Whiting, 2005), indicating it has a very limited distribution. Key locations of suitable habitat: Ashmore Reef, Shark Bay, Exmouth Gulf, Barrow Island and Montebello Islands (Udyawer *et al.*, 2020).

6.6 Crocodiles

The salt-water crocodile (*Crocodylus porosus*) is a listed migratory species under the EPBC Act known to occur within the NWMR. The species is found in most major river systems of the Kimberley, including the Ord, Patrick, Forrest, Durack, King, Pentecost, Prince Regent, Lawley, Mitchell, Hunter, Roe and Glenelg rivers. The largest populations occur in the rivers draining into the Cambridge Gulf and the Prince Regent River and Roe River systems. There have also been isolated records in rivers of the Pilbara region, around Derby near Broome and as far south as Carnarvon on the mid-west coast.

No BIAs for salt-water crocodile have been identified in the NWMR.

7. MARINE MAMMALS

7.1 Regional Context

The offshore waters of WA include important habitat for marine mammals, including areas that support key life stages such as breeding, foraging, and migration. Of the 45 species of cetacean occurring in Australian waters, 27 species occur regularly in the waters of the NWMR, nine species in the waters of the NMR and 33 species in the SWMR. The waters of the NWMR and the NMR also support significant populations of dugong (DSEWPAC, 2012a, c).

The NWMR is an important migratory pathway between feeding grounds in the Southern Ocean and breeding grounds in tropical waters of the NWMR for several cetacean species (DSEWPAC, 2012a). Numerous large mysticetes (baleen whale) species, in particular the humpback whale, are known to utilise the region for migration and calving, and the pygmy blue whale for foraging and as a migration pathway between southern feeding and northern breeding/feeding areas, north of the equator.

The SWMR is an important area for numerous marine mammal species including pinniped species, large, migratory whale species and resident coastal whale and dolphin species (DSEWPAC, 2012b).

The NMR and adjacent areas are important for several species of cetacean, particularly inshore dolphin species. These species, and other marine mammals, rely on the waters of the NMR and adjacent coastal areas for breeding and foraging. However, there is little knowledge of the seasonal movements, migrations and breeding seasonality for many of the marine mammal species in the NMR due to lack of extensive surveys (DSEWPAC, 2012c).

Table 7-1 outlines the threatened and migratory marine mammal species that may occur within the NWMR, with their conservation status and relevant recovery plans and/or conservation advice.

Table 7-1 Marine mammal species identified by the EPBC Act PMST as occurring within the NWMR

Species Name	Common Name	*Environment Protection and Biodiversity Conservation Act 1999*			WA *Biodiversity Conservation Act 2016*	EPBC Act Part 13 Statutory Instrument
		Threatened Status	Migratory Status	Listed	Conservation Status	
Cetaceans - Mysticeti						
Balaenoptera musculus	Blue whale	Endangered	Migratory	Cetacean	Endangered	Conservation Management Plan for the Blue Whale - A Recovery Plan under the *Environment Protection and Biodiversity Conservation Act 1999* 2015-2025 (Commonwealth of Australia, 2015a)
Eubalaena australis	Southern right whale	Endangered	Migratory	Cetacean	Vulnerable	Conservation Management Plan for the Southern Right Whale: A Recovery Plan under the *Environment Protection and Biodiversity Conservation Act 1999* 2011-2021 (DSEWPAC, 2012d)
Balaenoptera borealis	Sei whale	Vulnerable	Migratory	Cetacean	Endangered	Conservation Advice *Balaenoptera borealis* sei whale (Threatened Species Scientific Committee, 2015a)
Megaptera novaeangliae	Humpback whale	Vulnerable	Migratory	Cetacean	Conservation dependent	Conservation Advice *Megaptera novaeangliae* humpback whale (Threatened Species Scientific Committee, 2015b)
Balaenoptera physalus	Fin whale	Vulnerable	Migratory	Cetacean	Endangered	Conservation Advice *Balaenoptera physalus* fin whale (Threatened Species Scientific Committee, 2015c)
Balaenoptera edeni	Bryde's whale	N/A	Migratory	Cetacean	N/A	N/A
Balaenoptera bonaerensis	Antarctic minke whale	N/A	Migratory	Cetacean	N/A	N/A
Cetaceans - Odontoceti						
Physeter macrocephalus	Sperm whale	N/A	Migratory	Cetacean	Vulnerable	N/A
Orcinus orca	Killer whale	N/A	Migratory	Cetacean	N/A	N/A
Orcaella heinsohni	Australian snubfin dolphin	N/A	Migratory	Cetacean	Priority	N/A
Sousa chinensis	Indo-Pacific humpback dolphin	N/A	Migratory	Cetacean	Priority	N/A

Species Name	Common Name	*Environment Protection and Biodiversity Conservation Act 1999*			WA *Biodiversity Conservation Act 2016*	EPBC Act Part 13 Statutory Instrument
		Threatened Status	Migratory Status	Listed	Conservation Status	
Tursiops aduncus	Spotted bottlenose dolphin (Arafura/Timor Sea populations)	N/A	Migratory	Cetacean	N/A	N/A
Sirenians and Pinnipeds						
Dugong dugon	Dugong	N/A	Migratory	Marine	Other protected fauna	N/A
Neophoca cinerea	Australian sea lion	Endangered	N/A	Marine	Vulnerable	Recovery Plan for the Australian Sea Lion (*Neophoca cinerea*) 2013 (DSEWPAC, 2013a) Conservation Advice *Neophoca cinerea* Australian Sea Lion (Threatened Species Scientific Committee, 2020a) (in effect under the EPBC Act from 23-Dec-2020)

7.2 Cetaceans in the NWMR

Cetaceans are generally widely distributed and highly mobile. In general, distribution patterns reflect seasonal feeding areas, characterised by high productivity, and migration routes associated with reproductive patterns. The NWMR is thought to be an important migratory pathway between feeding grounds in the Southern Ocean and breeding grounds in tropical waters for several cetacean species (DSEWPAC, 2012a).

From the Protected Matters search, 34 EPBC Act listed species were recorded as potentially occurring or having habitat within the NWMR (**Appendix A**). Of those, 12 cetacean species are listed as threatened and/or migratory, including baleen whales, toothed whales and dolphins that occur within the NWMR (**Table 7-2**).

7.3 Dugongs in the NWMR

The dugong is listed as migratory under the EPBC Act. Dugongs inhabit seagrass meadows in coastal waters, estuarine creeks and streams, and reef systems (DSEWPAC, 2012a).

Some of the coastal waters adjacent to the NWMR support significant populations of dugongs, including Shark Bay, Exmouth Gulf, in and adjacent to Ningaloo Reef, in coastal waters along the Kimberley coast, and on the edge of the continental shelf at Ashmore Reef (DEWHA, 2008).

Although the patterns of dugong movement in WA are not well understood, it is thought that dugongs move in response to availability of seagrass (Marsh *et al.*, 1994; Preen *et al.*, 1997) and water temperature.

There are a number of BIAs for dugong within and adjacent to waters of the NWMR (refer **Section 7.5**).

7.4 Pinnipeds in the NWMR

The Australian sea lion is listed as a species that may occur, or may have habitat within the NWMR (Protected Matters search - **Appendix A**). It is included here as the Australian sea lion is the only pinniped endemic to Australia (Strahan, 1983) and has been recorded within the southern extent of the NWMR at Shark Bay, WA (Kirkwood *et al.*, 1992). The most northern known breeding colony is at the Houtman Abrolhos Islands in the SWMR. The Australian sea lion's breeding range extends from the Houtman Abrolhos Islands, WA to The Pages Island, east of Kangaroo Island, SA. The Australian sea lion was listed as endangered in 2020 (Threatened Species Scientific Committee, 2020a). An assessment of the status and trends in abundance of this endemic, coastal pinniped species (Goldsworthy *et al.* 2021) documented an overall reduction in pup abundance over three generations, providing strong evidence that the species meets IUCN endangered criteria.

There are no BIAs for the Australian sea lion in the NWMR.

Table 7-2 Information on the threatened/migratory marine mammal species within the NWMR

Species	Key Information
	Baleen whales (Mysticeti)
Humpback whale	In Australian waters two genetically distinct populations migrate annually along the west (Group IV) and east coasts (Group V) between May and November. In WA, the migration pathway for the Group IV population (also known as Breeding Stock D) extends from Albany to the Kimberley coastline, passing through the NWMR (Threatened Species Scientific Committee, 2015b). Since the 1982 moratorium on commercial whaling population numbers have recovered significantly; from approximately 2000 to 3000 individuals in 1991, to between 19,200–33,850 individuals in 2008 (Bannister and Hedley, 2001; Bejder *et al.*, 2019; Hedley *et al.*, 2011). Aerial surveys off the WA coast undertaken between 2000 and 2008 produced a population estimate for the Group IV population of 26,100 individuals (CI 20,152–33,272) in 2008 (Salgado Kent *et al.*, 2012). Current population growth for the Group IV population is estimated to be between 9.7 and 13% per annum (Threatened Species Scientific Committee, 2015b). Using the Salago-Kent *et al.* (2012) estimate of 26,100 individuals and an annual population growth rate of ~10%, current population size could be in excess of 75,000 individuals (Woodside, 2019). The Group IV population migrates northward from their Antarctic feeding grounds around May each year, reaching the NWMR around early June. The southward migration subsequently starts in mid-September, around the time of breeding and calving (typically August to September) (Threatened Species Scientific Committee, 2015b). Within the NWMR there are key calving areas between Broome and the northern end of Camden Sound, and resting areas in the southern Kimberley region, Exmouth Gulf and Shark Bay. In particular, high numbers of humpback whales are observed in Camden Sound and Pender Bay from June to September each year (Threatened Species Scientific Committee, 2015b). There are reports of neonates further south, suggesting that the calving areas may be poorly defined. Aerial photogrammetric surveys in 2013 and 2015 recorded large numbers of humpback whale calves along North-west Cape, with estimated minimum relative calf abundance of 463–603 in 2013 and 557–725 in 2015 (Irvine *et al.*, 2018). The majority of calves sighted in both years (85% in 2013; 94% in 2015) were neonates, and these observations indicate that a minimum of approximately 20% of the expected number of calves of this population are born near, or south of, North-west Cape. Thus, the calving grounds for the Group IV population extend south from Camden Sound to at least North-west Cape, 1000 km south-west of the currently recognized calving area (Irvine *et al.*, 2018). There are BIAs for migration and breeding and calving for the humpback whale along the WA coast and within the NWMR (refer **Table 7-3** and **Figure 7-1**).
Blue whale	There are two recognised sub-species of blue whale in the Southern Hemisphere, both of which are recorded in Australian waters. These are the southern (or 'true') blue whale (*Balaenoptera musculus*) and the 'pygmy' blue whale (*Balaenoptera musculus brevicauda*) (Commonwealth of Australia, 2015a). In general, southern blue whales occur in waters south of 60°S and pygmy blue whales occur in waters north of 55°S (i.e. not in the Antarctic). On this basis, nearly all blue whales sighted in the NWMR are likely to be pygmy blue whales. The East Indian Ocean (EIO) pygmy blue whale population is seasonally distributed from Indonesia (a potential breeding ground) to south-west of Australia and east across the Great Australian Bight and Bonney Upwelling to beyond the Bass Strait (Blue Planet Marine, 2020). Migration seems to be variable, with some individuals appearing as resident to areas of high productivity and others undertaking migrations across long distances (Commonwealth of Australia, 2015a). McCauley *et al.* (2018) describe three migratory stages around Australia for the EIO pygmy blue whale population: a 'southbound migratory stage' where whales travel southwards from Indonesian waters offshore from the WA coastline, mostly from October to December but possibly into January of the following year; a protracted 'southern Australian stage' (January to June) where animals spread across southern waters of the Indian Ocean and south of Australia; and a 'northbound migratory stage' (April to August) where animals travel north back to Indonesia again. There are currently insufficient data to accurately estimate population numbers of the pygmy blue whale in Australian waters (Blue Planet Marine, 2020; Commonwealth of Australia, 2015a). There are, however, two estimates of population size of the EIO pygmy blue whale for WA. McCauley and Jenner (2010) calculated the population to be between 662 and 1559 individuals in 2004 based on passive acoustics (whale vocalisations), and Jenner *et al.* (2008) (based on photographic mark and recapture) calculated between 712 and 1754 individuals, but both estimates did not account for animals

Species	Key Information
	travelling further west into the Indian Ocean (McCauley *et al.*, 2018). More recent passive acoustic data estimates a 4.3% growth rate that applies to the proportion of EIO pygmy blue whales seasonally present in offshore water of the south-eastern Australia and may not reflect the full population but does imply an increasing population (McCauley *et al.*, 2018). The pygmy blue whale is typically present in the Perth Canyon from November to June, with an observed peak between March and May (Commonwealth of Australia, 2015a; Blue Planet Marine, 2020). The pygmy blue whale feeds in the Perth Canyon at depths of 200 to 300 m, which overlaps the typical distribution of krill (200–500 m water depth (day) to surface (night) (McCauley *et al.*, 2004; Commonwealth of Australia, 2015a). Other possible feeding grounds off the WA coast include the wider area around the Perth Canyon, and possible foraging areas off the Ningaloo Coast and at Scott Reef (Commonwealth of Australia, 2015a). Refer **Table 7-3** and **Figure 7-2** for the location and type of BIAs for blue whales in the NWMR. There is a migratory BIA for the pygmy blue whale within WA waters, which extends for most of the length of the NWMR within offshore waters.
Bryde's whale	The Bryde's whale is the least migratory of its genus and is restricted geographically from the equator to approximately 40°N and S, or the 20° isotherm (Bannister *et al.*, 1996). The species is known to exhibit inshore and offshore forms in other international locations that vary in morphology and migratory behaviours (Bannister *et al.*, 1996). This appears to also be the case within Australian waters. Bryde's whales have been identified as occurring in both oceanic and inshore waters, with the only key localities recognised in WA being in the Houtman Abrolhos Islands and north of Shark Bay (Bannister *et al.*, 1996). Data suggests offshore whales migrate seasonally, heading towards warmer tropical waters during the winter; however, information about migration within the NWMR is not well known (McCauley and Duncan, 2011). McCauley (2011) detected Bryde's whales using acoustic loggers deployed in and around Scott Reef from 2006 to 2009. Other acoustic logger data of Bryde's whale vocalisations recorded between Ningaloo and north of Darwin showed no apparent trends or seasonality (McCauley, 2011). There are no identified BIAs for this species in the National Conservation Values Atlas.
Southern right whale	The southern right whale occurs primarily in waters between about 20°S and 60°S and moves from high latitude feeding grounds in summer to warmer, low latitude, coastal locations in winter (Bannister *et al.*, 1996). Southern right whales aggregate in calving areas along the south coast of WA outside of the NWMR. However, there have been sightings in waters of the NWMR as far north as Ningaloo (Bannister and Hedley, 2001), and a stranding record exists for the far north Kimberley coast (ALA, 2020). Southern right whale calving grounds are found at mid to lower latitudes and are occupied during the austral winter and early-mid spring. They are regularly present on the southern Australian coast from about mid-May to mid-November, and peak periods for mating are from mid-July through August. Mating occurs within these breeding grounds as evidenced by many observations of intromission and mating behaviours. Southern right whales in south-western Australia appear to be increasing at the maximum biological rate but there is limited evidence of increase in south-eastern Australian waters (DSEWPAC, 2012d). There are no identified BIAs for this species in the NWMR.
Antarctic minke whale	The Antarctic minke whale is distributed worldwide and has been recorded off all Australian states (but not in the NT), feeding in cold waters and migrating to warmer waters to breed. It is thought that the Antarctic minke whale migrates up the WA coast to about 20°S to feed and possibly breed (Bannister *et al.*, 1996); however, detailed information about timing and location of migrations and breeding grounds within the NWMR is not well known. In the high latitudinal winter breeding grounds in other regions, the species appears to be distributed off the continental shelf edge. No population estimates are available for Antarctic minke whales in Australian waters. There are no identified BIAs for this species in the National Conservation Values Atlas.
Sei whale	The sei whale is a baleen whale with a worldwide oceanic distribution and is expected to seasonally migrate between low latitude wintering areas and high latitude summer feeding grounds (Bannister *et al.*, 1996; Prieto *et al.*, 2012). There are no known mating or calving areas in Australian waters. The species has a preference for deep waters, typically occurs in oceanic basins and continental slopes (Prieto *et al.*, 2012), and exhibits a migration pathway influenced by seasonal feeding and breeding patterns. Sei whales have been infrequently recorded in Australian waters (Bannister *et al.*, 1996). Reliable estimates of the sei whale population size in Australian waters are currently not possible due to a lack of dedicated surveys and their elusive characteristics. Similarly, the extent of occurrence and area of occupancy of sei whales in Australian waters cannot be calculated due to the

Species	Key Information
	rarity of sighting records. They will typically travel in small pods of three to five individuals, with some segregation by age, sex and reproductive status. Calving grounds are presumed to exist in low latitudes with mating and calving potentially occurring during winter months (Threatened Species Scientific Committee, 2015a). There are no known mating or calving areas in Australian waters, and there are no identified BIAs for this species in the National Conservation Values Atlas.
Fin whale	The fin whale is a large baleen whale distributed worldwide. Fin whales migrate annually between high latitude summer feeding grounds and lower latitude over-wintering areas (Bannister *et al.*, 1996) and follow oceanic migration paths. The species is uncommonly encountered in coastal or continental shelf waters. Australian Antarctic waters are important feeding grounds for fin whales but there are no known mating or calving areas in Australian waters (Morrice *et al.*, 2004). The species has been observed in groups of six to 10 individuals, as well as in pairs and alone (Threatened Species Scientific Committee, 2015c). Accurate distribution patterns are not known within Australian waters and the majority of data are from stranding events. Fin whales have been recorded vocalising off the Perth Canyon, WA, between January and April 2000 (McCauley *et al.*, 2000). It is currently not possible to accurately estimate the population size of fin whales in Australian waters predominantly due to the species' behaviour and local ecology, as the proportion of time they spend at the surface varies greatly depending on these factors. In addition, natural fluctuations of fin whales in Australian waters are unknown; however, long-range movements do appear to be prey-related. A recent study by Aulich *et al.* (2019) used passive acoustic monitoring as a tool to identify the migratory movements of fin whales in Australian waters. On the west coast, the earliest arrival of these animals occurred at Cape Leeuwin in April, and between May and October they migrated along the WA coastline to the Perth Canyon, which likely acts as a way-station for feeding (Aulich *et al.*, 2019). Some whales were found to continue migrating as far north as Dampier (Aulich *et al.*, 2019). There are no identified BIAs for this species in the National Conservation Values Atlas.
Toothed whales (Odontoceti)	
Sperm whale	Sperm whales are the largest of the toothed whales and are distributed worldwide in deep waters (greater than 200 m) off continental shelves and sometimes near shelf edges (Bannister *et al.*, 1996). The species tends to inhabit offshore areas at depths of 600 m or more and is uncommon in waters less than 300 m deep (Ceccarelli *et al.*, 2011). There is limited information about sperm whale distribution in Australian waters, however, they are usually found in deep offshore waters, with more dense populations close to continental shelves and canyons. In the open ocean, there is a generalised movement of sperm whales southwards in summer, and corresponding movement northwards in winter, particularly for males. Detailed information about the distribution and migration patterns of sperm whales off the WA coast is not available. Females with young may reside within the NWMR all year round, males may migrate through the region and the species may be associated with canyon habitats (Ceccarelli *et al.*, 2011). Sperm whales have been recorded in deep waters off North-west Cape and appear to occasionally venture into shallower waters in other areas. Twenty-three (23) sightings of sperm whales (variable pod sizes, ranging from one to six animals) were recorded by marine mammal observers (MMOs) during the North West Cape MC3D marine seismic survey (December 2016 to April 2017) (Woodside, 2020). These animals were observed in deep, continental slope waters of the Montebello Saddle (maximum distance of approximately 90 km from North-west Cape), and the waters overlying the Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula KEF. The deep waters above the gully/saddle on the inner edge of the plateau (the Montebello Saddle) are thought to be important for sperm whales that may feed in the region (based on 19th Century whaling records; Townsend, 1935). There are no identified BIAs for this species in the NWMR.
Killer whale	The preferred habitat of killer whales includes oceanic, pelagic and neritic (relatively shallow waters over the continental shelf) regions, in both warm and cold waters. Killer whales appear to be more common in cold, deep waters; however, they have been observed along the continental slope and shelf, particularly near seal colonies, as well as in shallow coastal areas of WA (Bannister *et al.*, 1996; Thiele and Gill, 1999). The total number of killer whales in Australian waters is unknown, however, it may be that the total number of mature animals within waters around the continent is less than 10,000. Killer whales are known to make seasonal movements, and probably follow regular migratory routes, but no information is available for the

Species	Key Information
	species in Australian waters. Killer whales are top-level carnivores, and there are reports from around Australia of attacks on dolphins, juvenile humpback whales, blue whales, sperm whales, dugongs and Australian sea lions (Bannister *et al.*, 1996). Killer whales are known to target humpback whales, particularly calves, off Ningaloo Reef during the humpback southern migration season (Pitman *et al.*, 2015). Overall, observations suggest that humpback calves are a predictable, plentiful, and readily taken prey source for killer whales off Ningaloo Reef for at least five months of the year. Additionally, there are records of killer whales attacking dugongs in Shark Bay (Anderson and Prince, 1985). However, there are no recognised key localities or important habitats for killer whales within the NWMR (DSEWPAC, 2012a). There are no identified BIAs for this species in the NWMR.
Australian snubfin dolphin	Stranding and museum specimen records indicate that Australian snubfin dolphins occur only in waters off northern Australia, from approximately Broome on the west coast to the Brisbane River on the east coast (Parra *et al.*, 2002). Aerial and boat-based surveys indicate that Australian snubfin dolphins occur mostly in protected shallow waters close to the coast, and close to river and creek mouths (Parra, 2006; Parra *et al.*, 2006; Parra *et al.*, 2002). Within the NWMR, species has been found in the 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 for Australian snubfin dolphins (DEWHA, 2008). Roebuck Bay has generally been considered the south-western limit of snubfin dolphin distribution across northern Australia, but the species has been recorded in Port Hedland harbour, the Dampier Archipelago, Montebello Islands, Exmouth Gulf and off North-west Cape (Allen *et al.*, 2012). A first comprehensive catalogue of snubfin dolphin sightings has been compiled for the Kimberley, north-west Western Australia (Bouchet *et al.* 2021) and documented that snubfin dolphins are consistently encountered in shallow water (<21 m depth) close to (<15 km) freshwater inputs with high detection rates in known hotspots such as Roebuck Bay and Cygnet Bay as well as suitable coastal habitat in the wider Kimberley region. Refer **Table 7-3** and **Figure 7-3** for the location and type of BIAs for Australian snubfin dolphins in the NWMR.
Indo-Pacific humpback dolphin (Australian humpback dolphin)	Previously included with *Sousa chinensis*, the Australian humpback dolphin (*S. sahulensis*) was elevated to a species in 2014. *S. chinensis* is now applied for humpback dolphins in the eastern Indian and western Pacific Oceans and *S. sahulensis* for humpback dolphins in the waters of the Sahul Shelf from northern Australia to southern New Guinea (Jefferson and Rosenbaum, 2014). The Australian humpback dolphin is listed as *S. chinensis* under EPBC Act. The Australian humpback dolphin (referred to as 'humpback dolphin' hereafter) inhabits the tropical/subtropical waters of the Sahul Shelf across northern Australia and southern Papua New Guinea (Jefferson and Rosenbaum, 2014). Based on historical stranding data, museum specimens and opportunistic sightings collected during aerial and boat-based surveys for other fauna it has been inferred that humpback dolphins occur from the WA/NT border south-west to Shark Bay (Hanf *et al.*, 2016). Allen *et al.* (2012) suggested that humpback dolphins use a range of inshore habitats, including both clear and turbid coastal waters across northern WA. The waters surrounding North-west Cape are an important area for the species. Boat-based surveys up to 5 km out from the coast (Brown *et al.*, 2012) recorded humpback dolphins from 0.3 to 4.5 km away from shore and in depths ranging from 1.2 to 20 m, with a mean of ~8 m. Other studies around North-west Cape, surveying waters up to 5 km from the coast, recorded humpback dolphins in water depths of up to 40 m (Hanf *et al.*, 2016). Based on density, site fidelity and residence patterns, North-west Cape is clearly an important habitat toward the south-western limit of this species' range (Hunt *et al.*, 2017). Aerial surveys targeting dugongs over the western Pilbara have recorded humpback dolphins more than 60 km from the mainland in shallow shelf waters (i.e. <30 m deep) near Barrow Island and the western Lowendal Islands (Hanf, 2015). The species has also been recorded in fringing coral reef and shallow, sheltered sandy lagoons at the Montebello Islands (Raudino *et al.*, 2018). Over the past ten years a number of studies have focused on populations of humpback dolphins along the Kimberley coast, including Roebuck Bay, the Dampier Peninsula, Cone Bay, Yampi Sound, Prince Regent River and the Cambridge Gulf (Brown *et al.*, 2016). Refer Table **Table 7-3** and **Figure 7-4** for the location and type of BIAs for Indo-Pacific humpback dolphins in the NWMR.
Indo-Pacific bottlenose dolphin (Spotted bottlenose dolphin)	There are four known sub-populations of spotted bottlenose dolphins, of which the Arafura/Timor Sea populations were identified as potentially occurring within the NWMR. The species is restricted to inshore areas such as bays and estuaries, nearshore waters, open coast environments, and shallow offshore waters including coastal areas around oceanic islands, from Shark Bay to the western edge of the Gulf of Carpentaria. The species

Species	Key Information
	forages in a range of habitats but is generally restricted to water depths of less than 200 m (DSEWPAC, 2012a). Important foraging/breeding areas include the shallow coastal waters and estuaries along the Kimberley coast and Roebuck Bay. Refer **Table 7-3** the location and type of BIAs for spotted bottlenose dolphins in the NWMR.
Sirenians	
Dugong	Dugongs are distributed along the WA coast throughout the Gascoyne, Pilbara and Kimberley. Specific areas supporting dugong populations include: Shark Bay; Ningaloo and Exmouth Gulf; the Pilbara coast (Exmouth Gulf to De Grey River [Marsh *et al.*, 2002]); and Eighty Mile Beach and the Kimberley coast, including Roebuck Bay (Brown *et al.*, 2014). Dugong distribution is correlated with the seagrass habitats upon which it feeds, although water temperature has also been correlated with dugong movements and distribution (Preen *et al.*, 1997; Preen, 2004). Dugongs are known to migrate between seagrass habitats (hundreds of kilometres) (Sheppard *et al.*, 2006), and in Shark Bay they exhibit seasonal movements as a behavioural thermoregulatory response to winter water temperatures (Holley *et al.*, 2006; Marsh *et al.*, 2011). Aerial surveys since the mid-1980s indicate that dugong populations are now stable at a regional scale in Shark Bay and in the Exmouth/Ningaloo Reef. Refer **Table 7-3** and **Figure 7-5** for the location and type of BIAs for dugong in the NWMR.
Pinnipeds	
Australian sea lion	The Australian sea lion is the only endemic pinniped (true seals, fur seals and sea lions) in Australian waters. It is a member of the Otariidae (eared seals) family. The birth interval in Australian sea lions is around 17–18 months. The Australian sea lion is unique among pinnipeds in being the only species that has a non-annual breeding cycle that is also temporally asynchronous across its range (DSEWPAC, 2013a; Threatened Species Scientific Committee, 2020a). This means the breeding period (copulation and birthing) in one colony will occur at different times to breeding in another colony. The Australian sea lion is considered to be a specialised benthic forager—that is, it feeds primarily on the sea floor. Studies have shown that the species will eat a range of prey, including fish, cephalopods (squid, cuttlefish and octopus), sharks, rays, rock lobsters and penguins (DSEWPAC, 2013a; Threatened Species Scientific Committee, 2020a). The Australian sea lion feeds on the continental shelf, most commonly in depths of 20–100 m, and they typically travel up to about 60 km from their colony on each foraging trip, with a maximum distance of around 190 km when over shelf waters. The current breeding distribution of the Australian sea lion extends from the Houtman Abrolhos Islands on the west coast of WA to the Pages Islands in SA. Sites for the 58 breeding colonies occurring in WA and SA are designated as habitat critical to the survival of the species under the Recovery Plan for the Australian sea lion (DSEWPAC, 2013a). Of these, four are located in the SWMR along the west coast of WA: Abrolhos Islands (Easter Group), Beagle Island, North Fisherman Island and Buller Island. There are also a number of foraging BIAs for both males and females along the west coast, extending from the Abrolhos Islands south to Rockingham. There is no designated habitat critical to survival or identified BIAs for this species in the NWMR. **Figure 7-6** shows the foraging BIAs for the Australian sea lion to the south of the NWMR.

7.5 Biological Important Areas in the NWMR

BIAs representing important life cycle stages and behaviours for six species of marine mammal in the NWMR: the humpback whale, the pygmy blue whale, Australian snubfin dolphin, Australian humpback dolphin, spotted bottlenose dolphin and dugong, are presented in **Table 7-3**.

Table 7-3 Marine mammal BIAs within the NWMR

Species	Woodside Activity Area			BIAs				
	Browse	NWS/S	NWC	Resting	Foraging	Breeding	Calving	Migration
Humpback whale[1]	✓	✓	✓	Shark Bay Exmouth Gulf (north migration – early June) (south migration – late Aug to Oct) Southern Kimberley region	No foraging BIA identified within the NWMR	Kimberley coast from the Lacepede Islands to north of Camden Sound (mid Aug – early Sept)	Core calving in waters off the Kimberley coast from the Lacepede Islands to north of Camden Sound (mid Aug – early Sept)	Southern border of the NWMR to north of the Kimberley (arrive June)
Blue whale and Pygmy blue whale [1 2]	✓	✓	✓	No resting BIA identified within the NWMR	Possible foraging areas off Ningaloo and Scott Reef	No breeding BIA identified within the NWMR	No calving BIA identified within the NWMR	Augusta to Derby. Along the shelf edge at depths of 500 m to 1000 m; appear close to Ningaloo coast Montebello Islands area on southern migration (north: April – Aug) (south: Oct – late Dec)
Australian snubfin dolphin [1]	✓	✓	-	No resting BIA identified within the NWMR	Roebuck Bay Cambridge Gulf Camden Sound area King Sound (south) King Sound (north) Yampi Sound Talbot Bay Maret Islands Bigge Island Admiralty Gulf Parry Harbour Bougainville Peninsula Vansittart Bay Anjo Peninsula Napier	Roebuck Bay Cambridge Gulf Camden Sound area King Sound (south) King Sound (north) Yampi Sound Talbot Bay Maret Islands Bigge Island Admiralty Gulf Parry Harbour Bougainville Peninsula Vansittart Bay, Anjo Peninsula Napier Broome Bay Deep Bay Prince Regent River King George River Cape Londonderry	Roebuck Bay Cambridge Gulf Camden Sound area King Sound (south) King Sound (north) Yampi Sound Talbot Bay Maret Islands Bigge Island Admiralty Gulf Parry Harbour Bougainville Peninsula Vansittart Bay Anjo Peninsula Napier Broome Bay Deep Bay Prince Regent River	No migration BIA identified within the NWMR

Species	Woodside Activity Area			BIAs				
	Browse	NWS/S	NWC	Resting	Foraging	Breeding	Calving	Migration
					Broome Bay Deep Bay Prince Regent River King George River Cape Londonderry Ord River	Ord River	King George River Cape Londonderry Ord River	
Indo-Pacific humpback dolphin	✓	✓	-	No resting BIA identified within the NWMR	Roebuck Bay Willie Creek Prince Regent River King Sound (north) Yampi Sound Talbot Bay Walcott Inlet Doubtful Bay Deception Bay Augustus Island Maret Islands Bigge Island King Sound, southern sector Vansittart Bay, Anjo Peninsula	Roebuck Bay Willie Creek Prince Regent River King Sound (north) Yampi Sound Talbot Bay Walcott Inlet Doubtful Bay Deception Bay Augustus Island	Roebuck Bay Willie Creek Prince Regent River	No migration BIA identified within the NWMR
Spotted bottlenose dolphin	✓	✓	✓	No resting BIA identified within the NWMR	Roebuck Bay Cambridge Gulf Camden Sound area King Sound (south) King Sound (north) Yampi Sound	Roebuck Bay Cambridge Gulf Camden Sound area King Sound (south) King Sound (north) Yampi Sound	No calving BIA identified within the NWMR	No migration BIA identified within the NWMR

Species	Woodside Activity Area			BIAs				
	Browse	NWS/S	NWC	Resting	Foraging	Breeding	Calving	Migration
Dugong[1]	✓	✓	✓	No resting BIA identified within the NWMR	Exmouth Gulf Ningaloo Reef Shark Bay Roebuck Bay Dampier Peninsula	No breeding BIA identified within the NWMR	Exmouth Gulf Ningaloo Reef Shark Bay	Not listed as a migratory species

1. *DSEWPAC (2012a)*

2. *Commonwealth of Australia (2015a)*

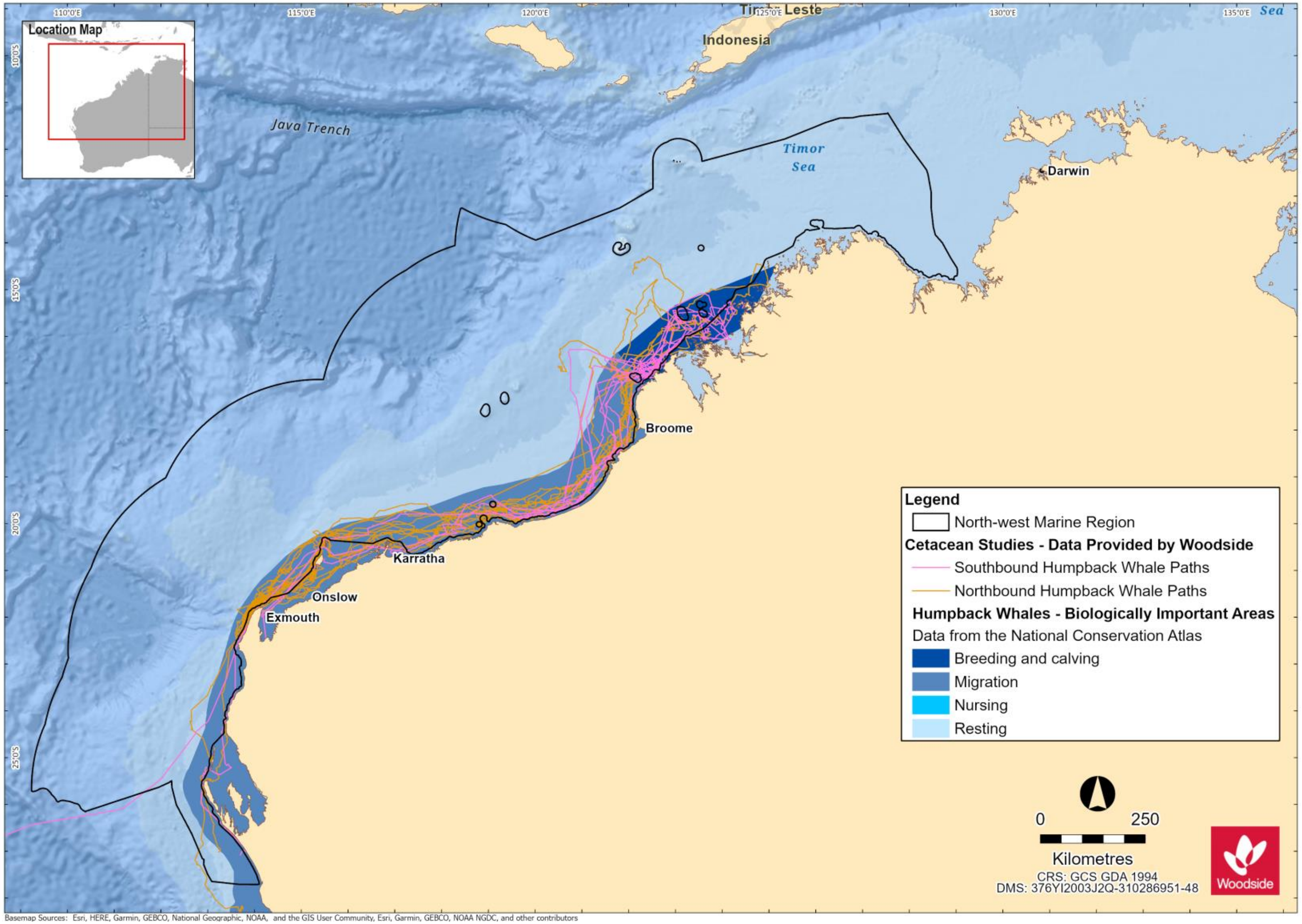

Figure 7-1 Humpback whale BIAs for the NWMR and tagged tracks for north and south bound migrations

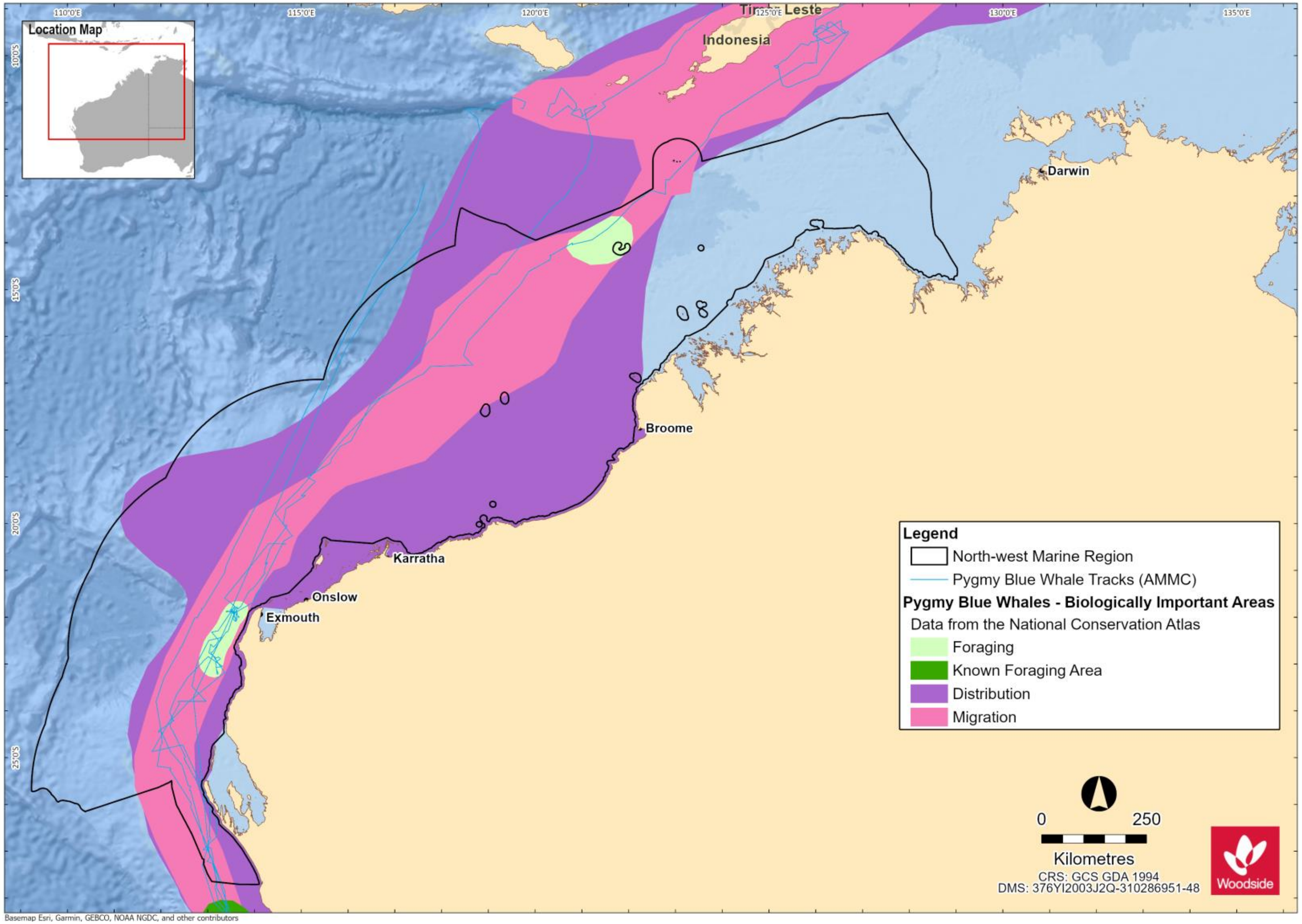

Figure 7-2 Pygmy blue whale BIAs for the NWMR and tagged whale tracks for northbound migration

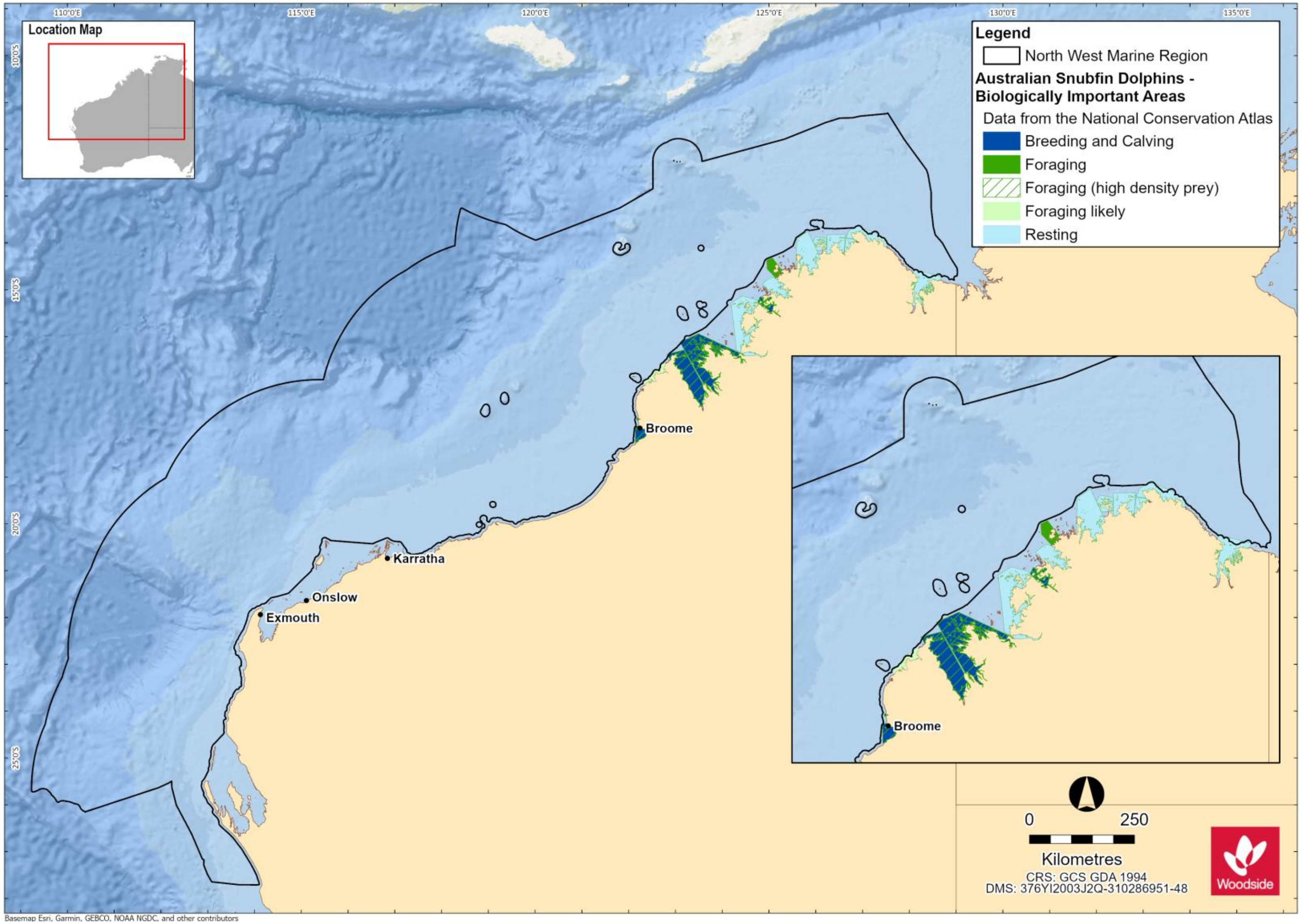

Figure 7-3 Australian snubfin dolphin BIAs for the NWMR

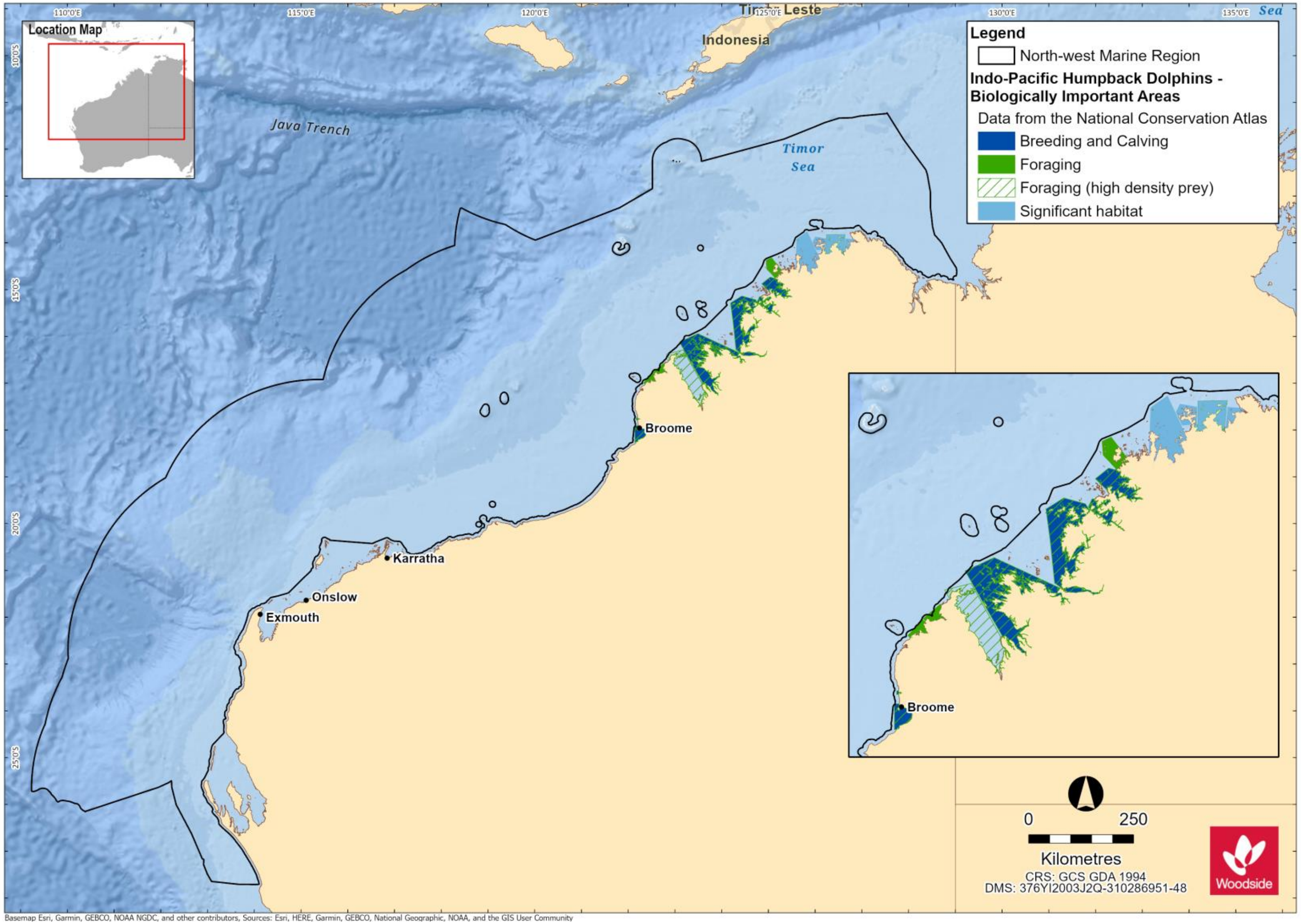

Figure 7-4 Indo-Pacific humpback dolphin BIAs for the NWMR

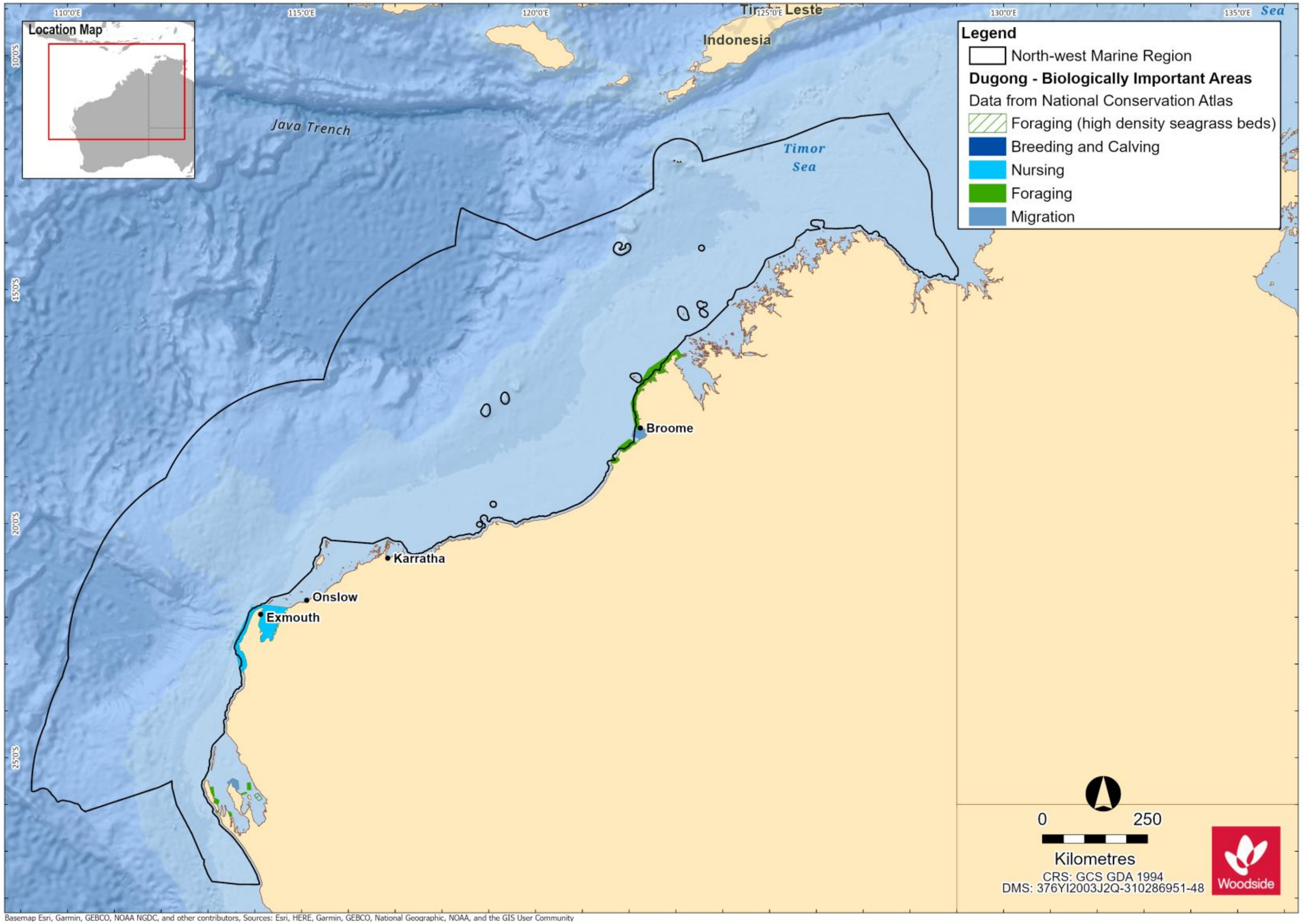

Figure 7-5 Dugong BIAs for the NWMR

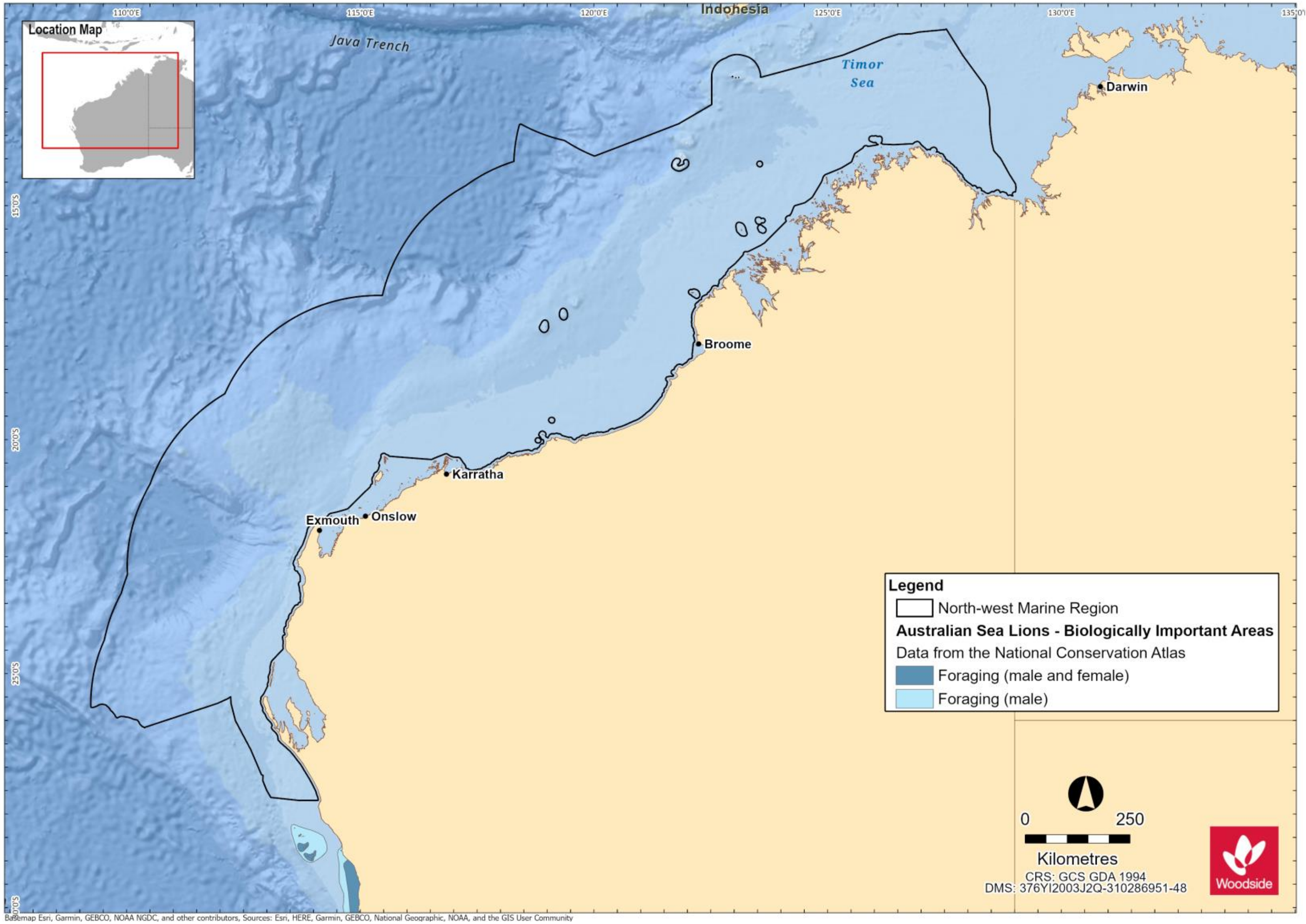

Figure 7-6 Australian sea lion BIAs in the northern extent of the SWMR closest to the NWMR

7.6 Marine Mammal Summary for the NWMR

7.6.1 Browse

The Browse activity area includes biologically important habitat for five threatened and/or migratory marine mammal species:

- blue whale and pygmy blue whale (foraging and migration areas);
- humpback whale (breeding, calving and migration areas);
- Indo-Pacific humpback dolphin (foraging, breeding and calving areas);
- Australian snubfin dolphin (foraging, breeding and calving areas); and
- dugong (foraging).

BIAs for the marine mammal species are outlined in **Table 7-3**.

7.6.2 North-west Shelf / Scarborough

The NWS / Scarborough activity area includes biologically important habitat for five threatened and/or migratory marine mammal species:

- blue whale and pygmy blue whale (foraging and migration areas);
- humpback whale (resting and migration areas);
- Indo-Pacific humpback dolphin (foraging, breeding and calving areas);
- Australian snubfin dolphin (foraging, breeding and calving areas); and
- dugong (foraging and calving areas).

BIAs for the marine mammal species are outlined in **Table 7-3**.

7.6.3 North-west Cape

The North-west Cape activity area includes biologically important habitat for three threatened and/or migratory marine mammal species:

- blue whale and pygmy blue whale (foraging and migration areas);
- humpback whale (resting and migration areas); and
- dugong (foraging and calving areas).

BIAs for the marine mammal species are outlined in **Table 7-3**.

8. SEABIRDS AND MIGRATORY SHOREBIRDS OF THE NWMR

8.1 Regional Context

The NWMR supports high numbers and species diversity of seabirds and migratory shorebirds including many that are EPBC Act listed, threatened and migratory. The NWMR marine bioregional plan reported 34 seabird species (listed as threatened, migratory and/or marine) that are known to occur, and 30 of 37 species of migratory shorebird species that regularly occur in Australia, are recorded at Ashmore Reef in the NWMR (DSEWPAC, 2012e). The NWMR marine bioregional plan also noted that Roebuck Bay and Eighty Mile Beach are internationally significant and recognised migratory shorebird locations.

Many migratory seabirds and shorebirds are protected through bilateral agreements between Australia and Japan (JAMBA), China (CAMBA) and the Republic of Korea (ROKAMBA), recognising the migratory route and important stopover and resting habitats of the East Asian-Australasian Flyway (EAAF). Important migratory bird habitats are also recognised as part of protected wetlands of the internationally significance under the Ramsar Convention. Important Bird Areas (IBAs) for the NWMR, which are also recognised as global Key Biodiversity Areas (KBAs) (BirdLife Australia[4]), include:

- Roebuck Bay KBA (and Ramsar site): Internationally significant migratory shorebird species.
- Mandora Marsh and Anna Plains KBA (adjacent to Eighty Mile Beach, Ramsar site): Internationally significant migratory shorebird species.
- Dampier Saltworks KBA: Internationally significant migratory shorebird species.
- Montebello Islands KBA: Shorebird and seabird species.
- Barrow Island KBA: Shorebird and seabird species.
- Exmouth Gulf Mangroves KBA: Internationally significant migratory shorebird species.

Table 8-1 presents a list of the threatened and migratory seabird and shorebird species that occur within the NWMR, with their conservation status and relevant recovery plans and/or conservation advice.

4 https://www.birdlife.org.au/projects/KBA#:~:text=The%20Key%20Biodiversity%20Areas%20(KBAs,of%20advocacy%20for%20protected%20areas. Accessed April, 2021.

Table 8-1. Bird species (threatened/migratory) identified by the EPBC Act PMST and other sources of information as potentially occurring within the NWMR

Species Name	Common Name	*Environment Protection and Biodiversity Conservation Act 1999*			WA *Biodiversity Conservation Act 2016*	EPBC Act Part 13 Statutory Instrument
		Threatened Status	Migratory Status	Listed	Conservation Status	
Seabirds						
Macronectes giganteus	Southern giant petrel	Endangered	Migratory	Marine	Migratory	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (DSEWPAC, 2011c)
Papasula abbotti	Abbott's booby	Endangered	N/A	Marine	N/A	Conservation Advice for the Abbott's booby - *Papasula abbotti* (Threatened Species Scientific Committee, 2020b)
Pterodroma mollis	Soft-plumaged petrel	Vulnerable	N/A	Marine	N/A	Conservation Advice *Pterodroma mollis* soft-plumaged petrel (Threatened Species Scientific Committee, 2015f)
Sternula nereis nereis	Australian fairy tern	Vulnerable	N/A	N/A	Vulnerable	Conservation Advice for *Sternula nereis nereis* (Fairy Tern) (DSEWPAC, 2011d)
Anous tenuirostris melanops	Australian lesser noddy	Vulnerable	N/A	Marine	Endangered	Conservation Advice *Anous tenuirostris melanops* Australian lesser noddy (Threatened Species Scientific Committee, 2015e)
Thalassarche carteri	Indian yellow-nosed albatross	Vulnerable	Migratory	Marine	Endangered	National recovery plan for threatened albatrosses and giant petrels 2011-2016 (DSEWPAC, 2011c)
Anous stolidus	Common noddy	N/A	Migratory	Marine	Migratory	Draft Wildlife Conservation Plan for Seabirds (Commonwealth of Australia, 2019)
Fregata ariel	Lesser frigatebird	N/A	Migratory	Marine	Migratory	
Fregata minor	Great frigatebird	N/A	Migratory	Marine	Migratory	
Sula leucogaster	Brown booby	N/A	Migratory	Marine	Migratory	
Sula sula	Red-footed booby	N/A	Migratory	Marine	Migratory	

Species Name	Common Name	*Environment Protection and Biodiversity Conservation Act 1999*			WA *Biodiversity Conservation Act 2016*	EPBC Act Part 13 Statutory Instrument
		Threatened Status	Migratory Status	Listed	Conservation Status	
Onychiprion anaethetus (listed as *Sterna anaethetus)*	Bridled tern	N/A	Migratory	Marine	Migratory	
Thalasseus bergii	Greater crested tern	N/A	Migratory	Marine	Migratory	
Sternula albifrons	Little tern	N/A	Migratory	Marine	Migratory	
Sterna dougallii	Roseate tern	N/A	Migratory	Marine	Migratory	
Onychoprion fuscata	Sooty tern	N/A	N/A	Marine	N/A	
Hydroprogne caspia	Caspian tern	N/A	Migratory	Marine	Migratory	
Ardenna pacifica	Wedge-tailed shearwater	N/A	Migratory	Marine	Migratory	
Puffinus assimillis	Little shearwater	N/A	N/A	Marine	N/A	
Ardenna carneipes	Flesh-footed shearwater	N/A	Migratory	Marine	Vulnerable	
Calonectris leucomelas	Streaked shearwater	N/A	Migratory	Marine	Migratory	
Phaethon lepturus	White-tailed tropicbird	N/A	Migratory	Marine	Migratory	
Chroicocephalus novaehollandiase	Silver gull	N/A	N/A	Marine	N/A	
Migratory shorebirds						
Numenius madagascariensis	Eastern curlew, Far Eastern curlew	Critically endangered	Migratory	Marine	Critically endangered	Conservation Advice *Numenius madagascariensis* eastern curlew (DOE, 2015a)
Calidris ferruginea	Curlew sandpiper	Critically endangered	Migratory	Marine	Critically endangered	Conservation Advice *Calidris ferruginea* curlew sandpiper (DOE, 2015b)
Calidris tenuirostris	Great knot	Critically endangered	Migratory	Marine	Critically endangered	Conservation Advice *Calidris tenuirostris* Great knot (Threatened Species Scientific Committee, 2016a)
Limosa lapponica menzbieri	Bar-tailed godwit (*menzbieri*)	Critically endangered	Migratory	Marine	Critically endangered	Conservation Advice *Limosa lapponica menzbieri* Bar-tailed godwit (northern Siberia). (Threatened Species Scientific Committee, 2016c)

Species Name	Common Name	*Environment Protection and Biodiversity Conservation Act 1999*			WA *Biodiversity Conservation Act 2016*	EPBC Act Part 13 Statutory Instrument
		Threatened Status	Migratory Status	Listed	Conservation Status	
Calidris canutus	Red knot	Endangered	Migratory	Marine	Endangered	Conservation Advice *Calidris canutus* Red knot (Threatened Species Scientific Committee, 2016b)
Charadrius mongolus	Lesser sand plover	Endangered	Migratory	Marine	Endangered	Conservation Advice *Charadrius mongolus* Lesser sand plover (Threatened Species Scientific Committee, 2016e)
Charadrius leschenaultii	Greater sand plover	Vulnerable	Migratory	Marine	Vulnerable	Conservation Advice *Charadrius leschenaultia* Greater sand plover (Threatened Species Scientific Committee, 2016d)
All migratory shorebird species	Wildlife Conservation Plan for Migratory Shorebirds (Commonwealth of Australia, 2015c).					

8.2 Seabirds in the NWMR

Seabirds are birds that are adapted to life within the marine environment (oceanic and coastal) and are generally long-lived, have delayed breeding and have fewer young than other bird species (Commonwealth of Australia, 2019). At least 34 seabird species listed as threatened, migratory and/or marine under the EPBC Act are known to occur regularly in the NWMR and include a variety of species of terns, noddies, petrels, shearwaters, frigatebirds, and boobies. Many of these species spend most of their lives at sea (predominately pelagic species), ranging over large distances to forage. These pelagic species only come onshore to breed and raise chicks at natal or high-fidelity breeding colonies on remote, offshore island locations in and adjacent to the NWMR. Many species are ecologically significant to the NWMR, as they are endemic to the region, can be present in large numbers in breeding seasons and non-breeding seasons, and many exhibit extensive annual migrations that include marine areas outside the Australian EEZ (DSEWPAC, 2012e).

The presence of seabirds within the NWMR is influenced by seabird species that migrate and forage in the area during the non-breeding season and this includes many seabird species that breed on the Houtman Abrolhos in the SWMR. Pelagic seabirds have been documented foraging at current boundaries and seasonal upwellings within the NWMR (refer to Sutton *et al*., 2019). The Houtman Abrolhos Islands National Park located in the SWMR, is one of the most significant seabird breeding locations in the eastern Indian Ocean. Sixteen (16) species of seabirds breed there. Eighty percent of common (brown) noddies, 40% of sooty terns and all the lesser noddies found in Australia nest at the Houtman Abrolhos (Surman, 2019). Important seabird areas in the NWMR are as identified by the KBAs (refer to **Section 8.1**) and the information on a select number of seabird species documented for the NWMR (based on the screening criteria presented in **Section 3**), as presented in **Table 8-2**.

Table 8-2 Information on threatened/migratory seabird species of the NWMR

Species	Key Information
Seabirds	
Southern giant petrel	This species is included in the National recovery plan for threatened albatrosses and giant petrels. Habitat critical to survival is defined for breeding and foraging. There are six known breeding localities under Australian jurisdiction (for all species giant petrels) and all are located in the Southern Ocean including islands off Tasmania and within the Australian Antarctic Territory (DSEWPAC, 2011c). Habitat critical to survival identified for foraging is defined as waters south of 25 degrees latitude. The giant petrel species distribution is mainly within the Southern Ocean but this species does migrate into subtropical waters during the winter and its distribution includes the southern extent of the NWMR. No BIAs for this species are located in the NWMR.
Abbott's booby	The Abbott's booby is a large, long-lived seabird known to nest only at Christmas Island. The recovery of this species is strongly dependent on the protection of breeding habitat defined habitat critical to the survival of this species on Christmas Island (Threatened Species Scientific Committee, 2020b). This species spends much of its time at sea and known to forage over large distances offshore when nesting and its range includes off the coast of Java, near the Chagos and in the Banda Sea, and may possibly extend into the north-western extent of the NWMR. No BIAs for this species are located in the NWMR.
Soft-plumaged petrel	This petrel species breeds only at two locations in Australian waters within the Southern Ocean (one off Tasmania and Macquarie Island) (Threatened Species Scientific Committee, 2015f). As a mainly sub-Antarctic species they are usually distributed in cooler seas but distribution extents into subtropical waters and its known distribution includes the southern extent of the NWMR. No BIAs for this species are located in the NWMR.
Australian fairy tern	The Australian fairy tern is listed as Vulnerable for the sub-species only recorded for WA. It has a coastal distribution from Sydney, south to Tasmania and around southern WA up to the Dampier Archipelago and out on the offshore island groups of Barrow, Montebello and the Lowendals (DSEWPAC, 2011d). The Australian fairy tern feeds on small baitfish and roosts and nests on sandy beaches below vegetation. These behaviours, generally, occur in inshore waters of island archipelagos and on the Australian mainland shores and adjacent wetlands. Fairy terns breed from August to February. The Australian fairy tern is unlikely to be present

Species	Key Information
	within the offshore environment of the NWMR. The largest breeding colony in Western Australia for this species is in the Houtman Abrolhos Islands, SWMR (Surman, 2019). For the description and location of BIAs in the NWMR, refer to **Table 8-3** and **Figure 8-2.**
Australian lesser noddy	The Houtman Abrolhos, WA is an important breeding habitat for the Australian lesser noddy in the eastern Indian Ocean. This species exhibits nesting habitat specialisation (white mangrove stands) and has a limited foraging range during the breeding season. Furthermore, the lesser noddy forages over shelf waters and appears not to disperse over their non-breeding period as they remain largely in the general vicinity or slightly to the south of the colony in the non-breeding season (February to September; Surman *et al*., 2018). No BIAs for this species are located in the NWMR.
Indian yellow-nosed albatross	This species is included in the National recovery plan for threatened albatrosses and giant petrels. Habitat critical to survival is defined for breeding and foraging. There are six known breeding localities under Australian jurisdiction (for all species of albatrosses) and all are located in the Southern Ocean including islands off Tasmania and within the Australian Antarctic Territory (DSEWPAC, 2011c). Habitat critical to survival identified for foraging is defined as waters south of 25 degrees latitude. All albatross species distribution (including the Indian yellow-nose albatross) is mainly within the Southern Ocean but this species does migrate into subtropical waters during the winter and its distribution includes the southern extent of the NWMR. No BIAs for this species are located in the NWMR.
Common noddy	This species is listed as migratory and marine. The common (or brown) noddy is the largest species of noddy found in Australian waters. The species is widespread in tropical and subtropical areas beyond Australia. This seabird species is gregarious and normally occurs in flocks, up to hundreds of individuals, when feeding or roosting. The Houtman Abrolhos, WA is the primary breeding habitat for the common noddy in the Eastern Indian Ocean. This species spends their non-breeding season (March to August) in the NWS area, around 950 km north from the breeding colony (Surman *et al*. 2018). The species occurs within NWMR waters, particularly around offshore islands such as the Montebello Island group. This species is recorded on unmanned oil and gas platforms within the NWS. No BIAs for this species are located in the NWMR.
Lesser frigatebird **Great frigatebird**	Both species of frigatebird are listed as migratory and marine. Within the NWMR, the lesser frigatebird is known to breed on Adele, Bedout and West Lacepede islands, Ashmore Reef and Cartier Island (Commonwealth of Australia, 2019). The lesser frigatebird feeds mostly on fish and sometimes cephalopods, and all food is taken while the bird is in flight. Lesser frigatebirds generally forage close to breeding colonies. Breeding/foraging BIAs for the lesser frigatebird are located in the NWMR; refer to **Table 8-3**.
Brown booby	The brown booby is the most common booby, occurring throughout all tropical oceans bounded by latitudes 30º N and 30º S. There are large colonies on offshore islands within the NWMR such as the Lacepede Islands (one of the largest colonies in the world), Ashmore Reef, and other offshore Kimberley islands. This seabird species is a specialised plunge diver, mostly eating fish and some cephalopods (Commonwealth of Australia, 2019). Breeding/foraging BIAs for the brown booby are located in the NWMR; refer to **Table 8-3** and **Figure 8-3**.
Red-footed booby	Within the NWMR, its known breeding sites for this species include Ashmore Reef and Cartier Island. It is a pelagic species and generally occurs away from land. It mainly eats flying fish and squid. Prey abundance is reliant on the high productivity in slope areas off remote islands where the birds breed (Commonwealth of Australia, 2019). Breeding/foraging BIAs for the red-footed booby are located in the NWMR; refer to **Table 8-3** and **Figure 8-3**.
Greater crested tern	The greater crested tern has a widespread distribution recorded on islands and coastlines of tropical and subtropical areas, ranging from the Atlantic coast of South Africa, Indian Ocean and through south-east Asia and Australia. Outside the breeding season it can be found at sea throughout its range, with the exception of the central Indian Ocean (Commonwealth of Australia, 2019). The largest breeding colony in WA for this species is the Houtman Abrolhos Islands, SWMR (Surman, 2019). No BIAs for this species are located in the NWMR.
Little tern	There are three sub-populations of this species in Australia and two of these occur in the NWMR: northern Australian breeding sub-population occurring around Broome and extending across in to the NMR, and an east Asian breeding sub-population, with the terns present from Shark Bay to south-eastern Queensland during the austral summer. Little terns

Species	Key Information
	usually forage close to breeding colonies in the shallow water of estuaries (Commonwealth of Australia, 2019). For the description and location of BIAs in the NWMR, refer to **Table 8-3** and **Figure 8-2**.
Roseate tern	This species is generally tropical in distribution and there are many breeding populations in the NWMR, including Ashmore Reef, Napier Broome Bay, Bonaparte Archipelago, Lacepede Islands, Dampier Archipelago and the Lowendal Islands. A large number of non-breeding roseate terns have been observed at several remote locations in the Kimberley and there are high numbers also recorded for Eighty Mile Beach Ramsar site. The Kimberley colonies are likely to be another sub-species that breeds in east Asia. Roseate terns predominately eat small pelagic fish (Commonwealth of Australia, 2019). The largest breeding colony in Western Australia for this species is in the Houtman Abrolhos Islands, SWMR (Surman, 2019). For the description and location of BIAs in the NWMR, refer to **Table 8-3** and **Figure 8-2**.
Wedge-tailed shearwater	The wedge-tailed shearwater is a pelagic, marine seabird known from tropical and subtropical waters. Its distribution is widespread across the Indian and Pacific oceans. It is known to breed on the east and west coasts (and offshore islands) of Australia. This species is known to consume fish, cephalopods, and other biota primarily via contact-dipping. Wedge-tailed shearwaters are now understood to undertake extensive foraging trips (over thousands of kilometres over periods of days when chicking and provisioning young) and much longer and extensive pelagic travels over the north-west Indian Ocean during the non-breeding season, targeting current boundaries and upwellings. The species breeds throughout its range, mainly on vegetated islands, atolls and cays and excavates burrows in the ground where chicks are raised (Commonwealth of Australia, 2019). Large breeding colonies of the wedge-tailed shearwater are located on the Houtman Abrolhos islands (SWMR) (Surman *et al*., 2018) and several locations in the NWMR including: Muiron Islands (North-west Cape), Varanus Island and the Dampier Archipelago in the Pilbara where burrow numbers were estimated to several hundred thousand to half a million such as on the Muiron Islands, though it is not known if all burrows are utilised on an annual basis (Birdlife Australia, 2018; Surman *et al.*, 2018). Cannell *et al* (2019) satellite tracked adult wedge-tailed shearwaters during egg incubation and chick rearing on the Muiron Islands in January 2018. For the incubation trips, there was a strong consistency for the birds to travel towards seamounts, typically located north-west of the Muiron Islands, between Australia and Indonesia. One bird however remained south-west of the islands, in the Cape Range Canyon. A similar pattern to utilise areas associated with sea mounts was also observed for the long foraging trips during chick rearing, though some of the foraging was concentrated in deeper waters. A bimodal foraging strategy during chick-rearing was observed, with adults undertaking long foraging trips after a series of shorter foraging trips within the NWMR. Surman *et al*. (2018) reported most wedge-tailed shearwaters from the breeding colonies on the Houtman Abrolhos undertook extensive non-breeding migrations. This seabird species occupied waters adjacent or to the north of their nesting sites or migrated 4200 km north-west into the equatorial central Indian Ocean near the Ninety East Ridge during the non-breeding season (later April to mid-November). For the description and location of BIAs in the NWMR, refer to **Table 8-3** and **Figure 8-1**.
Flesh-footed shearwater	The species mainly occurs in the subtropics, over continental shelves and slopes and occasionally inshore waters, with individual birds pass through the tropics and over deeper waters during migration to the North Pacific and Indian oceans (Commonwealth of Australia, 2019). They are a common visitor to the waters off southern Australia, from south-western WA to south-eastern Queensland. The fleshy-footed shearwater is a trans-equatorial migrant, breeding from late September to May off south-western Australia, and migrating north by early May, across the southern Indian and possibly Indonesia to the northern Pacific Ocean. No BIAs for the flesh-footed shearwater are located in the NWMR.
Streaked shearwater	The streaked shearwater has a broad distribution in the western Pacific Ocean, breeding on the coast and offshore islands of Japan, Russia, China and the Korean Peninsula. During winter months (non-breeding season), the species undertakes trans-equatorial migration to the coasts of Vietnam, New Guinea, the Philippines, Australia, southern India and Sri Lanka. The streaked shearwater feeds mainly on fish and squid that it catches by surface-seizing and shallow plunges (Commonwealth of Australia, 2019). No BIAs for the streaked shearwater are located in the NWMR.
White-tailed tropicbird	Tropicbirds are predominately pelagic species and the white-tailed tropicbird forages in warm waters and over long distances (pan-tropical). The species is most common off north-west Australia. In the NWMR, this species is considered a sub-species and are limited in number and distribution. Nesting sites are known for Clerke Reef (Rowley Shoals) and Ashmore

Species	Key Information
	Reef. Christmas Island is also a known nesting site and the species can disperse several thousand kilometres during foraging trips. This species feeds mainly on fish and cephalopods, captured by deep plunge diving (Commonwealth of Australia, 2019). There are breeding BIAs at the Rowley Shoals and Ashmore Reef within the NWMR for the white-tailed tropicbird; refer to **Table 8-3**.
Silver gull	The silver gull is typically described as an inshore and coastal foraging seabird and has an Australian-wide distribution including locations within the NWMR. It is noted as it has been recorded on unmanned oil and gas platforms located within the NWS.

8.2.1 Biologically Important Areas in the NWMR

BIAs representing important life cycle stages and behaviours for eight species of seabird in the NWMR are presented in **Table 8-3**.

Table 8-3 Seabird BIAs within the NWMR

Seabird Species	Woodside Activity Area			BIAs			
	Browse	NWS/S	NWC	Breeding/foraging	Foraging	Breeding	Resting
Australia fairy tern	-	✓	✓	-	No foraging BIAs in the NWMR Foraging in high numbers: the BIA is located in the SWMR including the Houtman Abrolhos Islands	Dampier Archipelago, Montebello, Lowendal and Barrow Island Groups, south Ningaloo and barrier island of Shark Bay	-
Wedge-tailed shearwater	✓	✓	✓	Widespread area of the NWMR offshore and inshore waters	Foraging in high numbers: the BIA is located in the SWMR including the Houtman Abrolhos Islands	-	-
Great frigatebird	✓	-	-	Ashmore Reef, Adele Island	-	-	-
Lesser frigatebird	✓	✓	-	Off Eighty Mile Beach, Lacepedes, Adele Island, North Kimberley and Ashmore Reef	-	-	-
Brown booby	✓	✓	-	Off Eighty Mile Beach, Lacepedes, Adele Island, North Kimberley and Ashmore Reef	-	-	-
Red-footed booby	✓	-	-	Adele Island, Ashmore Reef	-	-	-
Little tern	✓	✓	-	Rowley Shoals, Adele Island	-	-	-
Roseate tern	✓	✓	✓	-	No foraging BIAs in the NWMR Foraging (provisioning young) and foraging BIAs located in the SWMR – Houtman Abrolhos Islands the	Dampier Archipelago, Montebello, Lowendal and Barrow Island Groups, south Ningaloo and barrier island of Shark Bay	Eighty Mile Beach

Seabird Species	Woodside Activity Area			BIAs			
	Browse	NWS/S	NWC	Breeding/foraging	Foraging	Breeding	Resting
					nearest BIA to the NWMR		
White-tailed tropicbird	✓	-	-			Rowley Shoals Ashmore Reef	

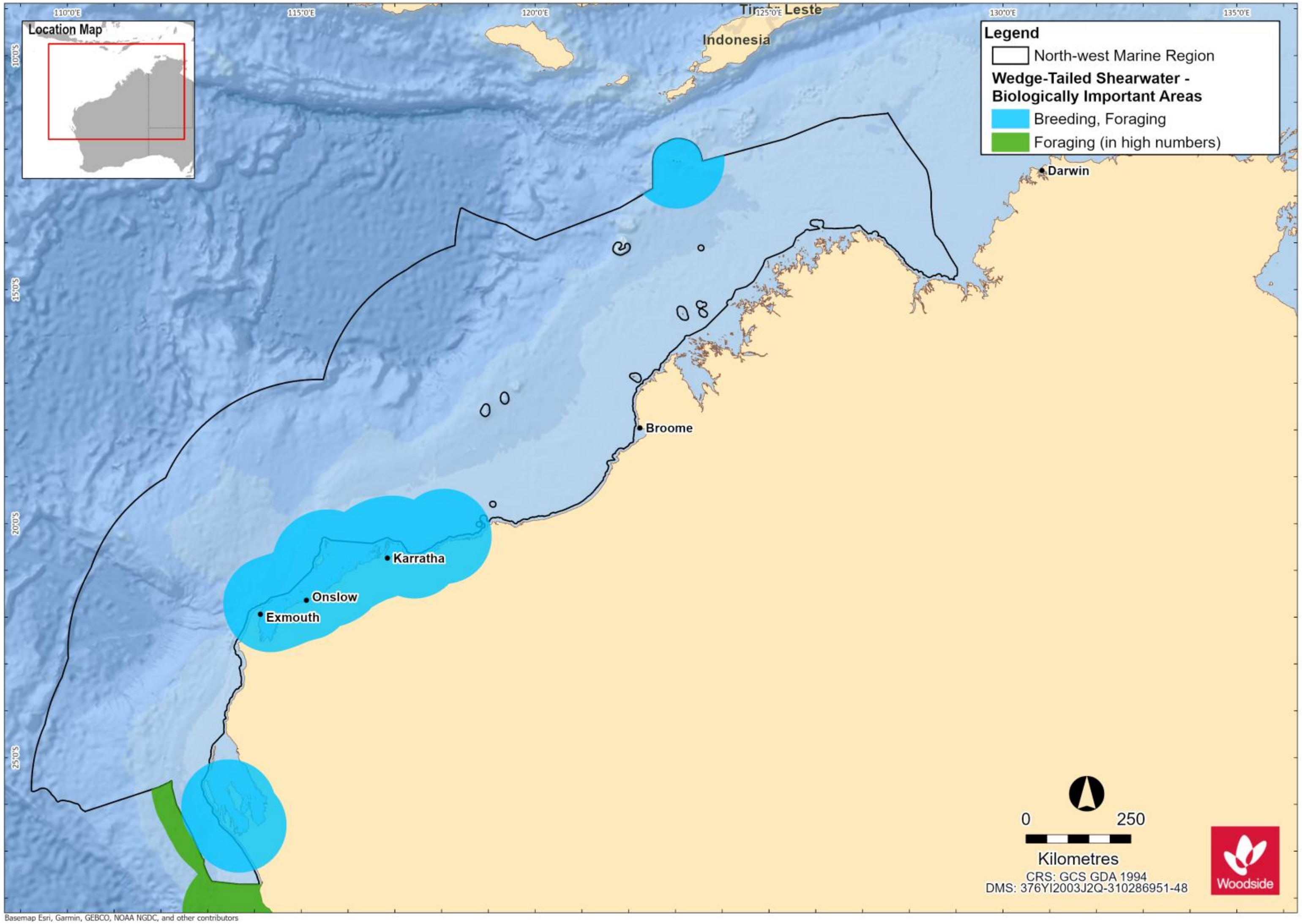

Figure 8-1 Wedge-tailed shearwater BIAs for the NWMR

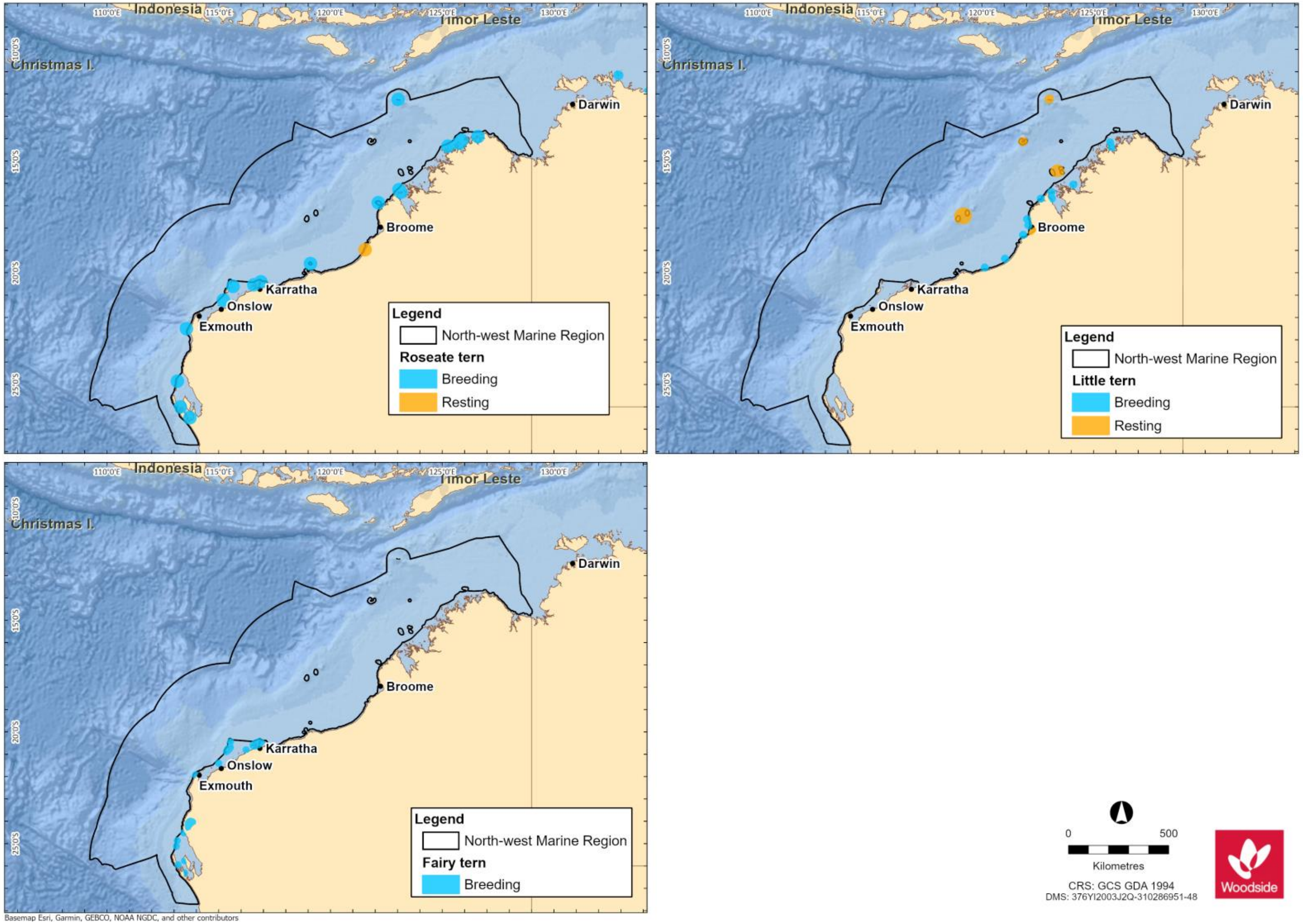

Figure 8-2 Tern species BIAs for the NWMR

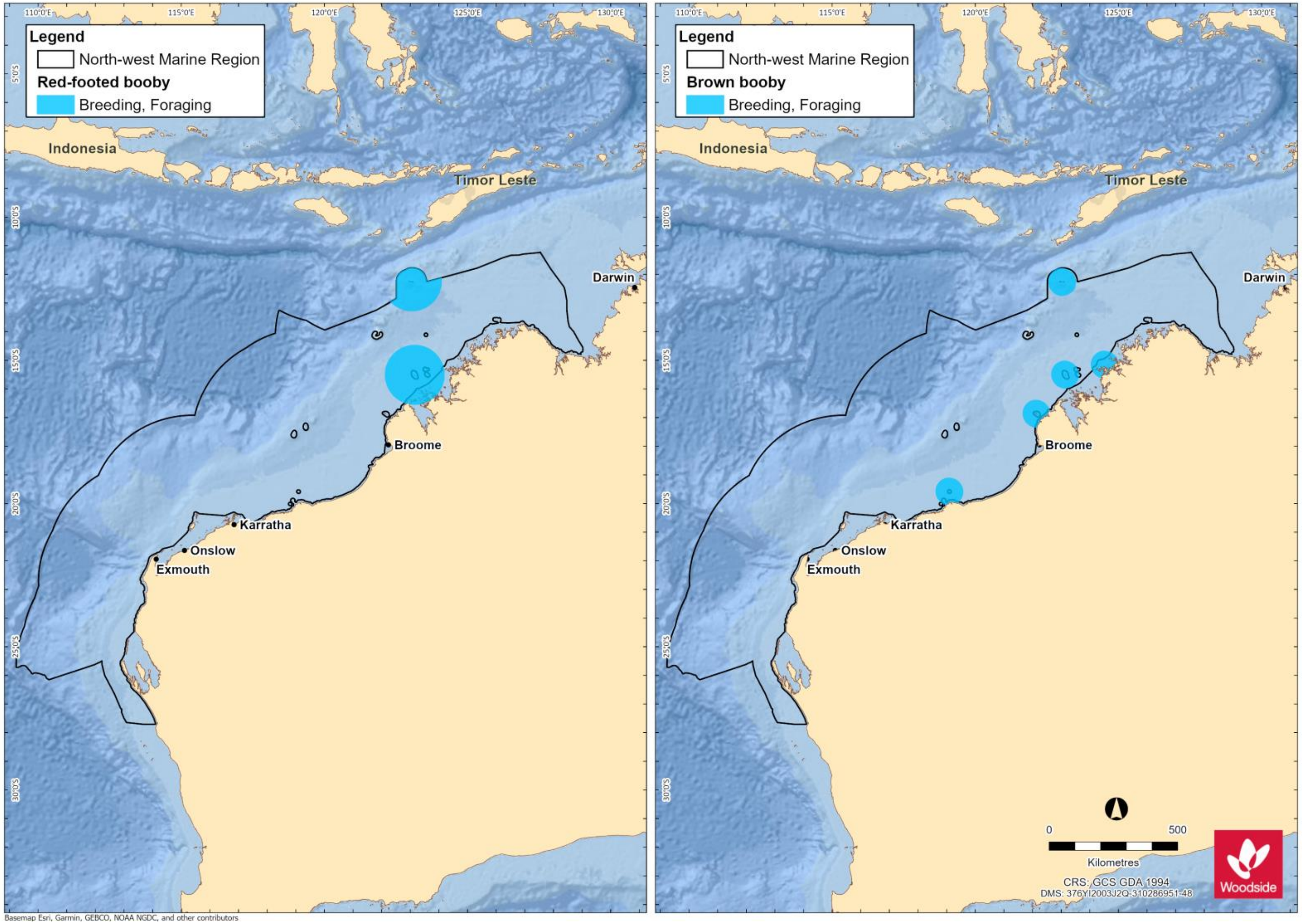

Figure 8-3 Red-footed and brown booby BIAs for the NWMR

8.2.2 Seabird Summary for NWMR

8.2.2.1 Browse

The Browse activity area includes biologically important habitat for seven threatened and/or migratory seabird species:

- wedge-tailed shearwater (breeding/foraging);
- great and lesser frigatebirds (breeding/foraging);
- brown booby (breeding/foraging);
- red-footed booby (breeding/foraging);
- little tern (breeding/foraging);
- roseate tern (breeding and resting); and,
- white-tailed tropicbird (breeding).

BIAs for the seabird species are outlined in **Table 8-3**.

8.2.2.2 NWS / Scarborough

The NWS / Scarborough activity area includes biologically important habitat for five threatened and/or migratory seabird species:

- wedge-tailed shearwater (breeding/foraging);
- lesser frigatebird (breeding/foraging);
- brown booby (breeding/foraging);
- little tern (breeding/foraging); and
- roseate tern (breeding and resting).

BIAs for the seabird species are outlined in **Table 8-3**.

8.2.2.3 North-west Cape

The North-west Cape activity area includes biologically important habitat for five threatened and/or migratory seabird species:

- Australian fairy tern (breeding);
- wedge-tailed shearwater (breeding/foraging); and
- roseate tern (breeding and resting).

BIAs for the seabird species are outlined in **Table 8-3**.

8.3 Shorebirds

Shorebirds (migratory and resident species) are generally associated with wetland or coastal environments, and the NWMR hosts a large number of many shorebird species, particularly in the Austral summer (refer to **Appendix A** for the EPBC Act PMST reports on listed species of shorebirds). Shorebirds may use coastal environments for feeding, nesting or migratory stopovers. In coastal environments, shorebirds generally feed during low tide on exposed intertidal mud and sand flats, and roost in suitable habitat above the high water mark. Many shorebird species undergo annual migrations, typically breeding at high latitudes of the Northern Hemisphere and migrating south for the non-breeding season and Australia is part of the East Asian-Australasian Flyway (EAAF). The EAAF extends from breeding grounds in the Russian tundra, Mongolia and Alaska southwards through east and south-east Asia, to non-breeding areas of Indonesia, Papua New Guinea, Australia and New Zealand (Weller and Lee, 2017). The EAAF is of most relevance to the NWMR. There are 37 species of shorebird which annually migrate to Australia via the EAAF and 36 of these species spend the austral summer (non-breeding season) foraging and roosting in coastal and wetland habitats (Commonwealth of Australia, 2015c; Weller and Lee, 2017).

Ashmore Reef is documented as a BIA for migratory shorebirds in the NWMR (DSEWPAC, 2012a).

Table 8-4. Information on threatened/migratory shorebird species of the NWMR

Species	Key Information
	Shorebirds
Eastern curlew, Far eastern curlew	This species is the largest, migratory shorebird in the world, with a long neck, long legs and a very long downcurved bill and is a long-haul flyer. The eastern curlew is a coastal species with a continuous distribution north from Barrow Island to the Kimberley region. The species is endemic to the EAAF and is a non-breeding visitor to Australia from August to March, primarily foraging on crabs and molluscs in intertidal mudflats. During the non-breeding season in Australia, this species is most associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass (DOE, 2015a).
Curlew sandpiper	The curlew sandpiper breeds in northern Siberia but has a non-breeding range that extends from western Africa to Australia, with small numbers reaching New Zealand (Bamford *et al*., 2008). In Australia, curlew sandpipers occur around the coasts and are also quite widespread inland, though in smaller numbers. Records occur in all states and the NT during the non-breeding period, and also during the breeding season when many non-breeding one-year old birds remain in Australia rather than migrating north along the EAAF. The species preferred habitat for foraging is mudflats and nearby shallow waters in sheltered coastal areas such as estuaries, bay, inlets and lagoons (DOE, 2015b).
Great knot	The great knot breeds in the Northern Hemisphere and undertakes biannual migrations along the EAAF to non-breeding habitat in Australia. The great knot winters in Australia and has been recorded around the entirety of the Australian coast the greatest numbers are found in northern Western Australia (Pilbara (Dampier Archipelago) and Kimberley and the Northern Territory. In Australia, this species prefers sheltered, coastal habitat with large intertidal mudflats or sandflats (inkling inlets, bays, harbours, estuaries and lagoons). High numbers (exceeding several thousand birds are regularly recorded from Roebuck Bay. The great knot feeds on a variety of invertebrates by pecking at or just below the surface of moist mud or sand (Threatened Species Scientific Committee, 2016a).
Bar-tailed godwit (*menzbieri*)	The bar-tailed godwit is a large, migratory shorebird and there are two sub-species in the EAAF (*Limosa lapponica baueri* and *L. l. menzbieri*). The sub-species *L. l. menzbieri* breeds in northern Siberia and spends its non-breeding period mostly in the north of WA but also in South-east Asia. The bar-tailed godwit (*menzbieri*) usually forages near the water in shallow water, mainly in tidal estuaries and harbours with a preference for exposed sandy or soft mud substrates on intertidal flats, banks and beaches (Threatened Species Scientific Committee, 2016c).
Red knot (*piersmai*)	This species is a small to medium migratory shorebird. There are two sub-species that cannot be distinguished from each other in nonbreeding plumage, however, *Calidris canutus piersmai* tend to overwinter almost exclusively in north-west Australia. The red knot migrates long distances from breeding grounds in high northern latitudes, where it breeds during the boreal summer, to the Southern Hemisphere during the austral summer with migration along the EAAF. Very large numbers are recorded for the north-west Australia and is common in all suitable habitats around the coast, including inland clay pans near Roebuck Bay (where the species roosts). The red knot usually forages in soft substrate along the waters edge on intertidal mudflats, sandflats and sandy beaches of sheltered coasts (Threatened Species Scientific Committee, 2016b).
Lesser sand plover	The lesser sand plover is a small to medium shorebird and one of 36 migratory shorebirds that breed in the Northern Hemisphere during the boreal summer and are known to annually migrate to the non-breeding grounds of Australia along the EAAF for the austral summer. There are five different sub-species and it is most likely the non-breeding ranges of the sub-species *Charadrius m. mongolus* overlaps with the NWMR. This species is widespread in coastal regions, preferring sandy beaches, mudflats of coastal bays and estuaries (Threatened Species Scientific Committee, 2016e).
Greater sand plover	The greater sand plover is a small to medium shorebird and in its non-breeding plumage is difficult to distinguish from the lesser sand plover. This species breeds in the Northern

Species	Key Information
	Hemisphere and undertakes annual migrations to and from Southern Hemisphere feeding grounds in the austral summer along the EAAF. The species distribution in Australia during the non-breeding season is widespread, in WA the greater sand plover is widespread between Northwest Cape and Roebuck Bay (Threatened Species Scientific Committee, 2016d).

9. KEY ECOLOGICAL FEATURES

Key ecological features (KEFs) are elements of the Commonwealth marine environment that are considered to be important for a marine region's biodiversity or ecosystem function and integrity. KEFs have been identified by the Australian Government based on advice from scientists about the ecological processes and characteristics of the area.

KEFs meet one or more of the following criteria:

- a species, group of species, or a community with a regionally important ecological role (e.g. a predator, prey that affects a large biomass or number of other marine species),
- a species, group of species or a community that is nationally or regionally important for biodiversity,
- an area or habitat that is nationally or regionally important for:
  - enhanced or high productivity (such as predictable upwellings – an upwelling occurs when cold nutrient-rich waters from the bottom of the ocean rise to the surface),
  - aggregations of marine life (such as feeding, resting, breeding or nursery areas), or
  - biodiversity and endemism (species which only occur in a specific area),
- a unique seafloor feature, with known or presumed ecological properties of regional significance.

Thirteen KEFs are designated within the NWMR, twelve KEFs within the SWMR and eight KEFs within the NMR. These KEFs have been identified in the Protected Matters search (**Appendix A**) and outlined in **Table 9-1, Table 9-2** and **Table 9-3,** and **Figure 9-1, Figure 9-2** and **Figure 9-3**.

Table 9-1 Key Ecological Features (KEF) within the NWMR

KEF Name	Woodside Activity Area			Values[1]	Description
	Browse	NWS/S	NW Cape		
Carbonate bank and terrace system of the Sahul Shelf	✓	-	-	Unique seafloor feature with ecological properties of regional significance 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	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 NMR. The bank and terrace system of the Van Diemen Rise covers approximately 31,278 km^2 and forms part of the larger system associated with the Sahul Banks to the north and Londonderry Rise to the east. The feature is characterised by terrace, banks, channels and valleys (DSEWPAC, 2012c). The banks, ridges and terraces of the Van Diemen Rise are raised geomorphic features with relatively high proportions of hard substrate that support sponge and octocoral gardens. These, in turn, provide habitat to other epifauna, by providing structure in an otherwise flat environment (Przeslawski *et al.*, 2011). Plains and valleys are characterised by scattered epifauna and infauna that include polychaetes and ascidians. These epibenthic communities support higher order species such as olive ridley turtles, sea snakes and sharks (DSEWPAC, 2012c)
Pinnacles of the Bonaparte Basin	✓	-	-	Unique seafloor feature with ecological properties of regional significance Provide areas of hard substrate in an otherwise soft sediment environment and so are important for sessile species Recognised as a biodiversity hotspot for sponges The Pinnacles of the Bonaparte Basin KEF is located within both the NWMR and NMR (refer **Table 9-3**)	The Pinnacles of the Bonaparte Basin provide areas of hard substrate in an otherwise relatively featureless environment, the pinnacles are likely to support a high number of species, although a better understanding of the species richness and diversity associated with these structures is required (DSEWPAC, 2012a, 2012c). Covering >520 km^2 within the Bonaparte Basin, this feature contains the largest concentration of pinnacles along the Australian margin. The Pinnacles of the Bonaparte Basin are thought to be the eroded remnants of underlying strata; it is likely that the vertical walls generate local upwelling of nutrient-rich water, leading to phytoplankton productivity that attracts aggregations of planktivorous and predatory fish, seabirds, and foraging turtles (DSEWPAC, 2012a, 2012c).
Ashmore Reef and Cartier Island and surrounding Commonwealth waters	✓	-	-	High productivity, biodiversity and aggregation of marine life that apply to both the benthic and pelagic habitats within the feature	Ashmore Reef is the largest of only three emergent oceanic reefs present in the north-eastern Indian Ocean and is the only oceanic reef in the region with vegetated islands. 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

KEF Name	Woodside Activity Area			Values[1]	Description
	Browse	NWS/S	NW Cape		
					surrounding waters. Rising from a depth of more than 100 m, the reef platform is at the edge of the NWS and covers an area of 239 km². Ashmore Reef and Cartier Island and the surrounding Commonwealth waters are regionally important for feeding and breeding aggregations of birds and other marine life; they are areas of enhanced primary productivity in an otherwise low-nutrient environment (DSEWPAC, 2012a). Ashmore Reef supports the highest number of coral species of any reef off the WA coast.
Seringapatam Reef and the Commonwealth waters in the Scott Reef complex	✓	-	-	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 within the feature	Seringapatam Reef and the 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 north-west, they provide an important biophysical environment in the region (DSEWPAC, 2012a).
Continental slope demersal fish communities	✓	✓	✓	High biodiversity of demersal fish assemblages, including high levels of endemism	The diversity of demersal fish assemblages on the continental slope in the Timor Province, the Northwest Transition and the North-west Province is high compared to elsewhere along the Australian continental slope (DSEWPAC, 2012a). The continental slope between North-west Cape and the Montebello Trough has more than 500 fish species, 76 of which are endemic, which makes it the most diverse slope bioregion in Australia (Last *et al.*, 2005). The slope of the Timor Province and the Northwest Transition also contains more than 500 species of demersal fishes of which 64 are considered endemic (Last *et al.*, 2005), making it the second richest area for demersal fishes throughout the whole continental slope. Demersal fish species occupy two distinct demersal biomes associated with the upper slope (225–500 m water depths) and the mid-slope (750–1000 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 fishes, molluscs and crustaceans (Brewer *et al.*, 2007). Higher-order consumers may include carnivorous fishes, deepwater sharks, large squid, and toothed whales (Brewer *et al.*, 2007). Pelagic production is phytoplankton-based, with hot spots around oceanic reefs and islands (Brewer *et al.*, 2007).

KEF Name	Woodside Activity Area			Values[1]	Description
	Browse	NWS/S	NW Cape		
Ancient coastline at 125 m depth contour	✓	✓	✓	Unique seafloor feature with ecological properties of regional significance 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	Several steps and terraces as a result of Holocene sea level changes occur in the region, with the most prominent of these features occurring as an escarpment along the NWMR and Sahul Shelf at a water depth of 125 m. The Ancient Coastline is not continuous throughout the NWMR and coincides with a well-documented eustatic stillstand at about 130 m worldwide (Falkner *et al.*, 2009). Where the Ancient Coastline provides areas of hard substrate, it may contribute to higher diversity and enhanced species richness relative to soft sediment habitat (Falkner *et al.*, 2009). Parts of the Ancient Coastline, represented as rocky escarpment, are considered to provide biologically important habitat in an area predominantly made up of soft sediment. The escarpment type features may also potentially facilitate mixing within the water column due to upwelling, providing a nutrient-rich environment. Although the Ancient Coastline adds additional habitat types to a representative system, the habitat types are not unique to the coastline as they are widespread on the upper shelf (Falkner *et al.*, 2009)
Canyons linking the Argo Abyssal Plain and Scott Plateau	-	✓	-	Facilitates nutrient upwelling, creating enhanced productivity and encouraging diverse aggregations of marine life	Interactions with the Leeuwin Current and strong internal tides are thought to result in upwelling at the canyon heads, thus creating conditions for enhanced productivity in the region (Brewer *et al.*, 2007). As a result, aggregations of whale sharks, manta rays, humpback whales, sea snakes, sharks, predatory fishes and seabirds are known to occur in the area due to its enhanced productivity (Sleeman *et al.*, 2007).
Glomar Shoal	-	✓	-	An area of high productivity and aggregations of marine life including commercial and recreational fish species	Glomar Shoal is a submerged littoral feature located about 150 km north of Dampier on the Rowley shelf at depths of 33–77 m (Falkner *et al.*, 2009). Studies by Abdul Wahab *et al.* (2018) found a number of hard coral and sponge species in water depths less than 40 m. One hundred and seventy (170) different species of fishes were detected with greatest species richness and abundance in shallow habitats (Abdul Wahab *et al.*, 2018). Fish species present include a number of commercial and recreational species such as Rankin cod, brown striped snapper, red emperor, crimson snapper, bream and yellow-spotted triggerfish (Falkner *et al.*, 2009; Fletcher and Santoro, 2009). These species have recorded high catch rates associated with Glomar Shoal, indicating that the shoal is likely to be an area of high productivity.

KEF Name	Woodside Activity Area			Values[1]	Description
	Browse	NWS/S	NW Cape		
Mermaid Reef and Commonwealth waters surrounding Rowley Shoals	-	✓	-	Regionally important in supporting high species richness, higher productivity and aggregations of marine life	The Mermaid Reef and Commonwealth waters surrounding the Rowley Shoals KEF and is adjacent to the three nautical mile State waters limit surrounding Clerke and Imperieuse reefs, and include the Mermaid Reef Marine Park as described in **Section 10**. The reefs provide a distinctive biophysical environment in the region. They have steep and distinct reef slopes and associated fish communities. 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. Both coral communities and fish assemblages differ from similar habitats in eastern Australia (Done *et al.*, 1994).
Exmouth Plateau	-	✓	✓	Unique seafloor feature with ecological properties of regional significance, which apply to both benthic and pelagic habitats Likely to be an important area of biodiversity as it provides an extended area offshore for communities adapted to depths of approximately 1000 m	The Exmouth Plateau is a large, mid-slope, continental margin plateau that lies off the northwest coast of Australia. It ranges in depth from about 500 to more than 5000 m and is a major structural element of the Carnarvon Basin (Miyazaki and Stagg, 2013). The large size of the Exmouth Plateau and its expansive surface may modify deep water flow and be associated with the generation of internal tides; both of which may subsequently contribute to the upwelling of deeper, nutrient-rich waters closer to the surface (Brewer *et al.*, 2007). Satellite observations suggest that productivity is enhanced along the northern and southern boundaries of the plateau (Brewer *et al.*, 2007). Sediments on the plateau suggest that biological communities include scavengers, benthic filter feeders and epifauna (DSEWPAC, 2012a). Fauna in the pelagic waters above the plateau are likely to include small pelagic species and nekton attracted to seasonal upwellings, as well as larger predators such as billfishes, sharks and dolphins (Brewer *et al.*, 2007). Protected and migratory species are also known to pass through the region, including whale sharks and cetaceans.
Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	-	-	✓	Unique seafloor feature with ecological properties of regional significance The feature is an area of moderately enhanced productivity, attracting aggregations of fish and higher-order consumers such as large predatory	The canyons are associated with upwelling as they channel deep water from the Cuvier Abyssal Plain up onto the slope. This nutrient-rich water interacts with the Leeuwin Current at the canyon heads (DSEWPAC, 2012a). Aggregations of whale sharks, manta rays, sea snakes, sharks, large predatory fish, and seabirds are known to occur in this area.

KEF Name	Woodside Activity Area			Values[1]	Description
	Browse	NWS/S	NW Cape		
				fish, sharks, toothed whales and dolphins Likely to be important due to their historical association with sperm whale aggregations	
Commonwealth waters adjacent to Ningaloo Reef	-	-	✓	High productivity and diverse aggregations of marine life 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, globally significant as the only extensive coral reef in the world that fringes the west coast of a continent	The Leeuwin and Ningaloo currents interact, leading to areas of enhanced productivity in the Commonwealth waters adjacent to Ningaloo Reef. Aggregations of whale sharks, manta rays, humpback whales, sea snakes, sharks, large predatory fish, and seabirds are known to occur in this area (DSEWPAC, 2012a). The spatial boundary of this KEF, as defined in the NCVA, is defined as the waters contained in the existing Ningaloo AMP provided in **Section 10**.
Wallaby Saddle	-	-	✓	High productivity and aggregations of marine life: Representing almost the entire area of this type of geomorphic feature in the NWMR. It is a unique habitat that neither occurs anywhere else nearby (within hundreds of kilometres) nor with as large an area (Falkner *et al.* 2009)	The Wallaby Saddle may be an area of enhanced productivity. Historical whaling records provide evidence of sperm whale aggregations in the area of the Wallaby Saddle, possibly due to the enhanced productivity of the area and aggregations of baitfish (DSEWPAC, 2012a).

[1.] Values description sourced from Marine bioregional plan for the North-west Marine Region (DSEWPAC, 2012a) and the Department of Agriculture, Water and the Environment (DAWE) SPRAT database.

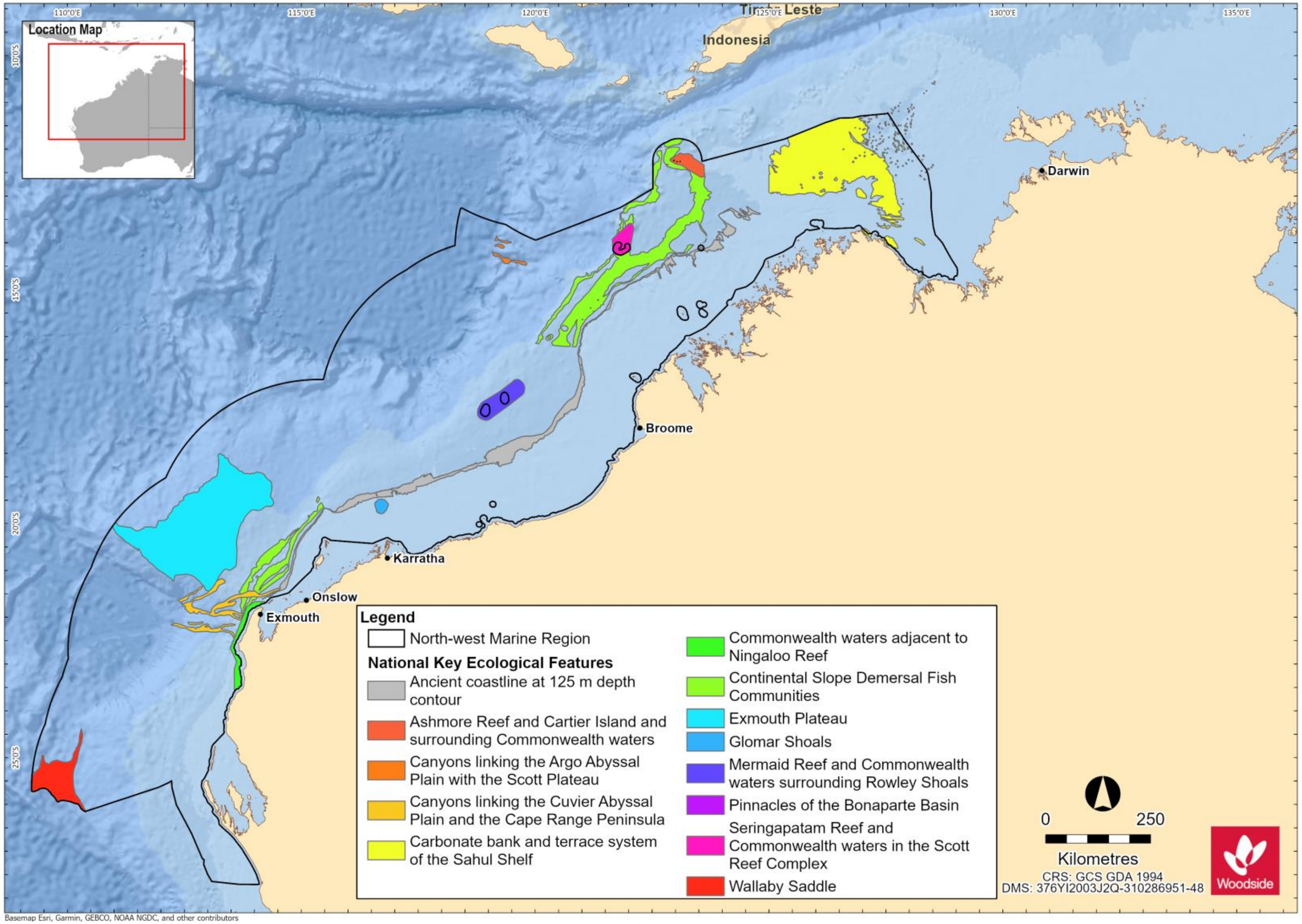

Figure 9-1 Key Ecological Features (KEFs) within the NWMR.

Table 9-2 Key Ecological Features (KEF) within the SWMR

KEF Name	Values[1]	Description
Albany Canyons group and adjacent shelf break	High productivity and aggregations of marine life, and unique seafloor feature with ecological properties of regional significance Both benthic and demersal habitats within the feature are of conservation value	The Albany Canyons group is thought to be associated with small, periodic subsurface upwelling events, which may drive localised regions of high productivity. The canyons are known to be a feeding area for sperm whale and sites of orange roughy aggregations. Anecdotal evidence also indicates that this area supports fish aggregations that attract large predatory fish and sharks.
Ancient coastline at 90-120 m depth	Relatively high productivity and aggregations of marine life, and high levels of biodiversity and endemism The feature creates topographic complexity, that may facilitate benthic biodiversity and enhanced biological productivity	Benthic biodiversity and productivity occur where the ancient coastline forms a prominent escarpment, such as in the western Great Australian Bight, where the sea floor is dominated by sponge communities of significant biodiversity and structural complexity.
Cape Mentelle upwelling	Facilitates nutrient upwelling, supporting high productivity and diverse aggregations of marine life	The Cape Mentelle upwelling draws relatively nutrient-rich water from the base of the Leeuwin Current, up the continental slope and onto the inner continental shelf, where it results in phytoplankton blooms at the surface. The phytoplankton blooms provide the basis for an extended food chain characterised by feeding aggregations of small pelagic fish, larger predatory fish, seabirds, dolphins and sharks.
Commonwealth marine environment surrounding the Houtman Abrolhos Islands (and adjacent shelf break)	High levels of biodiversity and endemism within benthic and pelagic habitats	The Houtman Abrolhos Islands and surrounding reefs support a unique mix of temperate and tropical species, resulting from the southward transport of species by the Leeuwin Current over thousands of years. The Houtman Abrolhos Islands are the largest seabird breeding station in the eastern Indian Ocean. They support more than one million pairs of breeding seabirds.

KEF Name	Values[1]	Description
Commonwealth marine environment surrounding the Recherche Archipelago	Aggregations of marine life and high levels of biodiversity and endemism within benthic and demersal communities	The Recherche Archipelago is the most extensive area of reef in the SWMR. Its reef and seagrass habitat supports a high species diversity of warm temperate species, including 263 known species of fish, 347 known species of molluscs, 300 known species of sponges, and 242 known species of macroalgae. The islands also provide haul-out (resting areas) and breeding sites for Australian sea lions and New Zealand fur seals.
Commonwealth marine environment within and adjacent to the west-coast inshore lagoons	High productivity and aggregations of marine life within benthic and pelagic habitats Important for benthic productivity and recruitment for a range of marine species	These lagoons are important for benthic productivity, including macroalgae and seagrass communities, and breeding and nursery aggregations for many temperate and tropical marine species. They are important areas for the recruitment of commercially and recreationally important fish species. Extensive schools of migratory fish visit the area annually, including herring, garfish, tailor and Australian salmon.
Commonwealth marine environment within and adjacent to Geographe Bay	High productivity and aggregations of marine life, and high levels of biodiversity, recruitment within benthic and pelagic communities	Geographe Bay is known for its extensive beds of tropical and temperate seagrass that support a diversity of species, many of them not found anywhere else. The bay provides important nursery habitat for many species. 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). It is also an important resting area for migratory humpback whales.
Diamantina Fracture Zone	Unique seafloor feature with ecological properties of regional significance which apply to its benthic and demersal habitats	The Diamantina Fracture Zone is a rugged, deep- water environment of seamounts and numerous closely spaced troughs and ridges. Very little is known about the ecology of this remote, deep- water feature, but marine experts suggest that its size and physical complexity mean that it is likely to support deep-water communities characterised by high species diversity, with many species found nowhere else.
Naturaliste Plateau	Unique seafloor feature with ecological properties of regional significance including high species diversity and endemism which apply to its benthic and demersal habitats	The Naturaliste Plateau is Australia's deepest temperate marginal plateau. The combination of its structural complexity, mixed water dynamics and relative isolation indicate that it supports deep- water communities with high species diversity and endemism.
Perth Canyon and adjacent shelf break, and other west-coast canyons	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	The Perth Canyon is the largest known undersea canyon in Australian waters. Deep ocean currents rise to the surface, creating a nutrient-rich cold- water habitat attracting feeding aggregations of deep-diving mammals, such as pygmy blue whales and large predatory fish that feed on aggregations of small fish, krill and squid.

KEF Name	Values[1]	Description
Western demersal slope and associated fish communities of the Central Western Province	Provides important habitat for demersal fish communities and supports species groups that are nationally or regionally important to biodiversity	The western demersal slope provides important habitat for demersal fish communities, with a high level of diversity and endemism. A diverse assemblage of demersal fish species below a depth of 400 m is dominated by relatively small benthic species such as grenadiers, dogfish and cucumber fish. Unlike other slope fish communities in Australia, many of these species display unique physical adaptations to feed on the sea floor (such as a mouth position adapted to bottom feeding), and many do not appear to migrate vertically in their daily feeding habits.
Western rock lobster	A species that plays a regionally important ecological role	This species is the dominant large benthic invertebrate in the region. The lobster plays an important trophic role in many of the inshore ecosystems of the SWMR. Western rock lobsters are an important part of the food web on the inner shelf, particularly as juveniles.

[1.] *Values description sourced from Marine bioregional plan for the South-west Marine Region (DSEWPAC, 2012b) and the Department of Agriculture, Water and the Environment (DAWE) SPRAT database*

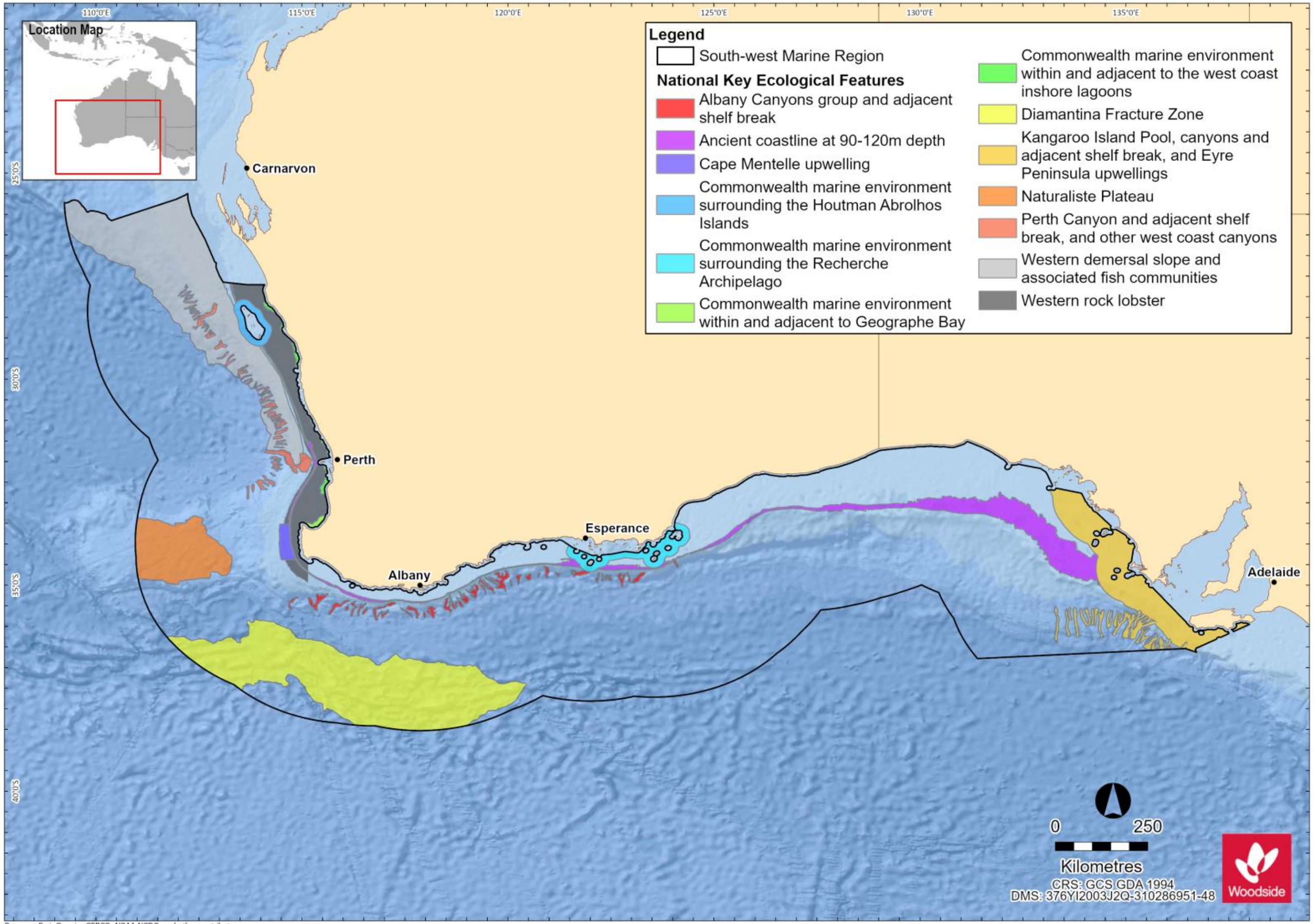

Figure 9-2. Key Ecological Features (KEFs) within the SWMR

Table 9-3 Key Ecological Features (KEF) within the NMR

KEF Name	Values[1]	Description
Carbonate bank and terrace system of the Van Diemen Rise	Important for its role in enhancing biodiversity and local productivity relative to its surrounds and for supporting relatively high species diversity The feature has been identified as a sponge biodiversity hotspot (Przeslawski *et al.* 2014)	The bank and terrace system of the Van Diemen Rise is part of the larger system associated with the Sahul Banks to the north and Londonderry Rise to the east; it is characterised by terrace, banks, channels and valleys. The variability in water depth and substrate composition may contribute to the presence of unique ecosystems in the channels. Species present include sponges, soft corals and other sessile filter feeders associated with hard substrate sediments of the deep channels; epifauna and infauna include polychaetes and ascidians. Olive ridley turtles, sea snakes and sharks are also found associated with this feature.
Gulf of Carpentaria basin	Regional importance for biodiversity, endemism and aggregations of marine life relevant to benthic and pelagic habitats	The Gulf of Carpentaria basin is one of the few remaining near-pristine marine environments in the world. Primary productivity in the Gulf of Carpentaria basin is mainly driven by cyanobacteria that fix nitrogen but is also strongly influenced by seasonal processes. The soft sediments of the basin are characterised by moderately abundant and diverse communities of infauna and mobile epifauna dominated by polychaetes, crustaceans, molluscs, and echinoderms. The basin also supports assemblages of pelagic fish species including planktivorous and schooling fish, with top predators such as shark, snapper, tuna, and mackerel.
Gulf of Carpentaria coastal zone	High productivity, aggregations of marine life (including several endemic species) and high biodiversity compared to broader region	Nutrient inflow from rivers adjacent to the NMR generates higher productivity and more diverse and abundant biota within the Gulf of Carpentaria coastal zone than elsewhere in the region. The coastal zone is near pristine and supports many protected species such as marine turtles, dugongs, and sawfishes. Ecosystem processes and connectivity remain intact; river flows are mostly uninterrupted by artificial barriers and healthy, diverse estuarine and coastal ecosystems support many species that move between freshwater and saltwater environments.
Pinnacles of the Bonaparte Basin	Unique seafloor feature with ecological properties of regional significance Provide areas of hard substrate in an otherwise soft sediment environment and so are important for sessile species Recognised as a biodiversity hotspot for sponges The Pinnacles of the Bonaparte Basin KEF is located within both the NWMR and NMR (refer **Table 9-1**)	Covering more than 520 km^2 within the Bonaparte Basin, this feature contains the largest concentration of pinnacles along the Australian margin. The Pinnacles of the Bonaparte Basin are thought to be the eroded remnants of underlying strata; it is likely that the vertical walls generate local upwelling of nutrient-rich water, leading to phytoplankton productivity that attracts aggregations of planktivorous and predatory fish, seabirds and foraging turtles.

KEF Name	Values[1]	Description
Plateaux and saddle north-west of the Wellesley Islands	High species abundance, diversity and endemism of marine life	Abundance and species density are high in the plateaux and saddle as a result of increased biological productivity associated with habitats rather than currents. Submerged reefs support corals that are typical of northern Australia, including corals that have bleach-resistant zooxanthellae; and particular reef fish species that are different to those found elsewhere in the Gulf of Carpentaria. Species present include marine turtles and reef fish such as coral trout, cod, mackerel, and shark. Seabirds frequent the plateaux and saddle, most likely due to the presence of predictable food resources for feeding offspring.
Shelf break and slope of the Arafura Shelf	The Shelf break and slope of the Arafura Shelf is defined as a key ecological feature for its ecological significance associated with productivity emanating from the slope It also forms part of a unique biogeographic province (Last *et al.*, 2005)	The shelf break and slope of the Arafura Shelf is characterised by continental slope and patch reefs and hard substrate pinnacles. The ecosystem processes of the feature are largely unknown in the region; however, the Indonesian Throughflow and surface wind-driven circulation are likely to influence nutrients, pelagic dispersal and species and biological productivity in the region. Biota associated with the feature is largely of Timor–Indonesian Malay affinity.
Submerged coral reefs of the Gulf of Carpentaria	High aggregations of marine life, biodiversity and endemism Twenty per cent of the reefs found in the NMR are situated within this KEF (Harris *et al.*, 2007)	The submerged coral reefs of the Gulf of Carpentaria are characterised by submerged patch, platform and barrier reefs that form a broken margin around the perimeter of the Gulf of Carpentaria basin, rising from the sea floor at depths of 30–50 m. These reefs provide breeding and aggregation areas for many fish species including mackerel and snapper and offer refuges for sea snakes and apex predators such as sharks. Coral trout species that inhabit the submerged reefs are smaller than those found in the Great Barrier Reef and may prove to be an endemic sub-species.
Tributary Canyons of the Arafura Depression	High productivity and high levels of species diversity and endemism of marine life within the benthic and pelagic habitats of the feature	The tributary canyons are approximately 80–100 m deep and 20 km wide. The largest of the canyons extend some 400 km from Cape Wessel into the Arafura Depression, and are the remnants of a drowned river system that existed during the Pleistocene era. Sediments in this feature are mainly calcium-carbonate rich, although sediment type varies from sandy substrate to soft muddy sediments and hard, rocky substrate. Marine turtles, deep sea sponges, barnacles and stalked crinoids have all been identified in the area.

[1.] Values description sourced from Marine bioregional plan for the North Marine Region (DSEWPAC, 2012c) and Department of Agriculture, Water and the Environment (DAWE) SPRAT database.

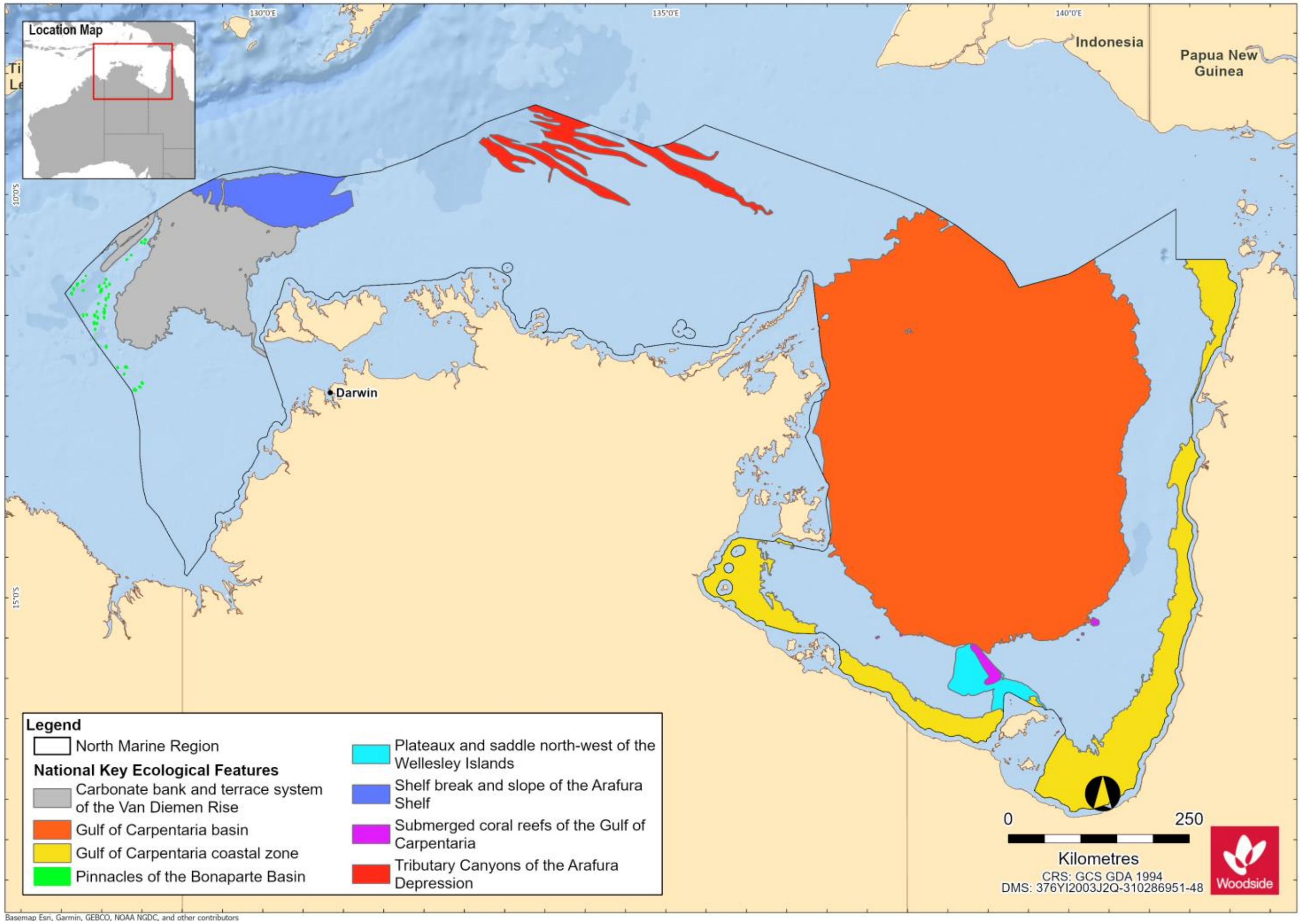

Figure 9-3. Key Ecological Features (KEFs) within the NMR

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10. PROTECTED AREAS

10.1 Regional Context

Protected areas included World Heritage Properties, National Heritage Places, Wetlands of International Importance, Australian Marine Parks, State Marine Parks and Reserves, Threatened Ecological Communities and the Australian Whale Sanctuary. The PMST Reports (**Appendix A**) shows that there are twenty-nine protected areas found in the NWMR, eighteen in the SWMR and nine in the NMR.

Table 10-1, Table 10-2 and **Table 10-3** outline the protected areas of each of the marine regions NWMR, SWMR and NMR, respectively.

10.2 World Heritage Properties

Properties nominated for World Heritage listing are inscribed on the list only after they have been carefully assessed as representing the best examples of the world's cultural and natural heritage. Only World Heritage listings classed as natural are discussed in this section. World Heritage sites classed as cultural are discussed in **Section 11**.

The list of Australia's World Heritage Properties and the PMST Reports (**Appendix A**) show two World Heritage Properties within the NWMR (**Table 10-1**), no World Heritage Properties within the SWMR (**Table 10-2),** and though not reported in the NMR PMST Report, Kakadu National Park and World Heritage Area is included in **Table 10-3**.

10.3 National and Commonwealth Heritage Places - Natural

The National Heritage List is Australia's list of natural, historic, and Indigenous places of outstanding significance to the nation. The National Heritage List Spatial Database describes the place name, class (Indigenous, natural, historic), and status. Commonwealth Heritage Places are a collection of sites recognised for their Indigenous, historical and/or natural values which are owned or controlled by the Australian Government.

Only National and Commonwealth Heritage Places classed as natural are discussed in this section. Heritage Places classed as indigenous or historic are discussed in **Section 11**.

A search of the National Heritage List Spatial Database and the PMST Reports (**Appendix A**) identified three natural National Heritage Places in the NWMR (**Table 10-1**), three in the SWMR (**Table 10-2**) and for the NMR, Kakadu National Park (not included in the PMST report) is included in **Table 10-3**.

A search of the Commonwealth Heritage List identified four natural commonwealth heritage places within the NWMR (**Table 10-1**).

10.4 Wetlands of International Importance (listed under the Ramsar Convention)

Australia has 65 Ramsar wetlands that cover >8.3 million ha. Ramsar wetlands are those that are representative, rare, or unique wetlands, or that are important for conserving biological diversity.

The List of Wetlands of International Importance held under the Ramsar Convention and the PMST Reports (**Appendix A**) identified four Ramsar Sites with coastal features within the NWMR (**Table 10-1**), four in the SWMR (**Table 10-2**) and two for the New Territory, included for the NMR (**Table 10-3**).

10.5 Australian Marine Parks

Australian Marine Parks (AMPs), proclaimed under the EPBC Act in 2007 and 2013, are located in Commonwealth waters that start at the outer edge of State and Territory waters, generally three nautical miles (~5.5 km) from the shore, and extend to the outer boundary of Australia's EEZ, 200 nm (~370 km) from the shore.

PMST Reports (**Appendix A**) show sixteen AMPs within the NWMR (**Table 10-1**), ten within the SWMR (**Table 10-2**) and eight within the NMR (**Table 10-3**).

10.6 Threatened Ecological Communities

No Threatened Ecological Communities (TECs) as listed under the EPBC Act are known to occur within the marine waters of the NWMR, SWMR or NMR as indicated by the PMST Reports (**Appendix A**).

10.7 Australian Whale Sanctuary

The Australian Whale Sanctuary has been established to protect all whales and dolphins found in Australian waters. Under the EPBC Act all cetaceans (whales, dolphins and porpoises) are protected in Australian waters.

The Australian Whale Sanctuary includes all Commonwealth waters from the three nautical mile State/Territory waters limit out to the boundary of the EEZ (i.e. out to 200 nm and further in some places). Within the Sanctuary it is an offence to kill, injure or interfere with a cetacean. Severe penalties apply to anyone convicted of such offences.

10.8 State Marine Parks and Reserves

State Marine Parks and Reserves, proclaimed under the *Conservation and Land Management Act 1984* (CALM Act), are located in State waters and vested in the WA Conservation and Parks Commission. State Marine Parks and Reserves of Western Australia have been considered, with 14 occurring in the NWMR (**Table 10-1**) and six occurring in the SWMR (**Table 10-2**).

10.9 Summary of Protected Areas within the NWMR

Table 10-1 Protected Areas within the NWMR

Protected Area	Woodside Activity Area			IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
	Browse	NWS/S	NW Cape			
World Heritage Properties						
Shark Bay World Heritage Property	-	-	✓		The Shark Bay World Heritage Property is adjacent to the Shark Bay AMP and was included on the World Heritage List in 1991.	Universal values of the Shark Bay World Heritage Property include large and diverse seagrass beds, stromatolites and populations of dugong and threatened species. Inscribed under Natural Criteria vii, viii, ix and x.
The Ningaloo Coast World Heritage Property	-	-	✓		The Ningaloo Coast World Heritage Property lies within the Ningaloo AMP and was included on the World Heritage List in 2011.	Universal values of the Ningaloo Coast World Heritage Property include high marine species diversity and abundance; in particular, Ningaloo Reef supports both tropical and temperate marine reptiles and mammals. Inscribed under Natural Criteria vii and x.
National Heritage Places - Natural						
Shark Bay	-	-	✓		The Shark Bay National Heritage Place consists of the same area included in the Shark Bay World Heritage Property (refer above) and was established on the National Heritage List in 2007.	The national heritage place has a number of exceptional natural features, including one of the largest and most diverse seagrass beds in the world, colonies of stromatolites and rich marine life including a large population of dugongs, and also provides a refuge for a number of other globally threatened species. Shark Bay meets the national heritage listing criteria a, b, c, d, e, f, g, h and i.
The Ningaloo Coast	-	-	✓		The Ningaloo Coast National Heritage Place consists of the same area included in the Ningaloo	The Ningaloo Coast contains one of the best developed near-shore reefs in the world, being home to rugged limestone peninsulas, spectacular coral and sponge gardens and the whale shark.

Protected Area	Woodside Activity Area			IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
	Browse	NWS/S	NW Cape			
					Coast World Heritage Property (refer above) and was established on the National Heritage List in 2010.	The Ningaloo Coast meets the national heritage listing criteria a, b, c, d, and f.
The West Kimberley	✓	✓	-		The West Kimberley National Heritage Place covers an area of around 192,000 km^2 located in the north-west of Australia from Broome to Wyndham, and was established on the National Heritage List in 2011.	The Kimberley plateau, north-western coastline and northern rivers of the West Kimberley provide a vital refuge for many native plants and animals that are found nowhere else or which have disappeared from much of the rest of Australia. In addition, Roebuck Bay is internationally recognised as one of Australia's most significant sites for migratory wading birds. The national heritage place also contains a remarkable history of Aboriginal occupation, with many places of indigenous sacred value. The West Kimberley meets the national heritage listing criteria a, b, c, d, e, f, g, h and i.
Commonwealth Heritage Places - Natural						
Mermaid Reef – Rowley Shoals	-	✓	-	N/A	The Mermaid Reef – Rowley Shoals Commonwealth Heritage Place is located within the boundary of the Mermaid Reef Marine National Nature Reserve. The site was listed as a Commonwealth Heritage Place in 2004.	The Mermaid Reef-Rowley Shoals Commonwealth Heritage Place is regionally important for the diversity of its fauna and together with Clerke and Imperieuse reefs, has biogeographical significance due to the presence of species which are at, or close to, the limits of their geographic ranges, including fishes known previously only from Indonesian waters. Rowley Shoals is important for benchmark studies as one of the few places off the north-west coast of Western Australia which have been the site of major biological collection trips by the WA Museum.

Protected Area	Woodside Activity Area			IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
	Browse	NWS/S	NW Cape			
Ashmore Reef National Nature Reserve	✓	-	-		The Ashmore Reef Commonwealth Heritage Place is located within the boundary of the Ashmore Reef Marine Park (refer AMPs below). The site was listed as a Commonwealth Heritage Place in 2004.	Ashmore Reef has major significance as a staging point for wading birds migrating between Australia and the Northern Hemisphere and supports high concentrations of breeding seabirds, many of which are nomadic and typically breed on small isolated islands. Ashmore Reef is an important scientific reference area for migratory seabirds, sea snakes and marine invertebrates. The Ashmore Reef Commonwealth Heritage Place is significant for its history of human occupation and use. The island is believed to have been visited by Indonesian fisherman since the early eighteenth century. The islands were used both for fishing and as a staging point for voyages to the southern reefs off Australia's coast.
Scott Reef and Surrounds – Commonwealth Area	✓	-	-		Scott Reef and Surrounds Commonwealth Heritage Place is located within the Western Australian Coastal Waters surrounding North and South Scott Reef. The site was listed as a Commonwealth Heritage Place in 2004.	The Scott Reef and Surrounds Commonwealth Heritage Place is regionally important for the diversity of its fauna and has biogeographical significance due to the presence of species which are at, or close to, the limits of their geographic ranges, including fish known previously only from Indonesian waters. Scott Reef is recognised as important for scientific research and benchmark studies due to its age, the extensive documentation of its geophysical and physical environmental characteristics and its use as a site of major biological collection trips and surveys by the WA Museum and the Australian Institute of Marine Science.

Protected Area	Woodside Activity Area			IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
	Browse	NWS/S	NW Cape			
Ningaloo Marine Area – Commonwealth Waters	-	-	✓		The Ningaloo Marine Area Commonwealth Heritage Place is located within the Commonwealth waters of the Ningaloo Marine Park (refer AMPs below). The site was listed as a Commonwealth Heritage Place in 2004.	The Ningaloo Marine Area Commonwealth Heritage Place provides a migratory pathway for humpback whales and foraging habitat for whale sharks. The place is an important breeding area for billfish and manta ray. The Ningaloo Marine Area provides opportunities for scientific research relating to aspects of the area's unique features including tourism (marine ecology, whales, turtles, whale sharks, fish and oceanography.
Wetlands of International Importance (Ramsar)						
Ashmore Reef National Nature Reserve	✓	-	-	Ramsar	The Ashmore Reef Ramsar site is located within the boundary of the Ashmore Reef Marine Park (refer AMPs below). The site was listed under the Ramsar Convention in 2002.	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 WA 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.
Eighty Mile Beach	-	✓	-	Ramsar	The Eighty Mile Beach Ramsar site covers an area of 1250 km^2, located along a long section of the Western Australian coastline adjacent to the Eighty Mile Beach AMP (refer below).	The Eighty Mile Beach Ramsar site includes saltmarsh and a raised peat bog more than 7000 years old. The site contains the most important wetland for waders in north-western Australia, supporting up to 336,000 birds, and is especially important as a land fall for waders migrating south for the austral summer.
Roebuck Bay	-	✓	-	Ramsar	The Roebuck Bay Ramsar site covers an area of 550	The Roebuck Bay Ramsar site is recognised as one of the most important areas for migratory shorebirds in Australia.

Protected Area	Woodside Activity Area			IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
	Browse	NWS/S	NW Cape			
					km^2, located south of Broome and adjacent to the Roebuck AMP (refer below).	The site regularly supports over 100,000 waterbirds, with numbers being highest in the austral spring when migrant species breeding in the Palearctic stop to feed during migration.
Ord River Floodplain	✓			Ramsar	The Ord River Floodplain Ramsar Site is in the East Kimberley region and encompasses an extensive system of river, seasonal creek, tidal mudflat, and floodplain wetlands. The Ramsar Site is a nursery, feeding and/or breeding ground for migratory birds, waterbirds, fish, crabs, prawns, and crocodiles.	The site represents the best example of wetlands associated with the floodplain and estuary of a tropical river system in the Tanami-Timor Sea Coast Bioregion in the Kimberley. In addition, the False Mouths of the Ord are the most extensive mudflat and tidal waterway complex in Western Australia.
Wetlands of National Importance (DAWE, 2019)						
Ashmore Reef	✓	-	-		Ashmore Reef is a shelf-edge platform reef located among the Sahul Banks of north-western Australia. It covers an area of 583 km^2 and consists of three islets surrounded by intertidal reef and sand flats.	These islets are major seabird nesting sites with 20 breeding species recorded to date. The total bird population has been estimated to exceed 100,000 during the peak breeding season. The marine reserve also has the highest diversity of marine fauna of the reefs on the NWS and differs from other reefs and coastal areas in the region. The area meets criteria 1, 3, 4 and 5 for inclusion on the Directory of Important Wetlands in Australia.
Mermaid Reef	-	✓	-		Mermaid Reef Marine Park covers an area of around 540 km^2, located ~280 km west north-west of Broome, and is the most north-easterly atoll of the Rowley Shoals.	The reefs of the Mermaid Reef Marine Park have biogeographic value due to the presence of species that are at or close to the limit of their distribution. The coral communities are one of the special values of Mermaid Reef. The area meets criteria 1, 2 and 3 for inclusion on the Directory of Important Wetlands in Australia.

Protected Area	Woodside Activity Area			IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
	Browse	NWS/S	NW Cape			
Exmouth Gulf East	-	-	✓		Exmouth Gulf East covers an area of 800 km^2 and includes wetlands in the eastern part of Exmouth Gulf, from Giralia Bay; to Urala Creek, Locker Point.	The Exmouth Gulf East is an outstanding example of tidal wetland systems of low coast of north-west Australia, with well- developed tidal creeks, extensive mangrove swamps and broad saline coastal flats. The site is one of the major population centres for dugong in WA and its seagrass beds and extensive mangroves provide nursery and feeding areas for marine fishes and crustaceans in the Gulf. The area meets criteria 1, 2 and 3 for inclusion on the Directory of Important Wetlands in Australia.
Hamelin Pool	-	-	✓		Hamelin Pool covers an area of 900 km^2 in the far south-east part of Shark Bay.	Hamelin Pool is an outstanding example of a hypersaline marine embayment and supports extensive microbialite (subtidal stromatolite) formations, which are the most abundant and diverse examples of growing marine microbialites in the world. The area meets criteria 1 and 6 for inclusion on the Directory of Important Wetlands in Australia.
Shark Bay East	-	-	✓		Shark Bay East covers a 250 km area of coastline comprising tidal wetlands, and marine waters less than 6 m deep at low tide, in the east arm of Shark Bay.	The site is an outstanding example of a very large, shallow marine embayment, with particularly extensive occurrence of seagrass beds and substantial areas of intertidal mud/sandflats and mangrove swamp. The site supports what is probably the world's largest discrete population of dugong; it is also a major nursery and/or feeding area for turtles, rays, sharks, other fishes, prawns and other marine fauna; and is a major migration stop-over area for shorebirds. The area meets criteria 1, 2, 3, 4, 5 and 6 for inclusion on the Directory of Important Wetlands in Australia.
Australian Marine Parks (DNP, 2018a)						
Abrolhos Marine Park	-	-	✓	II, IV, VI	Abrolhos Marine Park is located adjacent to the WA Houtman Abrolhos Islands, covering a large offshore	Abrolhos Marine Park is significant because it contains habitats, species and ecological communities associated with four bioregions:

Protected Area	Woodside Activity Area			IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
	Browse	NWS/S	NW Cape			
					area of 88,060 km^2 extending from the WA State waters boundary to the edge of Australia's EEZ. The Abrolhos Marine Park is located within both the NWMR and SWMR.	• Central Western Province • Central Western Shelf Province • Central Western Transition • South-west Shelf Transition It includes 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 at 90-120 m depth; and Wallaby Saddle. The AMP supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP 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 AMP is adjacent to the northernmost Australian sea lion breeding colony in Australia on the Houtman Abrolhos Islands.
Carnarvon Canyon Marine Park	-	-	✓	IV	Carnarvon Canyon Marine Park covers an area of 6177 km^2, located ~300 km north-west of Carnarvon.	Carnarvon Canyon Marine Park is significant because it contains habitats, species and ecological communities associated with the Central Western Transition bioregion. The AMP supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act. There is limited information about species' use of this AMP.
Shark Bay Marine Park	-	-	✓	VI	Shark Bay Marine Park covers an area of 7443 km^2 located ~60 km offshore of Carnarvon, adjacent to the Shark Bay World Heritage Property and National Heritage Place.	Shark Bay Marine Park is significant because it contains habitats, species and ecological communities associated with two bioregions: • Central Western Shelf Province • Central Western Transition. The AMP supports a range of species including species listed as threatened, migratory, marine or cetacean under

Protected Area	Woodside Activity Area			IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
	Browse	NWS/S	NW Cape			
						the EPBC Act. BIAs within the AMP include breeding habitat for seabirds, internesting habitat for marine turtles, and a migratory pathway for humpback whales.
Gascoyne Marine Park	-	-	✓	II, IV, VI	Gascoyne Marine Park covers an area of 81,766 km^2, located ~20 km off the west coast of the Cape Range Peninsula, adjacent to the Ningaloo Marine Park.	Gascoyne Marine Park is significant because it contains habitats, species and ecological communities associated with three bioregions: • Central Western Shelf Transition • Central Western Transition • Northwest Province. It includes 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 Exmouth Plateau. The AMP supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP 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.
Ningaloo Marine Park	-	-	✓	II, IV	Ningaloo Marine Park covers an area of 2435 km^2, stretching ~300 km along the west coast of the Cape Range Peninsula, and is adjacent to the WA Ningaloo Marine Park and Gascoyne Marine Park.	Ningaloo Marine Park is significant because it contains habitats, species and ecological communities associated with four bioregions: • Central Western Shelf Transition • Central Western Transition • Northwest Province • Northwest Shelf Province. It includes 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. The AMP supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP include breeding and

Protected Area	Woodside Activity Area			IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
	Browse	NWS/S	NW Cape			
						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.
Montebello Marine Park	-	✓	-	VI	Montebello Marine Park covers an area of 3413 km^2, located offshore of Barrow Island and 80 km west of Dampier extending from the WA State waters boundary, and is adjacent to the WA Barrow Island and Montebello Islands Marine Parks.	Montebello Marine Park is significant because it contains habitats, species and ecological communities associated with the Northwest Shelf Province bioregion. It includes one KEF: Ancient coastline at 125 m depth contour. The AMP supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP 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.
Dampier Marine Park	-	✓	-	II, IV, VI	Dampier Marine Park covers an area of 1252 km^2, located ~10 km north-east of Cape Lambert and 40 km from Dampier extending from the WA State waters boundary.	Dampier Marine Park is significant because it contains habitats, species and ecological communities associated with the Northwest Shelf Province bioregion. The AMP 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 AMP supports a range of species including those listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP include breeding and foraging habitat for seabirds, internesting habitat for marine turtles and a migratory pathway for humpback whales.
Eighty Mile Beach Marine Park	-	✓	-	VI	Eighty Mile Beach Marine Park covers an area of 10,785 km^2, located ~74 km north-east of Port Hedland, adjacent to the	Eighty Mile Beach 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.

Protected Area	Woodside Activity Area			IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
	Browse	NWS/S	NW Cape			
					WA Eighty Mile Beach Marine Park.	The AMP supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP include breeding, foraging and resting habitat for seabirds, internesting and nesting habitat for marine turtles, foraging, nursing and pupping habitat for sawfishes and a migratory pathway for humpback whales.
Argo – Rowley Terrace Marine Park	✓	✓	-	II, VI, VI (Trawl)	Argo-Rowley Terrace Marine Park covers an area of 146,003 km^2, located ~270 km north-west of Broome, and extends to the limit of Australia's EEZ. The AMP is adjacent to the Mermaid Reef Marine Park and the WA Rowley Shoals Marine Park.	Argo–Rowley Marine Park is significant because it contains habitats, species and ecological communities associated with two bioregions: • Northwest Transition • Timor Province. It includes two KEFs: Canyons linking the Argo Abyssal Plain with the Scott Plateau; and Mermaid Reef and Commonwealth waters surrounding Rowley Shoals. The AMP supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP include resting and breeding habitat for seabirds and a migratory pathway for the pygmy blue whale.
Mermaid Reef Marine Park	-	✓	-	II	Mermaid Reef Marine Park covers an area of 540 km^2, located ~280 km north-west of Broome, adjacent to the Argo–Rowley Terrace Marine Park and ~13 km from the WA Rowley Shoals Marine Park. Mermaid Reef is one of three reefs forming the Rowley Shoals. The other two are Clerke Reef and Imperieuse Reef, to the	Mermaid Reef Marine Park is significant because it contains habitats, species and ecological communities associated with the Northwest Transition. It includes one KEF: Mermaid Reef and Commonwealth waters surrounding Rowley Shoals. The Rowley Shoals have been described as the best geological examples of shelf atolls in Australian waters. The AMP supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP include breeding habitat for seabirds and a migratory pathway for the pygmy blue whale.

Protected Area	Woodside Activity Area			IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
	Browse	NWS/S	NW Cape			
					south-west of the AMP, which are included in the WA Rowley Shoals Marine Park.	
Roebuck Marine Park	-	✓	-	VI	Roebuck Marine Park covers an area of 304 km^2, located ~12 km offshore of Broome, and is adjacent to the WA Yawuru Nagulagun/Roebuck Bay Marine Park.	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 AMP supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP 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.
Kimberley Marine Park	✓	✓	-	II, IV, VI	Kimberley Marine Park covers an area of 74,469 km^2, located ~100 km north of Broome, extending from the WA State waters boundary north from the Lacepede Islands to the Holothuria Banks offshore from Cape Bougainville.	Kimberley Marine Park is significant because it includes habitats, species and ecological communities associated with three bioregions: • Northwest Shelf Province • Northwest Shelf Transition • Timor Province. It includes two KEFs: Ancient coastline at 125 m depth contour; and Continental slope demersal fish communities. The AMP supports a range of species, including protected species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP 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.
Ashmore Reef Marine Park	✓	-	-	Ia, IV	Ashmore Reef Marine Park covers an area of 583 km^2, located ~630 km north of	Ashmore Reef Marine Park is significant because it includes habitats, species and ecological communities associated with the Timor Province. It includes two KEFs:

Protected Area	Woodside Activity Area			IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
	Browse	NWS/S	NW Cape			
					Broome and 110 km south of the Indonesian island of Roti. The AMP 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.	Ashmore Reef and Cartier Island and surrounding Commonwealth waters; and Continental slope demersal fish communities. The AMP supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP 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.
Cartier Island Marine Park	✓	-	-	Ia	Cartier Island Marine Park covers an area of 172 km^2, located ~45 km south-east of Ashmore Reef Marine Park and 610 km north of Broome. It is also located in Australia's External Territory of Ashmore and Cartier Islands and within an area subject to an MoU between Indonesia and Australia, known as the MoU Box.	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 and continental slope demersal fish communities. The AMP supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP include breeding and foraging habitat for seabirds, internesting, nesting and foraging habitat for marine turtles and foraging habitat for whale sharks. The AMP is also internationally significant for its abundance and diversity of sea snakes, some of which are listed species under the EPBC Act.
Joseph Bonaparte Gulf Marine Park	✓	-	-	VI	Joseph Bonaparte Gulf Marine Park covers an area of 8597 km^2 and is located ~15 km west of Wadeye, NT, and ~90 km north of Wyndham, WA, in the Joseph Bonaparte Gulf.	Joseph Bonaparte Gulf Marine Park is significant because it contains habitats, species and ecological communities associated with the Northwest Shelf Transition bioregion. It includes one KEF: Carbonate bank and terrace system of the Sahul Shelf. The AMP supports a range of species, including species listed as threatened, migratory, marine or cetacean under

Protected Area	Woodside Activity Area			IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
	Browse	NWS/S	NW Cape			
					It is adjacent to the WA North Kimberley Marine Park. The Joseph Bonaparte Gulf Marine Park is located within both the NWMR and NMR.	the EPBC Act. BIAs within the AMP include foraging habitat for marine turtles and the Australian snubfin dolphin.
Oceanic Shoals Marine Park	✓	-	-	II, IV, VI	Oceanic Shoals Marine Park covers an area of 71,743 km^2 and is located west of the Tiwi Islands, ~155 km north-west of Darwin, NT and 305 km north of Wyndham, WA. The Oceanic Shoals Marine Park is located within both the NWMR and NMR.	Oceanic Shoals Marine Park is significant because it contains habitats, species and ecological communities associated with the Northwest Shelf Transition bioregion. It contains four KEFs: 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. The AMP supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP include foraging and internesting habitat for marine turtles.
State Marine Parks and Reserves						
North Kimberley Marine Park	✓	-	-	Sanctuary, Special Purpose and General Use Zones	The North Kimberley Marine Park covers approx. 18,450 km^2 with its south-western boundary located ~270 km north-east of Derby.	The coral reefs of the north Kimberley have the greatest diversity in Western Australia and are some of the most pristine and remarkable reefs in the world. The park surrounds more than 1000 islands and is home to listed species such as dugongs, marine turtles, and sawfishes (DPAW, 2016a).
Lalang-garram / Horizontal Falls Marine Park and North Lalang-garram Marine Park (jointly managed)	✓	-	-	Sanctuary, Special Purpose and General Use Zones	The Lalang-garram / Horizontal Falls Marine Park covers ~3530 km^2 from Talbot Bay in the west and Glenelg River in the east. The North Lalang-garram Marine Park covers ~1100	The Lalang-garram / Horizontal Falls Marine Park's most celebrated attraction is created by massive tides of up to 10 m and narrow gaps in two parallel tongues of land meaning the tide falls faster than the water can escape, producing 'horizontal falls'. There are also islands with fringing coral reefs and mangrove-lined creeks and bays. The North Lalang-garram Marine Park has a number of islands fringed with coral reef and has been identified as an

Protected Area	Woodside Activity Area			IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
	Browse	NWS/S	NW Cape			
					km^2 between Camden Sound and North Kimberley Marine Parks.	ecological hotspot and supports more than 1% of the world's population of brown boobies, with up to 2000 breeding pairs. About 500 pairs of crested terns also nest on the island (DPAW, 2016b).
Lalang-garram / Camden Sound Marine Park	✓	-	-	Sanctuary, Special Purpose and General Use Zones	Lalang-garram / Camden Sound Marine Park covers 7050 km^2 located about 150 km north of Derby.	The Lalang-garram / Camden Sound Marine Park is the most important humpback whale nursery in the Southern Hemisphere. It also features the spectacular coastal Montgomery Reef. The marine park is home to six species of threatened marine turtle. Australian snubfin and Indo-Pacific humpback dolphins, dugongs, saltwater crocodiles, and several species of sawfish (DPAW, 2013).
Rowley Shoals Marine Park	-	✓	-	Sanctuary, Recreation and General Use Zones	The Rowley Shoals comprise of three reef systems, Mermaid Reef, Clerke Reef and Imperieuse Reef, all 30-40 km apart. These reef systems are located ~300 km west north-west of Broome.	The three coral atolls of the Rowley Shoals Marine Park comprise of shallow lagoons inhabited by diverse corals and abundant marine life, each covering around 80 km^2 at the edge of Australia's continental shelf. Further offshore, the seafloor slopes away to the abyssal plain, some 6000 m below. Undersea canyons slice the slope; these features are commonly associated with diverse communities of deep-water corals and sponges and create localised upwellings that aggregate pelagic species like tunas and billfish (DEC, 2007a).
Yawuru Nagulagun / Roebuck Bay Marine Park	-	✓	-	Special Purpose Zone	Yawuru Nagulagun / Roebuck Bay Marine Park is a series of intertidal flats lying on the coast to the south-east of Broome.	Roebuck Bay is an internationally significant wetland and one of the most important feeding grounds for migratory shorebirds in Australia. Australian snubfin and Australian humpback dolphins frequent the waters and humpback whales pass through on their annual migration. Flatback turtles nest on the shores and are found in the bay's waters with other sea turtle species. Seagrass and macroalgae communities provide food for protected species such as the dugong and flatback turtle (DPAW, 2016c).
Eighty Mile Beach Marine Park	-	✓	-	Sanctuary, Recreation, Special	Eighty Mile Beach Marine Park covers ~2000 km^2 stretching across 220km of	Eighty Mile Beach Marine Park is one of the world's most important feeding grounds for small wading birds that migrate to the area each summer, travelling from countries

Protected Area	Woodside Activity Area			IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
	Browse	NWS/S	NW Cape			
				Purpose and General Use Zones	coastline between Port Hedland and Broome.	thousands of kilometres away. The marine park is a major nesting area for flatback turtles which are found only in northern Australia. Sawfishes, dugongs, dolphins and millions of invertebrates inhabit the sand and mud flats, seagrass meadows, coral reefs and mangroves (DPAW, 2014).
Montebello Islands Marine Park, Barrow Island Marine Park and Barrow Island Marine Management Area (jointly managed)	-	✓	-	Sanctuary, Recreation, General Use and Special Purpose Zones	The Montebello Islands Marine Park, Barrow Island Marine Park and Barrow Island Marine Management Area are located off the north-west coast of WA, ~1600 km north of Perth, and cover areas of ~583 km^2, 42 km^2 and 1,147 km^2, respectively.	The Montebello/Barrow islands marine conservation reserves have very complex seabed and island topography, resulting in a myriad of different habitats subtidal coral reefs, macroalgal and seagrass communities, subtidal soft-bottom communities, rocky shores and intertidal reef platforms, which support a rich diversity of invertebrates and finfish. The reserves are important breeding areas for several species of marine turtles and seabirds, which use the undisturbed sandy beaches for nesting. Humpback whales migrate through the reserves and dugongs occur in the shallow warm waters (DEC, 2007b).
Ningaloo Marine Park and Muiron Islands Marine Management Area (jointly managed)	-	-	✓	Sanctuary, Recreation, General Use and Special Purpose Zones	The Ningaloo Marine Park and Muiron Islands Marine Management Area are located off the North-west Cape of WA, ~1200 km north of Perth, and cover areas of ~2633 km^2 and 286 km^2, respectively.	Ningaloo Reef is the largest fringing coral reef in Australia. Temperate and tropical currents converge in the Ningaloo region resulting in highly diverse marine life including spectacular coral reefs, abundant fishes and species with special conservation significance such as turtles, whale sharks, dugongs, whales and dolphins. The region has diverse marine communities including mangroves, algae and filter-feeding communities and has high water quality. These values contribute to the Ningaloo Marine Park being regarded as the State's premier marine conservation icon. The Muiron Islands Marine Management Area is also important, containing a very diverse marine environment, with coral reefs, filter-feeding communities and macroalgal beds. In addition, the Islands are important seabird and green turtle nesting areas. (CALM, 2005a).

Protected Area	Woodside Activity Area			IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
	Browse	NWS/S	NW Cape			
Shark Bay Marine Park and Hamelin Pool Marine Nature Reserve (jointly managed)	-	-	✓	Sanctuary, Recreation, General Use and Special Purpose Zones	The Shark Bay Marine Park and Hamelin Pool Marine Nature Reserves are located 400 km north of Geraldton, covering areas of ~7487 km^2 and 1270 km^2, respectively.	Seagrass covers over 4000 km^2 of the Shark Bay Marine Park, with 12 different species making it one of the most diverse seagrass assemblages in the world. Dugongs regularly use this habitat, with the bay containing one of the largest dugong populations in the world. Humpback whales also use the bay as a staging post in their migration along the coast. Green and loggerhead turtles occur in the bay with Dirk Hartog Island providing the most important nesting site for loggerheads in Western Australia. Hamelin Pool contains the most diverse and abundant examples of stromatolites found in the world. These are living representatives of stromatolites that existed some 3500 million years ago (CALM, 1996).

**Conservation objectives for IUCN categories include:*

Ia: Strict Nature Reserve

Ib: Wilderness Area

II: national Park

III: Natural Monument or Feature

IV: Habitat/Species Management Area

V: Protected Landscape

VI: Protected area with sustainable use of natural resources – allow human use but prohibits large scale development.

IUCN categories for the marine park are provided and, in brackets, the IUCN categories for specific zones within each Marine Park as assigned under the North-west Marine Parks Network Management Plan 2018 (DNP, 2018a)

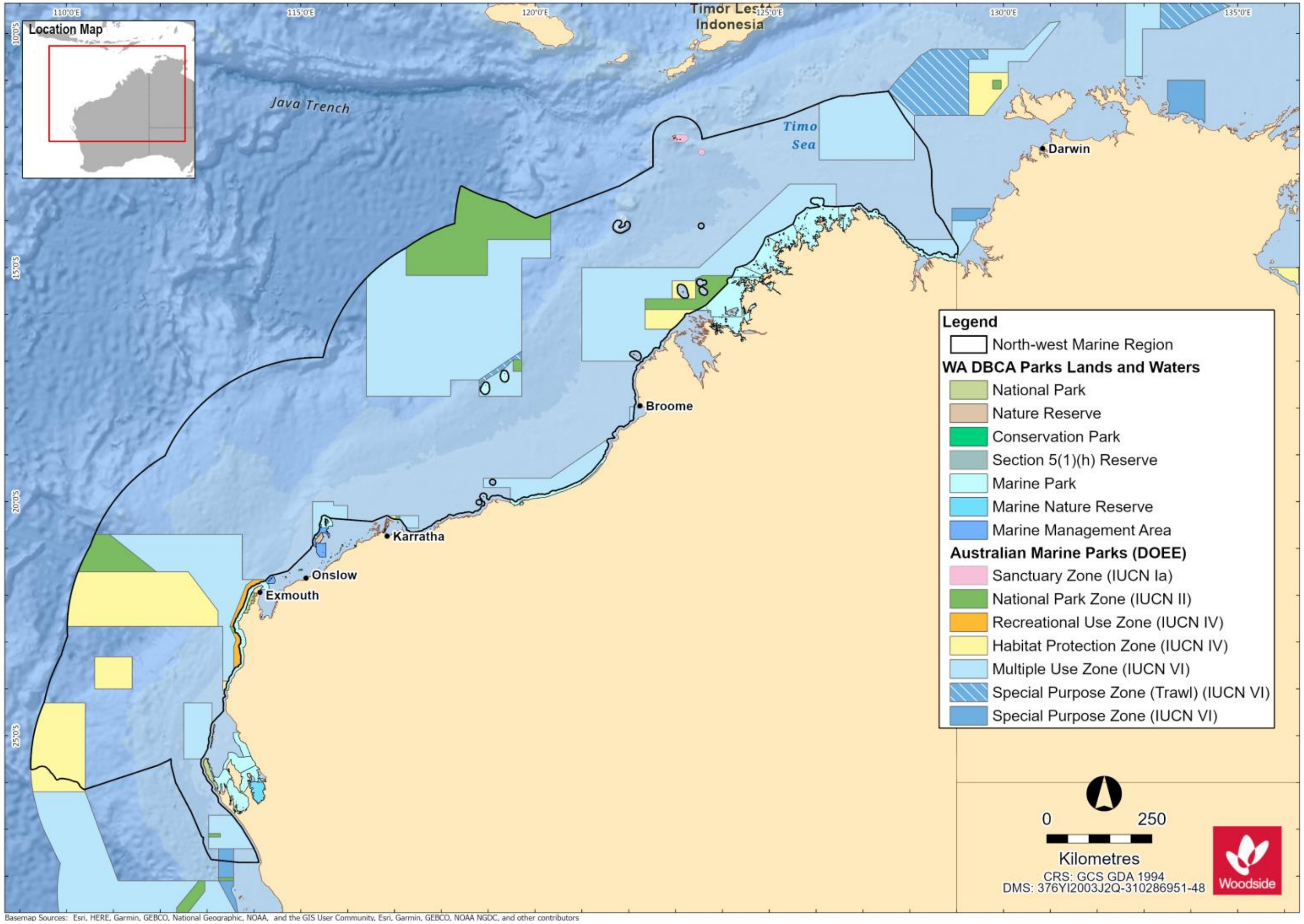

Figure 10-1 Commonwealth and State Marine Protected Areas for the NWMR

10.10 Summary of Protected Areas within the SWMR

Table 10-2 Protected Areas within the SWMR

Protected Area	IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
World Heritage Properties			
N/A			
National Heritage Places - Natural			
N/A			
Commonwealth Heritage Places - Natural			
N/A			
Wetlands of International Importance (Ramsar)			
Beecher Point Wetlands	Ramsar	Beecher Point Wetlands is a system of about sixty small wetlands located near Rockingham in south-west WA, covering an area of around 7 km^2. The site was listed under the Ramsar Convention in 2001.	The wetlands support sedgelands, herblands, grasslands, open-shrublands and low open-forests. The sedgelands that occur within the linear wetland depressions of the Ramsar site are a nationally listed TEC. At least four species of amphibians and twenty-one (21) species of reptiles have been recorded on the site. The site also supports the southern brown bandicoot. The site meets criteria 1 and 2 of the Ramsar Convention.
Forrestdale and Thomsons Lakes	Ramsar	Forrestdale Lake is located in the City of Armadale and Thomsons Lake is located in the City of Cockburn both of which lie within the southern Perth metropolitan area, in Western Australia. The site was listed under the Ramsar Convention in 1990.	The lakes are surrounded by medium density urban development and some agricultural land. The sediments of Thomsons Lake are between 30,000 and 40,000 years old, which are the oldest lake sediments discovered in WA to date. These lakes are the best remaining examples of brackish, seasonal lakes with extensive fringing sedgeland, typical of the Swan Coastal Plain. The site meets criteria 1, 3, 5 and 6 of the Ramsar Convention.
Peel-Yalgorup System	Ramsar	Peel-Yalgorup System, located adjacent to the City of Mandurah in	Peel-Yalgorup System Ramsar site is the most important area for waterbirds in south-western Australia. It supports a large number of waterbirds, and a

Protected Area	IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
		WA, is a large and diverse system of shallow estuaries, coastal saline lakes and freshwater marshes. The site was listed under the Ramsar Convention in 1990.	wide variety of waterbird species. It also supports a wide variety of invertebrates, and estuarine and marine fish. The site meets criteria 1, 3, 5 and 6 of the Ramsar Convention.
Vasse-wonnerup system	Ramsar	Vasse-Wonnerup System Ramsar wetland is situated in the Perth Basin, south-western WA. The site was listed under the Ramsar Convention in 1990.	Vasse-Wonnerup System is an extensive, shallow, nutrient-enriched wetland system of highly varied salinities. Large areas of the wetland dry out in late summer. Vasse-Wonnerup System supports tens of thousands of resident and migrant waterbirds of a wide variety of species. More than 80 species of waterbird have been recorded in the System such as red-necked avocets and black-winged stilts, wood sandpiper, sharp-tailed sandpiper, long-toed stint, curlew sandpiper and common greenshank. Thirteen waterbird species are also known to breed at the Ramsar site, including the largest regular breeding colony of black swans in south-western Australia. The site meets criteria 5 and 6 of the Ramsar Convention.
Wetlands of National Importance (DAWE, 2019)			
Rottnest Island Lakes		The Rottnest Island Lakes site is the cluster of 18 lakes and swamps on the north-east part of Rottnest Island.	An outstanding example of a series of lakes/swamps of varied depth and salinity located on an offshore island; the only island among 200 plus in WA exceeding 10 ha in area, that has a salt-lake complex; the only known example of seasonally meromictic lakes in Australia. The area meets criteria 1, 2, 3 and 6 for inclusion on the Directory of Important Wetlands in Australia.
Australian Marine Parks (DNP, 2018b)			
Abrolhos Marine Park	II, IV, VI	The Abrolhos Marine Park is located within both the NWMR and SWMR. Refer **Table 10-1** for description and conservation values.	
Bremer Marine Park	II, VI	Bremer Marine Park covers an area of 4472 km^2 and is located approximately half-way between Albany and Esperance, offshore from the Fitzgerald River National Park, extending from the WA State waters boundary.	Bremer Marine Park is significant because it contains habitats, species and ecological communities associated with two bioregions: • Southern Province • South-west Shelf Province. It includes two KEFs: Albany Canyon group and adjacent shelf break; and Ancient coastline at 90-120 m depth.

Protected Area	IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
			The AMP supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP include foraging habitat for seabirds, Australian sea lions, and white sharks, a migratory pathway for humpback whales, and a significant calving area for southern right whales. The AMP includes canyons—important aggregation areas for killer whales.
Eastern Recherche Marine Park	II, VI	Eastern Recherche Marine Park covers an area of 20,575 km^2 and is located ~135 km east of Esperance, adjacent to the Recherche Archipelago, close to the WA Cape Arid National Park.	Eastern Recherche Marine Park is significant because it contains habitats, species and ecological communities associated with three bioregions: • South-west Shelf Province • Southern Province • Great Australian Bight Shelf Transition. It includes three KEFs: Mesoscale eddies; Ancient coastline at 90-120 m depth; and Commonwealth marine environment surrounding the Recherche Archipelago. The AMP supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP include foraging habitat for seabirds, Australian sea lions and white sharks, and a calving buffer area for southern right whales.
Geographe Marine Park	II, IV, VI	Geographe Marine Park covers an area of 977 km^2 and is located in Geographe Bay, ~8 km west of Bunbury and 8 km north of Busselton, adjacent to the WA Ngari Capes Marine Park.	Geographe Marine Park is significant because it contains habitats, species and ecological communities associated with the South-west Shelf Province bioregion. It includes two KEFs: Commonwealth marine environment within and adjacent to Geographe Bay; and Western rock lobster. The AMP supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP include foraging habitat for seabirds, a migratory pathway for humpback and pygmy blue whales, and a calving buffer area for southern right whales.
Great Australian Bight Marine Park	II, VI	Great Australian Bight Marine Park covers an area of 45,822 km^2 and is located ~12 km south-east of Eucla and 174 km west of Ceduna, adjacent to the SA Far West Coast and Nuyts Archipelago Marine Parks.	Great Australian Bight Marine Park is significant because it contains habitats, species and ecological communities associated with two bioregions: • Great Australian Bight Shelf Transition • Southern Province. It includes three KEFs: Ancient coastline at 90-120 m depth; Benthic invertebrate communities of the eastern Great Australian Bight; and Small pelagic fish of the South-west Marine Region. The AMP supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP include foraging habitat for seabirds, Australian sea lions, white sharks and

Protected Area	IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
			pygmy blue and sperm whales, and a calving area, migratory pathway and large aggregation area for southern right whales.
Jurien Marine Park	II, VI	Jurien Marine Park covers an area of 1851 km^2 and is located ~148 km north of Perth and 155 km south of Geraldton, adjacent to the WA Jurien Bay Marine Park.	Jurien Marine Park is significant because it includes habitats, species and ecological communities associated with two bioregions: • South-west Shelf Transition • Central Western Province. It includes three KEFs: Ancient coastline at 90-120 m depth; Demersal slope and associated fish communities of the Central Western Province; and Western rock lobster The AMP supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP include foraging habitat for seabirds, Australian sea lions and white sharks, and a migratory pathway for humpback and pygmy blue whales.
Perth Canyon Marine Park	II, IV, VI	Perth Canyon Marine Park covers an area of 7409 km^2 and is located ~52 km west of Perth and ~19 km west of Rottnest Island.	Perth Canyon Marine Park is significant because it includes habitats, species and ecological communities associated with four bioregions: • Central Western Province • South-west Shelf Province • Southwest Transition • South-west Shelf Transition. It includes 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. The AMP supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP 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.
South-west Corner Marine Park	II, IV, VI	South-west Corner Marine Park covers an area of 271,833 km^2 and is located adjacent to the WA Ngari Capes Marine Park. It covers an extensive offshore area that is closest to WA State waters ~48 km west of Esperance, 73 km west of Albany and 68 km west of Bunbury.	South-west Corner Marine Park is significant because it contains habitats, species and ecological communities associated with three bioregions: • Southern Province • South-west Transition • South-west Shelf Province. It includes six KEFs: Albany Canyon group and adjacent shelf break; Cape Mentelle upwelling; Diamantina Fracture Zone; Naturaliste Plateau; Western rock lobster; and Ancient coastline at 90 m-120 m depth.

Protected Area	IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
			The AMP supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP 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.
Twilight Marine Park	II, VI	Twilight Marine Park covers an area of 4641 km^2 and is located ~245 km south-west of Eucla and 373 km north-east of Esperance, adjacent to the WA State waters boundary.	Twilight Marine Park is significant because it contains habitats, species and ecological communities associated with the Great Australian Bight Shelf Transition bioregion. The AMP supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP include foraging habitat for seabirds, Australian sea lions and white sharks, and a calving buffer area for southern right whales.
Two Rocks Marine Park	II, VI	Two Rocks Marine Park covers an area of 882 km^2 and is located ~25 km north-west of Perth, to the north-west of the WA Marmion Marine Park.	Two Rocks Marine Park is significant because it includes habitats, species and ecological communities associated with the South-west Shelf Transition bioregion. It includes three KEFs: Commonwealth marine environment within and adjacent to the west-coast inshore lagoons; Western rock lobster; and Ancient coastline at 90-120 m depth. The AMP supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP 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.
State Marine Parks and Reserves			
Jurien Bay Marine Park	Sanctuary, Special Purpose and General Use Zones.	The Jurien Bay Marine Park is located on the central west coast of WA ~200 km north of Perth and covers an area of 824 km^2.	An extensive limestone reef system parallel to the shore has created a huge shallow lagoon that provides perfect habitat for Australian sea lions, dolphins and a myriad of juvenile fish. Extensive seagrass meadows inside the reef shelter many marine animals such as western rock lobsters, octopus and cuttlefish that make up the diet of young sea lions. The marine park also surrounds dozens of ecologically important islands that contain rare and endangered animals found nowhere else in the world (CALM, 2005b).
Marmion Marine Park	Sanctuary, Recreation and Special Use Zones.	The Marmion Marine Park lies within State waters between Trigg Island and Burns Beach and encompasses a coastal area of ~95 km^2. Marmion	The marine park has a number of sanctuary zones including Little Island, The Lumps and the Boyinaboat Reef protecting a variety of habitats from limestone reefs, seagrass beds and clear shallow lagoons that support a diversity of marine life. In addition, to a general use zone and the Waterman Recreation Area. The marine park contains important habitat for the endemic Australian

Protected Area	IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
		Marine Park was the State's first marine park, declared in 1987.	sea lion, an array of seabird species migratory whales are regular visitors (CALM, 1992; DPAW, 2016d).
Swan Estuary Marine Park	Special Purpose and Nature Reserve Zones.	Three biologically important areas of Perth's Swan River make up the Swan Estuary Marine Park, including Alfred Cove, Pelican Point and Crawley. These three sites cover a total area of 3.4 km^2.	The sand flats, mud flats and beaches at the three locations of the Swan Estuary Marine Park provide the only remaining significant feeding and resting areas in the Swan Estuary, for trans-equatorial migratory wading and waterbirds. The Park and adjacent reserves also provide habitat for a diverse assemblage of aquatic and terrestrial flora and fauna (CALM, 1999).
Shoalwater Islands Marine Park	Sanctuary, Special Purpose and General Use Zones.	The Shoalwater Islands Maine Park is located adjacent to Rockingham on the south-west coast of WA, ~50 km south of Perth and covers an area of ~66 km^2.	The Shoalwater Islands Marine Park consists of a complex seabed and coastal topography consisting of islands, limestone ridges and reef platforms, protected inshore areas and deeper basins, sandbars and beaches, and is home to five species of cetacean and 14 species of sea and shore bird. The waters of the marine park are also used to access feeding grounds for the little penguin (*Eudyptula minor*) colony on Penguin Island, which is close to the northernmost limit of the species' range and is the largest known breeding colony in Western Australia (DEC, 2007c).
Ngari Capes Marine Park	Sanctuary, Special Purpose and Recreation Zones.	The Ngari Capes Marine Park is located off the south-west coast of WA, ~250 km south of Perth, covering ~1238 km^2.	The Ngari Capes Marine Park consists of a complex arrangement of sandy bays, high energy limestone and granite reefs bordered by headlands and cliffs and two weathered capes. Coral communities consist of both tropical and temperate species. Cetaceans and pinnipeds are resident in and/or transient through the marine park as well as a diverse range of seabirds and shorebirds (DEC, 2013).
Walpole and Nornalup Inlets Marine Park	Recreation Zone.	The Walpole and Nornalup Inlets Marine Park is located adjacent to the towns of Walpole and Nornalup on the south coast of WA, ~120 km west of Albany, and covers ~14 km^2.	The Walpole and Nornalup Inlets Marine Park consists of a geologically complex lagoonal estuarine system comprising three significant rivers and two connected inlets that are permanently open to the ocean. Approximately 40 marine and estuarine finfish species commonly inhabit the inlet system, as well as a variety of shark and ray species and numerous seabirds and shorebirds. The sandy beaches and shoreline vegetation of the inlet system are of high ecological and social importance to the marine park (DEC, 2009).

**Conservation objectives for IUCN categories include:*

Ia: Strict Nature Reserve

Ib: Wilderness Area

II: national Park

III: Natural Monument or Feature

IV: Habitat/Species Management Area

V: Protected Landscape

VI: Protected area with sustainable use of natural resources – allow human use but prohibits large scale development.

IUCN categories for the marine park are provided and, in brackets, the IUCN categories for specific zones within each Marine Park as assigned under the South-west Marine Parks Network Management Plan 2018 (DNP, 2018b)

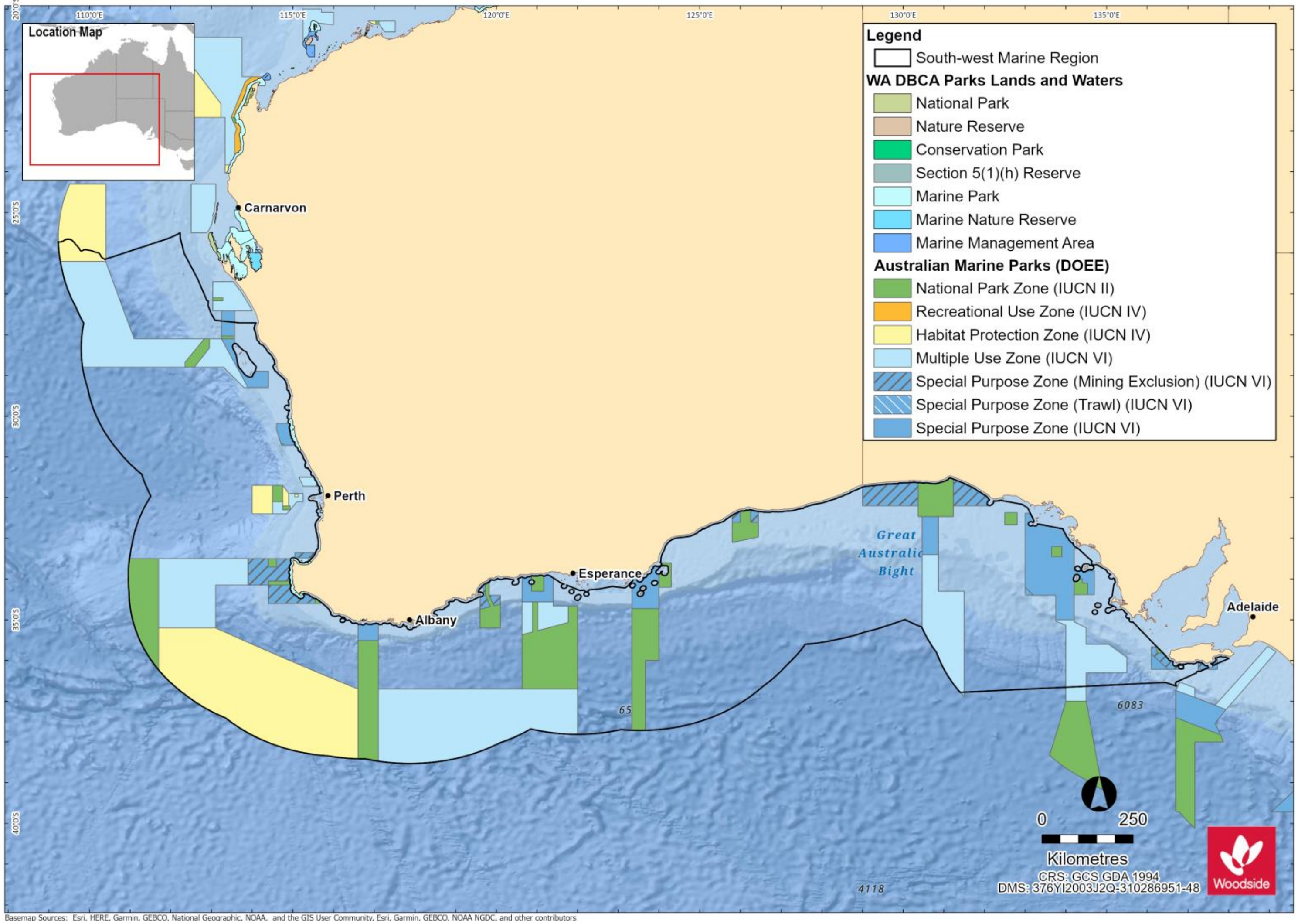

Figure 10-2. Commonwealth and State Marine Protected Areas for the SWMR

10.11 Summary of Protected Areas within the NMR

Table 10-3 Protected Areas within the NMR

Protected Area	IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
World Heritage Properties			
Kakadu National Park		Kakadu National Park is a living landscape with exceptional natural and cultural values. It is the largest National Park in Australia and preserves the greatest variety of ecosystems on the Australian continent including extensive areas of floodplains, mangroves, tidal mudflats, coastal areas and monsoon forests. The park was inscribed the World Heritage list in three stages over 11 years. It is located in tropical north Australia covering a total area of 19,804 square kilometres.	The conservation values reflect the WHA Criterion: (i), (vi), (vii) and (ix): Natural features relate to Criterion (vii) – the remarkable contrast between the internationally recognised Ramsar-listed wetlands and the spectacular rocky escarpment and its outliers and Criterion (ix) – four major river systems of tropical Australia and floodplains that are dynamic environments, shaped by changing sea levels and big floods every wet season. These floodplains illustrate the ecological and geomorphological effects that have accompanied Holocene climate change and sea level rise. Kakadu National Park contains important and significant habitats supporting a diverse range of flora and fauna.
National Heritage Places - Natural			
Kakadu National Park		Refer to World Heritage property description above.	Refer to World Heritage property conservation values above
Commonwealth Heritage Places - Natural			
N/A			
Wetlands of International Importance (Ramsar)			
Kakadu National Park		Australian Ramsar site number 2. The stage 1 and 2 Ramsar sites, established in 1980, 1985 and 1989, respectfully were combined into a single Ramsar site in 2010.	The Kakadu National Park Ramsar site straddles the western edge of the Arnhem Land Plateau encompassing a range of landforms and extensive floodplains. It is a mosaic of contiguous wetlands comprising the catchments of two large river systems, the East and South Alligator rivers and encompasses extensive tidal mudflat areas. It is an internationally important site for migratory shorebirds as part of the EAAF.

Protected Area	IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
Cobourg Peninsula		Australian Ramsar site number 1 established in 1974. This Ramsar site includes freshwater and extensive intertidal areas but excludes subtidal areas. It is in a remote location and there has been minimal human impact on the site.	The wetlands encompassed in the Ramsar site are some of the better protected and near-natural wetlands in the bioregion and there is a diverse array of wetland in a confined area. The site supports important turtle nesting habitat and habitat for coastal dolphin species and is an internationally significant migratory shorebird habitat as part of the EAAF and an important location for seabird breeding colonies.
Wetlands of National Importance (DAWE, 2019)			
Southern Gulf Aggregation		The site is a complex continuous wetland aggregation in the Gulf of Carpentaria, covering an area of ~5460 km^2 located 58 km east of Burketown, Queensland.	The Southern Gulf Aggregation is the largest continuous estuarine wetland aggregation of its type in northern Australia. It is one of the three most important areas for shorebirds in Australia. The area meets criteria 1, 2, 3, 4, 5 and 6 for inclusion on the Directory of Important Wetlands in Australia.
Australian Marine Parks (DNP, 2018c)			
Arafura Marine Park	VI	Arafura Marine Park covers an area of 22,924 km^2 is located ~256 km north-east of Darwin and 8 km offshore of Croker Island, NT. It extends from NT waters to the limit of Australia's EEZ.	The AMP is significant because it contains habitats, species and ecological communities associated with two bioregions: • Northern Shelf Province • Timor Transition. It includes one KEF: Tributary canyons of the Arafura Depression. The AMP supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP include internesting habitat for marine turtles and important foraging and breeding habitat for seabirds.
Arnhem Marine Park	VI	Arnhem Marine Park covers an area of 7125 km^2 and is located ~100 km south-east of Croker Island and 60 km south-east of the Arafura Marine Park. It extends from NT waters surrounding the Goulburn Islands, to the waters north of Maningrida.	Arnhem Marine Park is significant because it contains habitats, species and ecological communities associated with the Northern Shelf Province bioregion. The AMP supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP include foraging habitat and a migratory pathway for marine turtles and seabirds.
Gulf of Carpentaria Marine Park	II, VI	Gulf of Carpentaria Marine Park covers an area of 23,771 km^2 and is located ~90 km north-west of Karumba, Queensland and is adjacent to the Wellesley Islands in	Gulf of Carpentaria Marine Park is significant because it contains habitats, species and ecological communities associated with the Northern Shelf Province bioregion.

Protected Area	IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
		the south of the Gulf of Carpentaria basin.	It includes four KEFs: Gulf of Carpentaria basin; Gulf of Carpentaria coastal zone; Plateaux and saddle north-west of the Wellesley Islands; and Submerged coral reefs of the Gulf of Carpentaria. The AMP supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP include breeding and foraging areas for seabirds and internesting and foraging areas for turtles.
Joseph Bonaparte Gulf Marine Park	VI	The Joseph Bonaparte Gulf Marine Park is located within both the NWMR and NMR. Refer **Table 10-1** for description and conservation values.	
Limmen Marine Park	IV	Limmen Marine Park covers an area of 1399 km^2 and is located ~315 km south-west of Nhulunbuy, NT, in the south-west of the Gulf of Carpentaria. It extends from NT waters, between the Sir Edward Pellew Group of Islands and Maria Island in the Limmen Bight, adjacent to the NT Limmen Bight Marine Park.	Limmen Marine Park is significant because it contains habitats, species and ecological communities associated with the Northern Shelf bioregion. It includes one KEF: Gulf of Carpentaria coastal zone. The AMP supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP include internesting and foraging habitat for marine turtles.
Oceanic Shoals Marine Park	II, IV, VI	The Oceanic Shoals Marine Park is located within both the NWMR and NMR. Refer **Table 10-1** for description and conservation values.	
Wessel Marine Park	IV, VI	Wessel Marine Park covers an area of 5908 km^2 and is located ~22 km east of Nhulunbuy, NT. It extends from NT waters adjacent to the tip of the Wessel Islands to NT waters adjacent to Cape Arnhem.	Wessel Marine Park is significant because it contains habitats, species and ecological communities associated with the Northern Shelf bioregion. It includes one KEF: Gulf of Carpentaria basin. The AMP supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP include breeding habitat for seabirds and internesting and foraging habitat for marine turtles.
West Cape York Marine Park	II, IV, VI	West Cape York Marine Park covers an area of 16,012 km^2 and is located adjacent to the northern end	West Cape York Marine Park is significant because it contains species and ecological communities associated with two bioregions: • Northeast Shelf Transition

Protected Area	IUCN Protected Area Category* or Relevant Park Zone	Description	Conservation Values
		of Cape York Peninsula ~25 km south-west of Thursday Island and 40 km north-west of Weipa, Queensland.	• Northern Shelf Province. It includes two KEFs: Gulf of Carpentaria basin; and Gulf of Carpentaria coastal zone. The AMP supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the AMP include breeding and foraging habitat for seabirds, internesting and foraging habitat for marine turtles and dugong, and foraging, breeding and calving habitat for dolphins.
Territory Marine Parks and Reserves			
Cobourg Marine Park	II, IV, VI	Cobourg Marine Park covers an area of 2,290 km^2 and is located in the waters surrounding the Cobourg Peninsula ~220 km north-east of Darwin. The Marine Park is part of the larger Garig Gunak Barlu National Park. Garig Gunak Barlu National Park includes both the Marine Park and the Cobourg Sanctuary.	Cobourg Marine Park is located in the Cobourg and Van Diemen Gulf marine bioregions with the northern portion of the Park covered by the Cobourg marine bioregion and the southern portion covered by the Van Diemen Gulf marine bioregion. The Marine Park is characterised by a number of deeply incised bays and estuaries on its northern shores. These bays are ancient river valleys that were drowned during periods of sea level rise and provide a varied environment and habitat that is quite distinct from the open water areas of the Park. The areas of the Park that have been studied and where extensive collections have been made indicates that the Park supports rich and diverse marine life including live coral reefs, seagrass, diverse reef and pelagic fish populations, marine turtles and dugong.

**Conservation objectives for IUCN categories include:*

Ia: Strict Nature Reserve

Ib: Wilderness Area

II: National Park

III: Natural Monument or Feature

IV: Habitat/Species Management Area

V: Protected Landscape

VI: Protected area with sustainable use of natural resources – allow human use but prohibits large scale development.

IUCN categories for the marine park are provided and, in brackets, the IUCN categories for specific zones within each Marine Park as assigned under the North Marine Parks Network Management Plan 2018 (DNP, 2018c)

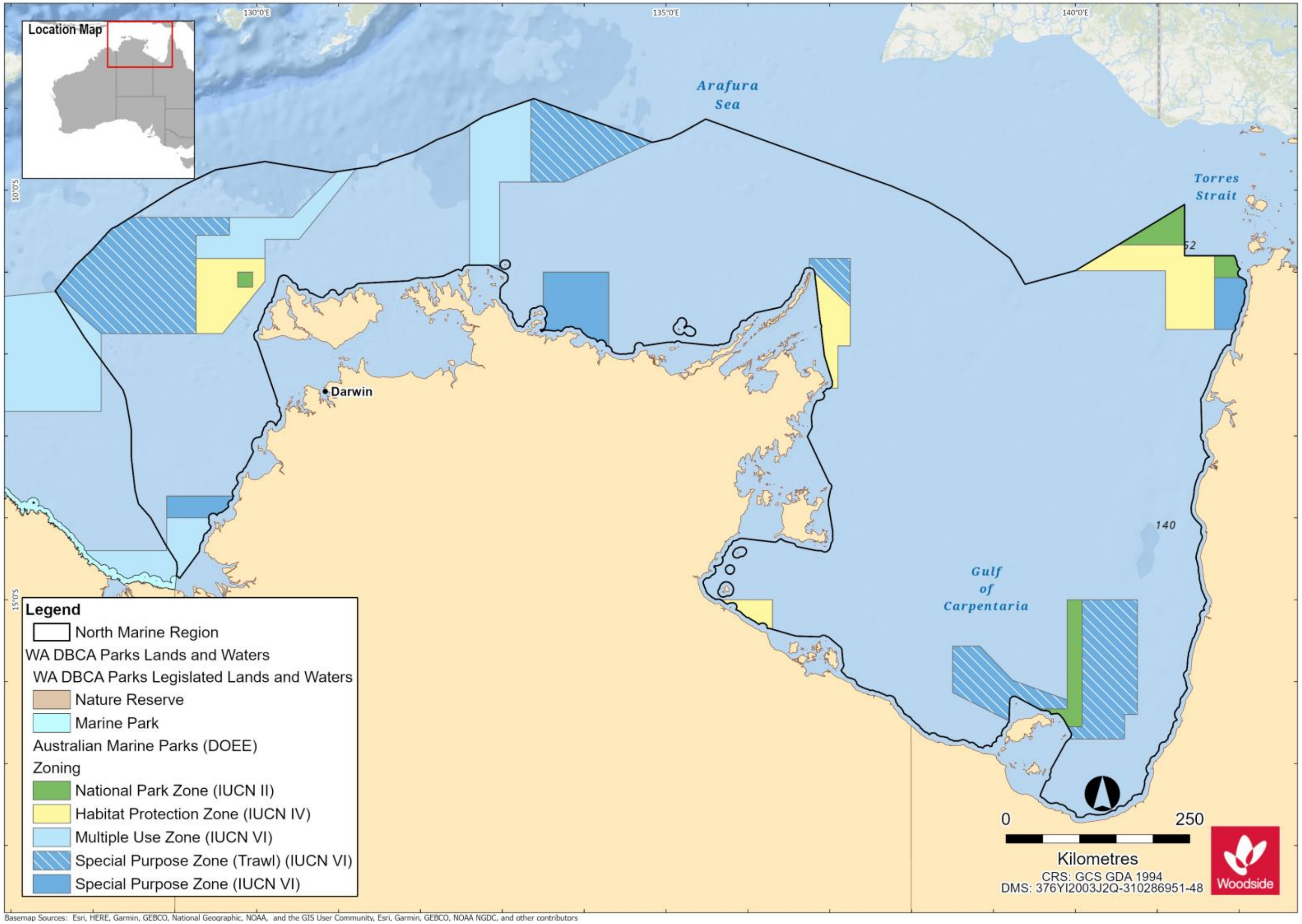

Figure 10-3. Commonwealth and State Marine Protected Areas within the NMR

11. SOCIO-ECONOMIC AND CULTURAL ENVIRONMENT

This section summarises the information relating to the socio-economic and cultural environment of the regions offshore Western Australia, with a focus on the NWMR and to a lesser extent the SWMR and NWR.

The cultural environment includes Indigenous and European heritage values, including underwater values such as historic shipwrecks. Socio-economic values include commercial and traditional fishing, tourism and recreation, shipping, oil and gas activities and defence activities.

11.1 Cultural Heritage

11.1.1 Indigenous Sites of Significance

Murujuga (the Burrup Peninsula) has a very high density of significant Indigenous heritage sites and places with tangible and intangible heritage values. The area has one of the largest, densest, and most diverse collections of rock art in the world. It is estimated that the peninsula and surrounding islands contain over a million petroglyphs (rock engravings) covering a broad range of styles and subjects. The landscape also contains quarries, middens, fish traps, rock shelters, ceremonial sites, artefact scatters, grinding patches and stone arrangements that evidence tens of thousands of years of human occupation. These places are linked to Aboriginal cosmology, Dreaming stories and songs through the stories, knowledge and customs that are still held by traditional custodians.

In 2007 the Dampier Archipelago (including the Burrup Peninsula) was included on the National Heritage List due to outstanding heritage values relating to Australia’s cultural history contained in the large number, density, diversity, distribution and fine execution of rock art. Within the National Heritage Place, the Murujuga National Park covers 4913 ha and is co-managed by the Murujuga Aboriginal Corporation and the Department of Biodiversity, Conservation and Attractions. The Murujuga Cultural Landscape was also added to Australia’s Tentative World Heritage List in 2020, with full World Heritage Listing anticipated in 2024.

Woodside also recognises the potential for heritage to survive in submerged landscapes. Sea-level rises since the last ice age mean that areas now under the sea were once exposed, that many of today’s islands would have been connected to the mainland, and that Aboriginal people are highly likely to have inhabited these places. Woodside works with traditional custodians, academics and heritage professionals to identify tangible and intangible heritage values in the submerged landscape to avoid disturbing heritage where possible and to minimise impacts where heritage cannot be avoided.

It is an offence to excavate, destroy, damage, conceal or alter Indigenous heritage onshore or in state waters under section 17 of the *Aboriginal Heritage Act 1972 (WA) (AHA)* without ministerial authorisation. Where there is a risk of injury or desecration to a significant Aboriginal area, even where permitted under the AHA, any Aboriginal person may apply to the federal Environment Minister for a declaration under sections 9 or 10 of the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (Cth)* for the protection and preservation of that area.

The Department of Planning, Lands and Heritage maintains a register of registered sites and heritage places including middens, burial, ceremonial [sites], artefacts, rock shelters, mythological [sites] and engraving sites. There are over 1600 registered sites on Murujuga and the Dampier Archipelago with around 1100 other heritage places. This register is not comprehensive and will be complemented by heritage surveys where necessary. Protection of National and World Heritage values is also legislated through various provisions of the *Environment Protection and Biodiversity Conservation Act 1999 (Cth)*. Murujuga National Park is managed under the *Conservation and Land Management Act 1984 (WA)*.

11.1.2 European Sites of Significance

European sites of significance and heritage value are found along adjacent foreshores of the SWMR, NWMR and NWR. Heritage values are protected in Western Australia under the *Heritage Act 2018*.

11.1.3 Underwater Cultural Heritage

Places of historic cultural significance are protected under Commonwealth, State and local regimes. Places inscribed on the National or World Heritage list are protected through various provisions of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth). Historic places may also be protected under the *Heritage Act 2018* (WA); under section 129 the prohibited alteration, demolition, damage, despoilment or removal of objects from a registered place may result in a fine of A$1 million. Protection of heritage by local government typically emanates from local planning schemes produced under Part 5 of the *Planning and Development Act 2005* (WA).

The remains of vessels and aircraft in Commonwealth waters, along with any associated article, are automatically protected under the *Underwater Cultural Heritage Act 2018* (Cth) after 75 years. Remains and relics of any ship lost, wrecked or abandoned in Western Australian waters before 1900 are protected by the *Maritime Archaeology Act 1973* (WA).

The Australian National Shipwreck Database and the WA Maritime Museum Shipwreck Database list these protected wrecks.

11.1.4 National and Commonwealth Listed Heritage Places

Australia's National Heritage Sites are those of outstanding natural, historic and/or Indigenous significance to Australia. National Heritage places classed as natural are discussed in **Section 10.3**. Historic and/or Indigenous National Heritage Listed Places of the NWMR include:

- Dampier Archipelago (including Burrup Peninsula)
- Dirk Hartog Landing Site/Cape Inscription
- HMAS Sydney II and the HSK Kormoran Shipwreck Sites
- Batavia Shipwreck Site and Survivor Camps Area 1629 – Houtman Abrolhos

Commonwealth Heritage Places are a collection of sites recognised for their Indigenous, historical and/or natural values, which are owned or controlled by the Australian Government. A number of these sites are owned or controlled by the Department of Defence, as well as Government agencies relating to maritime safety, customs and communication. Commonwealth Heritage places classed as natural are discussed in **Section 10.3**. Listed Heritage Places in the NWMR include:

- Mermaid Reef – Rowley Shoals (refer **Section 10.3**)
- Ashmore Reef National Nature Reserve (refer **Section 10.3**)
- Scott Reef and Surrounds – Commonwealth Area (refer **Section 10.3**)
- Ningaloo Marine Area (refer **Section 10.3**)

World Heritage Properties are those sites that hold universal value which transcends any value they may be held by any one nation. These sites and their qualities are detailed in the Convention concerning the Protection of the World Cultural and Natural Heritage (the World Heritage Convention), to which Australia is a founding member. The Protected Matters Search Report (**Appendix A**) lists two natural World Heritage Properties in the NWMR (refer **Section 10.2**). There are no cultural heritage listings located within the NWMR.

Summary tables of heritage places for NWMR, SWMR and NMR are presented in **Table 11-1,Table 11-2** and **Table 11-3**.

11.2 Summary of Heritage Places within the NWMR

Table 11-1 Heritage Places (Indigenous and Historic) within the NWMR

Heritage Places	Woodside Activity Area			Class	Description	Conservation Values
	Browse	NWS/S	NW Cape			
National Heritage Properties						
Dampier Archipelago (including Burrup Peninsula)	-	✓	-	Indigenous	The Dampier Archipelago (including the Burrup Peninsula) contains one of the densest concentrations of rock engravings in Australia with some sites containing thousands or tens of thousands of images.	The rock engravings comprise images of avian, marine and terrestrial fauna, schematised human figures, figures with mixed human and animal characteristics and geometric designs. At a national level it has an exceptionally diverse and dynamic range of schematised human figures some of which are arranged in complex scenes. The fine execution and dynamic nature of the engravings, particularly some of the composite panels, exhibit a degree of creativity that is unusual in Australian rock engravings.
Dirk Hartog Landing Site 1616 – Cape Inscription Area	-	-	✓	Historic	Cape Inscription is the site of the oldest known landings of Europeans on the WA coastline.	The Cape Inscription area displays uncommon aspects of Australia's cultural history because of the cumulative effect its association with these explorers and surveyors had on growing knowledge of the great southern continent in Europe. The association of the site with these early navigators stimulated the development of the European view of the great southern continent at a time when they began to look at the world with a modern scientific outlook.
Commonwealth Heritage Properties						
N/A						

11.3 Summary of Heritage Places within the NMR

Table 11-2 Heritage Places (Indigenous and Historic) within the NMR

Heritage Places	Class	Description	Conservation Values
National Heritage Properties			
None			
Commonwealth Heritage Properties			
None			

11.4 Summary of Heritage Places within the SWMR

Table 11-3 Heritage Places (Indigenous and Historic) within the SWMR

Heritage Places	Class	Description	Conservation Values
National Heritage Properties			
Cheetup Rock Shelter	Indigenous	Cheetup meaning “place of the birds” is the name of a spacious rock shelter located in Cape Le Grand National Park, about 55 km east of Esperance in WA. Aboriginal people associated with the place identify themselves as Nyungar/Noongar, Ngadju (shortened from Ngadjunmaia) or Mirning.	Cheetup rock shelter provides outstanding evidence for the antiquity of processing and use of cycad seeds by Aboriginal people. The seeds of the cycad are extremely toxic and can cause speedy death if eaten fresh without proper preparation to remove the toxins. The presence of *Macrozamia riedlei* seeds in a pit lined with Xanthorrhoea (grass tree) leaf bases indicates that the Aboriginal people in the Esperance region had the knowledge to remove the toxins of this important source of carbohydrate and protein at least 13,200 years ago.

Heritage Places	Class	Description	Conservation Values
Batavia Shipwreck Site and Survivor Camps Area 1629 – Houtman Abrolhos	Historic	The Batavia and its associated sites hold an important place in the discovery and delineation of the WA coastline. The wreck of the Batavia, and other Dutch ships like her, convinced the VOC (Dutch East India Company) of the necessity of more accurate charts of the coastline and resulted in the commissioning of Vlamingh's 1696 voyage.	Because of its relatively undisturbed nature the archaeological investigation of the wreck itself has revealed a range of objects of considerable value as well as to artefact specialists and historians.
HMAS Sydney II and HSK Kormoran Shipwreck Sites	Historic	The naval battle fought between the Australian warship HMAS Sydney II and the German commerce raider HSK Kormoran off the WA coast during World War II was a defining event in Australia's cultural history. 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. The loss of HMAS Sydney II along with its entire crew of 645 following the battle with HSK Kormoran, remains as Australia's worst naval disaster.	The shipwreck sites of HMAS Sydney II and HSK Kormoran have outstanding heritage value to the nation because of their importance in a defining event in Australia's cultural history and for their part in development of the process of the defence of Australia.
Commonwealth Heritage Properties			
Cliff Point Historic Sites	Historic	Cliff Head is a limestone bluff on the east coast of Garden Island. Evidence of occupation has been reported from the beach just north of the head, the immediate hinterland, the ridge above and on the south face of the ridge.	The Cliff Point Historic Site, individually significant within the area of Garden Island is important as the first site inhabited by Governor Stirling's party in 1829 when founding the colony of WA, and as WA's first official non-convict settlement. The site was occupied in the first instance by Captain Charles Fremantle before the arrival of Captain Stirling. The party occupied the site for two months before a move was made to the Swan River settlement on the mainland.
HMAS Sydney II and HSK Kormoran Shipwreck Sites	Historic	As above	As above
J Gun Battery	Historic	J Battery comprised two 155 mm long range guns, the other similar battery being at Cape Peron on the mainland at the entrance to Cockburn Sound. Located in the dune systems at the north western	J Gun Battery (1942) is individually significant within the area of Garden Island (Register No. 019544) and is historically important as the first gun battery constructed on Garden Island and as one of two long range gun batteries which played a

Heritage Places	Class	Description	Conservation Values
		corner of Garden Island elements of the J Battery complex are now covered in part by sand.	strategic role in the coastal defences of Cockburn Sound and Fremantle following the entry of Japan into the Second World War (1939-45).

11.5 Fisheries - Commercial

11.5.1 Commonwealth and State Fisheries

The diverse range of habitats and species offshore WA has allowed for various fisheries to develop and operate throughout the region.

The Australian Fisheries Management Authority (AFMA) manages fisheries on behalf of the Commonwealth Government and is bound by objectives under the Commonwealth *Fisheries Management Act 1991*.

WA State commercial fisheries are managed by the WA Department of Primary Industries and Regional Development (WA DPIRD) under the WA *Fish Resources Management Act 1994* (FRMA), Fisheries Resources Management Regulations 1995, relevant gazetted notices and licence conditions, and applicable Fishery Management Plans.

Commonwealth and State managed fisheries that operate within the NWMR and in areas beyond this region are summarised in the **Table 11-4**.

Table 11-4 Commonwealth and State managed fisheries

<table>
<tr><th rowspan="2">Fishery</th><th colspan="3">Woodside Activity Area</th><th colspan="3" rowspan="2">Description</th></tr>
<tr><th>Browse</th><th>NWS/S</th><th>NW Cape</th></tr>
<tr><td colspan="7">Commonwealth Managed Fisheries</td></tr>
<tr><td rowspan="5">Southern Bluefin Tuna Fishery</td><td rowspan="5">✓</td><td rowspan="5">✓</td><td rowspan="5">✓</td><td>Management area</td><td colspan="2">The Southern Bluefin Tuna Fishery (SBTF) covers the entire EEZ around Australia, out to 200 nm from the coast. They do not fish in the Woodside activity area.</td></tr>
<tr><td>Species targeted</td><td>Fishing methods</td><td>Fishing depth</td></tr>
<tr><td>Southern bluefin tuna (Thunnus maccoyii)</td><td>Longline and purse seine fishing.</td><td>Southern bluefin tuna is a pelagic species which can be found to depths of 500 m (AFMA, 2021a)</td></tr>
<tr><td>Fishing effort</td><td colspan="2">Most of the Australian fishing effort is by purse-seine vessels in the Great Australian Bight and waters off South Australia during summer months, and by longline off the New South Wales coastline during winter months (Patterson et al., 2020).
SBTF is a fishery that is shared amongst many countries. Australia currently has a 35% share of the total global allowable catch, and while wild capture fishing in Australia to sell directly to market can occur anywhere throughout the SBTF’s range, currently the vast majority of that quota is value-added through ranching (on-growing the wild captured fish for extra 5-6 months). Ranching requires significant infrastructure, a resident labour force, plus proximity to a fishery able to supply a large quantity of natural feed/sardines (40,000+ tonnes) (for example as available in Port Lincoln). North-west WA is critically important regardless of how the quota is fished because of the proximity to the single spawning ground of this global roaming species.
The stock remains classified as overfished.</td></tr>
<tr><td>Active licences/vessels</td><td colspan="2">Seven purse seine vessels, 20 longline vessels (Patterson et al., 2020).</td></tr>
<tr><td>Western Skipjack Tuna Fishery</td><td>✓</td><td>✓</td><td>✓</td><td>Management area</td><td colspan="2">The combined western and eastern skipjack tuna (Katsuwonus pelamis) fisheries (STF) encompass the entire Australian EEZ. The Western Skipjack Tuna Fishery (WSTF) extends westward from the SA/Victorian border across the Great Australian Bight and around the west coast of WA to the Cape York Peninsula.</td></tr>
</table>

<table>
<tr><th rowspan="2">Fishery</th><th colspan="3">Woodside Activity Area</th><th rowspan="2" colspan="3">Description</th></tr>
<tr><th>Browse</th><th>NWS/S</th><th>NW Cape</th></tr>
<tr><td rowspan="4"></td><td rowspan="4"></td><td rowspan="4"></td><td rowspan="4"></td><td>Species targeted</td><td>Fishing methods</td><td>Fishing depth</td></tr>
<tr><td>Western skipjack tuna (Katsuwonus pelamis)</td><td>Fishers use purse seine gear (about 98% of catch) and sometimes pole and line when fishing for skipjack tuna.</td><td>Western skipjack tuna is a pelagic species that can be found to depths of 260 m (AFMA, 2021b).</td></tr>
<tr><td>Fishing effort:</td><td colspan="2">The Skipjack Tuna Fishery (STF) has not been actively fished since the 2008-2009 fishing season (Patterson et al., 2020). The management arrangements for this fishery will be reviewed if active boats re-enter the fishery.</td></tr>
<tr><td>Active licences/vessels:</td><td colspan="2">No active vessels operating since 2009.</td></tr>
<tr><td rowspan="5">Western Tuna and Billfish Fishery</td><td rowspan="5">✓</td><td rowspan="5">✓</td><td rowspan="5">✓</td><td>Management area</td><td colspan="2">The Western Tuna and Billfish Fishery (WTBF) extends to the Australian EEZ boundary in the Indian Ocean.</td></tr>
<tr><td>Species targeted</td><td>Fishing methods</td><td>Fishing depth</td></tr>
<tr><td>Bigeye tuna (Thunnus obesus)
Yellowfin tuna (Thunnus albacares)
Swordfish (Xiphias gladius)
Albacore (Thunnus alalonga)
Striped marlin (Kajikia audax)</td><td>Fishers mainly use pelagic longline fishing gear to catch the targeted species. Minor line (including handline, troll, rod and reel) can also be used.</td><td>Species have a broad depth distribution, with tuna occurring at 150 – 300 m, striped marlin at 150 m and swordfish at up to 600 m (BRS, 2007).</td></tr>
<tr><td>Fishing effort:</td><td colspan="2">The WTBF operates in Australia’s EEZ and high seas of the Indian Ocean. Fishing effort in recent years has been concentrated off south-west WA, with occasional activity off SA.</td></tr>
<tr><td>Active licences/vessels:</td><td colspan="2">Two pelagic longline vessels and two minor longline vessels (Patterson et al., 2020).</td></tr>
<tr><td>Western Deepwater Trawl Fishery</td><td></td><td></td><td>✓</td><td>Management area</td><td colspan="2">The Western Deepwater Trawl Fishery (WDTF) is located in deep water off WA, from the line approximating the 200 m isobath to the edge of the Australian Fishing Zone (AFZ).</td></tr>
</table>

Fishery	Woodside Activity Area			Description		
	Browse	NWS/S	NW Cape			
				Species targeted	**Fishing methods**	**Fishing depth**
				More than 50 species, historically dominated by six commercial finfish species or species groups: Orange roughy (*Hoplostethus atlanticus*) Oreos (Oreosomatidae) Boarfish (Pentacerotidae) Eteline snapper (Lutjanidae: Etelinae) Apsiline snapper (Lutjanidae: Apsilinae) Sea bream (Lethrinidae)	Demersal trawl.	Water deeper than 200 m, stakeholder consultation has indicated that this may be to depths of 800 m.
				Fishing effort:	The number of vessels active in the fishery and total hours trawled have fluctuated from year to year. Notably, total hours trawled were relatively high for a brief period during the early 2000s when fishers targeted ruby snapper and deepwater bugs (Patterson *et al*., 2020). Total fishing effort has been variable but relatively low since then. Effort in 2018-2019 (492 trawl hours) was less than half that of 2017-2018 (1108 trawl hours) (Patterson *et al*., 2020).	
				Active licences/vessels:	One active vessel in 2018-2019 (Patterson *et al.*, 2020).	
North-west Slope Trawl Fishery	✓	✓		**Management area**	The North-west Slope Trawl Fishery (NWSTF) extends, from 114 °E to 125 °E, from the 200 m isobath to the outer limit of the AFZ (200 nm from the coastline, which is the boundary of the Australian EEZ).	
				Species targeted	**Fishing methods**	**Fishing depth**
				Australian scampi (*Metanephrops australiensis*) and smaller quantities of velvet and Boschma's scampi (*M. velutinus* and *M. boschmai*) Mixed snappers have historically been an important component of the catch.	Demersal trawl.	Typically at depths of 350 to 600 m (Patterson *et al*., 2017), however stakeholder consultation has indicated that this may be to depths of 800 m.

<table>
<tr><th rowspan="2">Fishery</th><th colspan="3">Woodside Activity Area</th><th rowspan="2" colspan="3">Description</th></tr>
<tr><th>Browse</th><th>NWS/S</th><th>NW Cape</th></tr>
<tr><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td>Fishing effort:</td><td colspan="2">The NWSTF commenced in 1985 and the number of active vessels peaked at 21 in the 1986-1987 season and declined through the 1990s before increasing to 10 vessels in 2000-2001 and 2002-2002 seasons. Four vessels operated in the 2017-2018 and 2018-2019 seasons (Patterson et. al. 2020).
Fishing for scampi occurs over soft, muddy sediments or sandy habitats, using demersal trawl gear on the continental slope (Patterson et al., 2017).</td></tr>
<tr><td>Active licences/vessels:</td><td colspan="2">Four vessels (Patterson et. al., 2020).</td></tr>
<tr><td colspan="7">State Managed Fisheries</td></tr>
<tr><td rowspan="4">Pilbara Fish Trawl (Interim) Managed Fishery</td><td rowspan="4"></td><td rowspan="4">✓</td><td rowspan="4"></td><td>Management area</td><td colspan="2">The Pilbara Trawl (Interim) Managed Fishery is of high intensity and is divided into two zones and an area governed by Schedule 5 (prohibited to trawling). In addition to the Prohibited Trawl Fishing area, no fish trawl units are allocated for use in Zone 1 or Areas 3 and 6 of Zone 2 (which comprises six management areas) (Newman et al., 2020a). No fish trawl units have been allocated for use in Area 6 of Zone 2 since the management plan commenced operation in 1998.</td></tr>
<tr><td>Species targeted</td><td>Fishing methods</td><td>Fishing depth</td></tr>
<tr><td>The Pilbara Fish Trawl (Interim) Managed Fishery (PFTIMF) targets more than 50 scalefish species.
The five main demersal scalefish species landed by the fisheries in the Pilbara region are blue-spotted emperor, crimson snapper, rosy threadfin bream, red emperor and goldband snapper in 2018 (Newman et al., 2020a).</td><td>Demersal trawl.</td><td>The Pilbara Fish Trawl Fishery lands the largest component of the catch and operates in waters between 50 and 200 m water depth (Allen et al., 2014, Newman et al. 2015). Stakeholders have advised that trawling can occur in depths of up to approximately 800 m.</td></tr>
<tr><td>Fishing effort:</td><td colspan="2">Based on State of the Fisheries annual reports provided by DPIRD, catch trends are seen to be increasing over the past reporting years:</td></tr>
</table>

Fishery	Woodside Activity Area			Description		
	Browse	NWS/S	NW Cape			
					Pilbara Trawl (Interim) Managed Fishery caught 1996 t in 2018-19, 1780 t in 2017-18, 1529 t in 2016-17, 1172 t in 2015-16, 1105 t in 2014-15.	
				Active licences/vessels:	Two Pilbara Trawl (Interim) Managed Fishery vessels in 2017 (Newman *et al*., 2020a). Active vessels data are confidential as there were fewer than three vessels in the Pilbara Fish Trawl Interim Managed Fishery (Newman *et al*., 2020a).	
Pilbara Trap Managed Fishery		✓	✓	**Management area**	The Pilbara Trap Fishery covers the area from Exmouth northwards and eastwards to the 120° line of longitude, and offshore as far as the 200 m isobath. Like the trawl fishery, the trap fishery is also managed using input controls in the form of individual transferable effort allocations monitored with a satellite-based vessel management system. The fishery includes six licences allocated to three vessels, operating principally from Onslow.	
				Species targeted	**Fishing methods**	**Fishing depths**
				Pilbara Trap Managed Fishery catch is made up of around 45-50 different fish species. The four main species landed by the fisheries in the Pilbara region are blue-spotted emperor, red emperor, goldband snapper and Rankin cod.	Demersal fish traps.	Greatest effort in waters less than 50 m depth targeting high value species such as red emperor and goldband snapper.
				Fishing effort	Based on State of the Fisheries annual reports provided by DPIRD, catch trends are seen to be increasing over the past reporting years: Pilbara Trap Managed Fishery caught 563 t in 2018-19, 573 t in 2017-18, 495 t in 2016-17, 510 t in 2015-16, 268 t in 2014-15. In 2018, the total catch for the Pilbara Trap Managed Fishery was 563 t, making up 21% of the total catch by the Pilbara Demersal Scale Fishery (Newman *et al*., 2019).	

Fishery	Woodside Activity Area			Description		
	Browse	NWS/S	NW Cape			
				Active licences/vessels	In the 2019 season, there were six licences in the Pilbara Trap Managed Fishery, (Newman *et al*., 2020a). Active vessels data are confidential as there were fewer than three vessels in the Pilbara Trap Managed Fishery (Newman *et al*., 2019).	
Pilbara Line Managed Fishery		✓	✓	**Management area**	The Pilbara Line Managed Fishery boat licences are permitted to operate anywhere within "Pilbara waters", bounded by a line commencing at the intersection of 21°56'S latitude and the high water mark on the western side of the North-west Cape on the mainland of WA; west along the parallel to the intersection of 21°56'S latitude and the boundary of the AFZ and north to longitude 120°E.	
				Species targeted	**Fishing method**	**Fishing depths**
				The Pilbara Line Managed Fishery catch is made up around 45-50 different fish species. The Pilbara Line Managed Fishery targets similar demersal species to the Pilbara Trap and Trawl fisheries, as well as some deeper offshore species such as ruby snapper and eightbar grouper The Pilbara Line Managed Fishery operates on an exemption basis that enables licence holders to fish for any nominated five-month block during the year.	Demersal long line.	Pilbara Line Fishing Depth: Operates up to a depth of 600 m.
				Fishing effort	Based on State of the Fisheries annual reports provided by DPIRD, catch trends are seen to be increasing over the past reporting years: Pilbara Line Managed Fishery caught 93 t in 2018-19, 143 t in 2017-18, 126 t in 2016-17, 97 t in 2015-16, 40 t in 2014-15. The total catch in 2018 for the Pilbara Line Managed Fishery was 93 t, making up 3% of the total catch by the Pilbara Demersal Scalefish Fishery (Newman *et al*., 2019).	

<table>
<tr><th rowspan="2">Fishery</th><th colspan="3">Woodside Activity Area</th><th colspan="3" rowspan="2">Description</th></tr>
<tr><th>Browse</th><th>NWS/S</th><th>NW Cape</th></tr>
<tr><td></td><td></td><td></td><td></td><td>Active licences/vessels</td><td colspan="2">In the 2018 season there are nine individual licences in the Pilbara Line Fishery, held by seven operators.
Active vessels data is confidential as there were fewer than three vessels in the Pilbara Line Fishery (Newman et al., 2018).</td></tr>
<tr><td rowspan="5">Mackerel Managed Fishery</td><td rowspan="5">✓</td><td rowspan="5">✓</td><td rowspan="5">✓</td><td>Management area</td><td colspan="2">The commercial fishery extends from Geraldton to the Northern Territory border. There are three managed fishing areas: Kimberley (Area 1), Pilbara (Area 2), and Gascoyne and West Coast (Area 3).</td></tr>
<tr><td>Species targeted</td><td>Fishing methods</td><td>Fishing depth</td></tr>
<tr><td>Spanish mackerel (Scomberomorus commerson)
Grey mackerel (S. semifasciatus)
Other species from the genus Scomberomorus</td><td>Near-surface trawling gear.
Jig fishing.</td><td>Previous engagement with WAFIC suggests that the depth of fisheries may extend to 70 m.</td></tr>
<tr><td>Fishing effort:</td><td colspan="2">Most of the catch is taken from waters off the Kimberley coasts (Lewis and Brand-Gardner, 2018), reflecting the tropical distribution of mackerel species (Molony et al., 2015). Most fishing activity occurs around the coastal reefs of the Dampier Archipelago and Port Hedland area, with the seasonal appearance of mackerel in shallower coastal waters most likely associated with feeding and gonad development before spawning (Mackie et al., 2003).
Based on State of the Fisheries annual reports provided by DPIRD, catch trends are as follows:
213 t in 2018-19 (the lowest on record (Lewis et al., 2020), 283 t in 2017-18, 276 t in 2016-17, 302 t in 2015-16, 322 t in 2014-15.</td></tr>
<tr><td>Active licences/vessels:</td><td colspan="2">Fifteen boats fished in 2018, with approximately 35-40 people directly employed in the Mackerel Managed Fishery, primarily from May-November (Lewis et al., 2020).</td></tr>
<tr><td rowspan="2">Marine Aquarium Managed Fishery</td><td rowspan="2">✓</td><td rowspan="2">✓</td><td rowspan="2">✓</td><td>Management area</td><td colspan="2">The Marine Aquarium Managed Fishery is able to operate in all State waters. The fishery is typically more active in waters south of Broome and higher levels of effort around the Capes region, Perth, Geraldton, Exmouth, Dampier and Broome (Newman et al., 2020b).</td></tr>
<tr><td>Species targeted</td><td>Fishing methods</td><td>Fishing depth</td></tr>
</table>

<table>
<tr><th rowspan="2">Fishery</th><th colspan="3">Woodside Activity Area</th><th rowspan="2" colspan="4">Description</th></tr>
<tr><th>Browse</th><th>NWS/S</th><th>NW Cape</th></tr>
<tr><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td colspan="2">Finfish, hard coral, soft coral, tridacnid clams, syngnathids (seahorses and pipefish), other invertebrates (including molluscs, crustaceans, echinoderms etc.), algae, seagrasses and ‘live rock’.</td><td>The fishery is diver-based, which typically restricts effort to safe diving depths (less than 30 m).</td><td>Less than 30 m, as advised by WAFIC.</td></tr>
<tr><td>Fishing effort:</td><td colspan="3">Total catch for the Marine Aquarium Managed Fishery in 2018 was 156,188 fishes, 32.025 t of coral, live rock and living sand and 176.02 L of marine plants and live feed.</td></tr>
<tr><td>Active licences/vessels:</td><td colspan="3">Eleven licences were active in 2019 (Newman et al., 2020b).</td></tr>
<tr><td rowspan="5">Beche-de-mer Fishery</td><td rowspan="5">✓</td><td rowspan="5">✓</td><td rowspan="5">✓</td><td>Management area</td><td colspan="3">Fishing occurs in the northern half of WA from Exmouth Gulf to the NT border and is managed under Ministerial Exemptions.</td></tr>
<tr><td colspan="2">Species targeted</td><td>Fishing methods</td><td>Fishing depth</td></tr>
<tr><td colspan="2">The sea cucumber fishery targets two main species: sandfish (Holothuria scabra) and redfish (Actinopyga echinites).</td><td>Diving</td><td>The targeted species typically inhabit nearshore in shallow depths.</td></tr>
<tr><td>Fishing effort</td><td colspan="3">Based on State of the Fisheries annual reports provided by DPRID, catch trends are as follows:
62t in 2018 (Gaughan and Santoro, 2020), 135t in 2017, 93t in 2016, 38t in 2015</td></tr>
<tr><td>Active licences/vessels</td><td colspan="3">Six active licences in 2019 (Hart et al., 2019). Active vessels data is confidential as there were fewer than three vessels.</td></tr>
<tr><td rowspan="2">Onslow Prawn Managed Fishery</td><td rowspan="2"></td><td rowspan="2">✓</td><td rowspan="2"></td><td>Management area</td><td colspan="3">The Onslow Prawn Managed Fishery encompasses a portion of the continental shelf off the Pilbara.</td></tr>
<tr><td colspan="2">Species targeted</td><td>Fishing methods</td><td>Fishing depth</td></tr>
</table>

Fishery	Woodside Activity Area			Description		
	Browse	NWS/S	NW Cape			
				The fishery targets: Western king prawns (*Penaeus esculentus*) Brown tiger prawns (*Penaeus esculentus*) Blue endeavour prawns (*Metapenaeus endeavouri*	Low opening, otter prawn trawl systems.	Prawn trawling takes place in water depths of approximately 30 metres and less (licence holder feedback). Fishery and or fishing activity overlaps the Beadon Creek dredging scope (Sporer *et al*., 2015).
				Fishing effort:	The total landings for the Onslow Prawn Managed Fishery in 2018 were less than 60 t below the target catch range (Kangas *et al*., 2020a).	
				Active licences/vessels:	One vessel (Kangas *et al*., 2020a).	
Pearl Oyster Managed Fishery	✓	✓	✓	**Management area**	Located in shallow coastal waters with the pearl oyster managed fishery designated by four zones extending from Exmouth to Kununurra and the seaward boundary demarcated by the 200 nm EEZ.	
				Species targeted	**Fishing methods**	**Fishing depth**
				Pearl oysters (*Pinctada maxima*).	Drift diving.	Fishing effort is mostly focussed in shallow coastal waters (10-15 m depth), with a maximum depth of 35 m (Lulofs *et al.* 2002).
				Fishing effort:	In 2018, catch was taken from Zones 2 and 3 with no fishing in Zone 1. The number of pearl oysters caught for 2018-19 was 614,002. Total effort was 15,637 dive hours, this was an increase from 2017 effort of 12,845 hours. No fishing occurred in Zone 1 in 2017 and 2018 (Gaughan and Santoro, 2020).	
				Active licences/vessels:	15,637 diver hours (Hart *et al.*, 2020a).	
		✓	✓	**Management area**	The Pilbara Crab Managed Fishery comprises WA waters off the north-western coast of WA north of 23° 34′ south latitude and west of 120° 00′ east longitude. Areas of the fishery north and east of Exmouth and	

Fishery	Woodside Activity Area: Browse	Woodside Activity Area: NWS/S	Woodside Activity Area: NW Cape	Description			
Pilbara Crab Managed Fishery					nearshore are currently closed as per Schedule 2 of the Draft Management Plan for the Pilbara Crab Managed Fishery.		
				Species targeted		**Fishing methods**	**Fishing depth**
				Crabs of the Family Portunidae, excluding crabs of the genus *Scylla*.		Traps.	Up to 50 m deep.
				Fishing effort:	The capacity of the fishery is 600 traps.		
				Active licences/vessels:	No information available at this time.		
South-west Coast Salmon Managed Fishery	✓	✓	✓	**Management area**	The South-west Coast Salmon Managed Fishery operates on various beaches south of the metropolitan area and includes all WA waters north of Cape Beaufort except Geographe Bay.		
				Species targeted		**Fishing methods**	**Fishing depth**
				Western Australian salmon (*Arripis truttaceus*)		Beach seine nets.	Information not available however, species generally found in shallow waters (up to 30 m).
				Fishing effort:	No fishing occurs north of the Perth metropolitan area, despite the managed fishery boundary extending to Cape Beaufort (WA/Northern Territory border), as advised by WAFIC. The 2018 commercial catch was 191 t, with 72% taken by the South West Coast Salmon Managed Fishery, 25% by the South Coast Salmon Managed Fishery and 3% by other fisheries (Duffy and Blay, 2020a).		
				Active licences/vessels:	Six licences.		
	✓	✓	✓	**Management area**	The Specimen Shell Managed Fishery (SSMF) encompasses the entire WA coastline, but effort is concentrated in areas adjacent to the population centres such as Broome, Exmouth, Shark Bay,		

Fishery	Woodside Activity Area			Description			
	Browse	NWS/S	NW Cape				
Specimen Shell Managed Fishery					Geraldton, Perth, Mandurah, the Capes area and Albany (Hart *et al.*, 2020b). There are a number of closed areas where the SSMF is not permitted to operate. These include various marine parks and aquatic reserves, such as Ningaloo Marine Park.		
				Species targeted		**Fishing methods**	**Fishing depth**
				The Specimen Shell Managed Fishery targets the collection of specimen shells for display, collection, cataloguing and sale.		Collection is predominantly by hand when diving to wading in shallow, coastal waters, though in deeper water collection may be conducted by remotely operated vehicles (limited to one per licence).	For collection by hand, (diver-based) this typically restricts effort to safe diving depths (less than 30 m). ROV collection could enable depths up to 300 m (Hart *et al.*, 2017). In the past there has been one licence holder in the Specimen Shell Managed Fishery who has trialled ROV means of shell collection, WAFIC have provided advice that this fishery is no longer active.
				Fishing effort:	Information not available.		
				Active licences/vessels:	In 2018 there were 31 licences with only two divers allowed in the water per licences at one time (Hart *et al.*, 2018). The number of people employed regularly in the fishery is likely to be about 21 (Hart *et al.*, 2018).		
West Australian Abalone Fishery	✓	✓	✓	**Management area**	The Western Australian Abalone Fishery includes all coastal waters from the WA and SA border to the WA and NT border. The fishery is concentrated on the south coast and the west coast.		
				Species targeted		**Fishing methods**	**Fishing depth**
				Greenlip abalone (*Haliotis laevigata*) Brownlip abalone (*Haliotis conicopora*) Roe’s abalone (*Haliotis roei*)		Divers.	Distribution to 5 m depth for Roe’s abalone and 40 m depth for greenlip / brownlip abalone (DOF, 2011).

Fishery	Woodside Activity Area: Browse	Woodside Activity Area: NWS/S	Woodside Activity Area: NW Cape	Description		
				Fishing effort:	In 2018, the total commercial catch was 48 t, 1 t less than the catch in each of the last two seasons. No commercial fishing for abalone north of Moore River (Zone 8 of the managed fishery) has occurred since 2011–2012 (Strain *et al.*, 2018).	
				Active licences/vessels:	26 vessels active in Roe's abalone fishery (WAFIC[5]).	
West Coast Deep Sea Crustacean Managed Fishery	✓	✓	✓	**Management area**	The West Coast Deep Sea Crustacean Managed Fishery extends north from Cape Leeuwin to the WA/NT border in water depths greater than 150 m within the AFZ.	
				Species targeted	**Fishing methods**	**Fishing depth**
				The fishery targets deepwater crustaceans. Catches were dominated by crystal crabs of which 99% of their Total Allowable Catch (TAC) was landed (How and Orme, 2020a). Crystal (snow) crab (*Chaceon albus*) Giant (king) crab (*Pseudocarcinus gigas*) Champagne (spiny) crabs (*Hypothalassia acerba*)	Baited pots, or traps, are operated in long-lines which have between 80 and 180 pots attached to a main line marked by a float at each end.	Deeper than 150 m (and mostly at depths of between 500 m – 800 m). Most of the commercial Crystal crab catch is taken in depths of 500 m – 800 m (WAFIC[6]).
				Fishing effort:	The total landings in 2018 was 168. t. Two vessels operated in the fishery in 2017, using baited pots operated in a longline formation in the shelf edge waters, mostly in depths between 500 and 800 m (How and Orme, 2020a). Fishing effort was concentrated between Fremantle and Carnarvon.	
				Active licences/vessels:	There were four active vessels in 2018 (How and Orme, 2020a).	

[5] https://www.wafic.org.au/fishery/roes-abalone-fishery/
[6] https://www.wafic.org.au/fishery/west-coast-deep-sea-crustacean-fishery/

<table>
<tr><th rowspan="2">Fishery</th><th colspan="3">Woodside Activity Area</th><th colspan="3" rowspan="2">Description</th></tr>
<tr><th>Browse</th><th>NWS/S</th><th>NW Cape</th></tr>
<tr><td rowspan="5">Abrolhos Islands and Mid-West Trawl Fishery</td><td rowspan="5"></td><td rowspan="5"></td><td rowspan="5">✓</td><td>Management area</td><td colspan="2">The Abrolhos Islands and Mid-West Trawl Fishery (AIMWTMF) operates around the Abrolhos Islands within the SWMR.</td></tr>
<tr><td>Species targeted</td><td>Fishing methods</td><td>Fishing depth</td></tr>
<tr><td>Saucer scallops (Ylistrum balloti, formerly Amusium balloti)</td><td>Trawl.</td><td>Information not available, however, the species occurs at depth of around 30-60 m and therefore fishing effort would likely be at these depths (Himmelman et al., 2009).</td></tr>
<tr><td>Fishing effort:</td><td colspan="2">The scallop landings in the AIMWTMF were 31.0 t meat weight (154.8 t whole weight). Between 2011 and 2015, the annual pre-season surveys showed very low recruitment (1-year old), as a result of the 2011 extreme marine heatwave and subsequent poor pawning stock (Kangas et al., 2020b). The fishery was closed between 2011 and 2016.</td></tr>
<tr><td>Active licences/vessels:</td><td colspan="2">Information about licences or vessels is not available but the Department of Primary Industry and Regional Development reported 774 t of catch from this fishery in the 2019 annual report (DPIRD, 2019).</td></tr>
<tr><td rowspan="4">Broome Prawn Managed Fishery</td><td rowspan="4">✓</td><td rowspan="4"></td><td rowspan="4"></td><td>Management area</td><td colspan="2">The Broome Prawn Managed Fishery (BPMF) operates off Broome and forms part of the North Coast Prawn Fishery.</td></tr>
<tr><td>Species targeted</td><td>Fishing methods</td><td>Fishing depth</td></tr>
<tr><td>Western king prawn (Penaeus latisulcatus)
Coral prawn</td><td>Trawl.</td><td>Trawling is generally in waters between 30 and 60 m deep, however can occur down to 100 m (DOEH, 2004).</td></tr>
<tr><td>Fishing effort:</td><td colspan="2">BPMF recorded extremely low fishing effort in 2018. Only two vessels undertook trial fishing to investigate whether the catch rates were sufficient for commercial fishing. This resulted in negligible landings of Western king prawn (Kangas et al., 2020a).</td></tr>
</table>

Fishery	Woodside Activity Area			Description		
	Browse	NWS/S	NW Cape			
				Active licences/vessels:	Two vessels conducting fishing trial operated in 2018 (Kangas *et al*., 2020a).	
Exmouth Gulf Prawn Managed Fishery			✓	**Management area**	The estimated employment in the fishery in 2017 was 18 people including skippers and other crew (Kangas *et al*., 2018). The fishery occupies a total area of 4000 km², with only half of this area being trawled (Fletcher and Santoro, 2015).	
				Species targeted	**Fishing methods**	**Fishing depth**
				Western king prawn (*Penaeus latisulcatus*) Brown tiger prawn (*Penaeus esculentus*) Blue endeavour prawn (*Metapenaeus endeavouri*) Banana prawn (*Penaeus merguinensis*)	Trawl.	Information not available.
				Fishing effort:	The total landings of prawns in 2018 were 880 t (Kangas *et al*., 2020a). In the 2016 season, a fishing effort of about 23,000 hours resulted in a catch of 822 t.	
				Active licences/vessels:	The precise number of vessels is unreported. Eighteen people were said to be employed in this fishery in 2018 (Kangas *et al.*, 2019); however, in 2013 it was reported that 18 skippers as well as other crew and support staff were employed (WAFIC[7]).	
Gascoyne Demersal Scalefish Managed Fishery			✓	**Management area**	The Gascoyne Demersal Scalefish Fishery (GDSF) is located between the southern Ningaloo Coast to south of Shark Bay (23°07.30'S to 26°.30'S) with a closure area at Point Maud to Tantabiddi (21°56.30'S) (WAFIC[8]).	
				Species targeted	**Fishing methods**	**Fishing depth**

[7] https://www.wafic.org.au/fishery/exmouth-gulf-prawn-fishery/
[8] https://www.wafic.org.au/fishery/gascoyne-demersal-scalefish-fishery/

<table>
<tr><th rowspan="2">Fishery</th><th colspan="3">Woodside Activity Area</th><th colspan="4" rowspan="2">Description</th></tr>
<tr><th>Browse</th><th>NWS/S</th><th>NW Cape</th></tr>
<tr><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td colspan="2">Pink snapper (Chrysophrys auratus)
Goldband snapper (Pristipomoides multidens)
Red emperor (Lutjanus sebae)
Cods (Gadus morhua)
Emperors (Lethrinus miniatus)</td><td>Mechanised handlines.</td><td>Information not available.</td></tr>
<tr><td>Fishing effort:</td><td colspan="3">The GDSF reported a total commercial catch of 210 t in 2017-18.</td></tr>
<tr><td>Active licences/vessels:</td><td colspan="3">In 2018, 13 vessels fished during the season, in the 2017 season there were 16 vessels (Gaughan and Santoro, 2018).</td></tr>
<tr><td rowspan="5">Kimberley Developing Mud Crab Fishery</td><td rowspan="5">✓</td><td rowspan="5"></td><td rowspan="5"></td><td>Management area</td><td colspan="3">The Kimberley Developing Mud Crab Fishery is one of two small trap-based crab fisheries that exist in the North Coast Bioregion between Cambridge Gulf and Broome (Gaughan and Santoro, 2018).</td></tr>
<tr><td colspan="2">Species targeted</td><td>Fishing methods</td><td>Fishing depth</td></tr>
<tr><td colspan="2">Brown mud crab (Scylla olivacea)
Green mud crab (Scylla serrata)</td><td>Trap.</td><td>Information not available.</td></tr>
<tr><td>Fishing effort:</td><td colspan="3">The catch landed represents all commercially caught mud crabs landed in WA for 2018. A nominal catch rate of 0.66 kg/traplift was recorded for 2018, which is a 28% decrease from 2017 but remains above the harvest strategy threshold (Johnston et al., 2020).</td></tr>
<tr><td>Active licences/vessels:</td><td colspan="3">There are currently three licences issued to commercial operators (600 trap limit), and three exemptions issued to Indigenous groups (total of 210 traps currently allocated of a maximum 600 traps) (Johnston et al., 2020).</td></tr>
<tr><td rowspan="2">Nickol Bay Prawn Managed Fishery</td><td rowspan="2"></td><td rowspan="2">✓</td><td rowspan="2"></td><td>Management area</td><td colspan="3">The Nickol Bay Prawn Managed Fishery operates in nearshore and offshore waters of the Pilbara region along the NWS.</td></tr>
<tr><td colspan="2">Species targeted</td><td>Fishing methods</td><td>Fishing depth</td></tr>
</table>

Fishery	Woodside Activity Area: Browse	Woodside Activity Area: NWS/S	Woodside Activity Area: NW Cape	Description		
				Banana prawn (*Penaeus merguiensis*) Western king prawn (*Penaeus latisulcatus*) Brown tiger prawn (*Penaeus esculentus*) Blue endeavour prawn (*Metapenaeus endeavouri*)	Trawl.	Information not available.
				Fishing effort:	Trawling has been reported to occur at several locations along the Pilbara coast to the east of the Burrup Peninsula, including within the waters of Nickol Bay (Fletcher and Santoro, 2015). The total landings for the 2018 season were 81 t. Fishing effort was less than half at 138 days, compared to 281 boat days in 2017 (Kangas *et al*., 2020a).	
				Active licences/vessels:	The precise number of vessels is unreported, though low effort produced a catch of 17 t in 2016 (Kangas *et al*., 2018).	
Northern Demersal Scalefish Managed Fishery	✓			**Management area**	The fishery is divided into two fishing areas: an inshore sector (Area 1) and an offshore sector (Area 2) (Newman *et al*., 2018). Area 1 permits line fishing only, between the high water mark and the 30 m isobath. Area 2 permits handline, dropline and fish trap fishing methods and is further divided into zones. Zone A is an inshore area, Zone B comprises the area with most historical fishing activity, and Zone C is an offshore deep slope area representing waters deeper than 200 m (Fletcher *et al*., 2017).	
				Species targeted	**Fishing methods**	**Fishing depth**
				Goldband snapper (*Pristipomoides multidens*) Blue-spotted emperor (*Lethrinus punctulantus*) Red emperor (*Lutjanus sebae*) Rankin cod (*Epinephelus multinotatus*)	Line fishing, handline, dropline and fish trap fishing.	Information not available.

<table>
<tr><th rowspan="2">Fishery</th><th colspan="3">Woodside Activity Area</th><th colspan="3" rowspan="2">Description</th></tr>
<tr><th>Browse</th><th>NWS/S</th><th>NW Cape</th></tr>
<tr><td></td><td></td><td></td><td></td><td>Fishing effort:</td><td colspan="2">In 2018, the fishery reported a total catch of 1297 t. Most of the catch is landed from Zone B, with a catch of 1106 t in 2018. The level of catch in Zone B is the highest reported since zoning was implemented in 2006 (Newman et al., 2019).</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Active licences/vessels:</td><td colspan="2">Six vessels fished in the 2018 season and at least 20 people were directly employed (Gaughan and Santoro, 2018).</td></tr>
<tr><td rowspan="5">Octopus Interim Management Fishery</td><td rowspan="5"></td><td rowspan="5"></td><td rowspan="5"></td><td>Management area</td><td colspan="2">The developing Octopus Fishery operates from Kalbarri Cliffs in the north to Esperance in the south.</td></tr>
<tr><td>Species targeted</td><td>Fishing methods</td><td>Fishing depth</td></tr>
<tr><td>Octopus sp. cf. tetricus</td><td>Passive shelter pots and active traps.</td><td>In inshore waters to a depth of 70 m (DPIRD, 2018).</td></tr>
<tr><td>Fishing effort:</td><td colspan="2">In 2019, the total commercial octopus catch was 314 t, which was 22% higher than the 2017 catch of 257 t. In 2016, about 200 vessels reported a total catch of 252 t (Hart et al., 2020c).</td></tr>
<tr><td>Active licences/vessels:</td><td colspan="2">About 21 vessels fish within the octopus specific fisheries, and about 200 vessels from the West Coast Rock Lobster Fishery catch octopus as bycatch (Gaughan and Santoro, 2018).</td></tr>
<tr><td rowspan="3">Shark Bay Beach Seine and Mesh Net Managed Fishery</td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td>Management area</td><td colspan="2">The Shark Bay Beach Seine and Mesh Net Managed Fishery operates from Denham.</td></tr>
<tr><td>Species targeted</td><td>Fishing methods</td><td>Fishing depth</td></tr>
<tr><td>Whiting (yellowfin Sillago schomburgkii and goldenline S. analis)
Sea mullet (Mugil cephalus)
Tailor (Pomatomus saltatrix)
Western yellowfin bream (Acanthopagrus australis)</td><td>Beach seine and mesh net.</td><td>Information not available.</td></tr>
</table>

Fishery	Woodside Activity Area			Description			
	Browse	NWS/S	NW Cape				
				Fishing effort:	In 2018, the total catch was 176 t (Gaughan and Santoro, 2020). The fishery currently employs about 14 fishers based on the seven fishery licences in operation (WAFIC[9]).		
				Active licences/vessels:	Six vessels operated employing around 12 fishers (Gaughan and Santoro, 2018).		
Shark Bay Crab Managed Fishery				**Management area**	The Shark Bay Crab Managed Fishery operates within the NWMR.		
				Species targeted		**Fishing methods**	**Fishing depth**
				Blue swimmer crab (*Portunus armatus*)		Trap and trawl.	Information not available.
				Fishing effort:	Commercial fishing for blue swimmer crabs in Shark Bay was voluntarily halted by industry in 2012 to facilitate stock rebuilding. The stock is still in a recovery phase; however, the fishery has resumed and reported a total commercial catch of 518 t in the 2017/18 season. The average commercial trap catch rate was 1.5 kg/traplift during 2017/18 (Chandrapavan *et al.*, 2017).		
				Active licences/vessels:	The precise number of vessels in the Shark Bay Blue Swimmer Crab Fishery is unreported. There are five crab trap permits. These permits are consolidated onto three active vessels (WAFIC[10]).		
Shark Bay Prawn and Scallop Managed Fishery				**Management area**	The Shark Bay Prawn Managed Fishery is the highest producing WA fishery for prawns.		
				Species targeted		**Fishing methods**	**Fishing depth**
				Western king prawn (*Penaeus latisulcatus*) Brown tiger prawn (*Penaeus esculentus*)		Low-opening otter trawls.	Information not available.

[9] https://www.wafic.org.au/fishery/inner-shark-bay-scalefish-fishery/
[10] https://www.wafic.org.au/fishery/shark-bay-prawn-and-scallop-managed-fisheries/

Fishery	Woodside Activity Area			Description		
	Browse	NWS/S	NW Cape			
				Endeavour prawns (*Metapenaeus endeavouri*) Coral prawns (*Metapenaeopsis sp.*) Saucer scallop (*Amusium balloti*)		
				Fishing effort:	The Shark Bay Scallop Managed Fishery is currently in a recovery phase due to the results from the pre-season survey of stock abundance (Fletcher and Santoro, 2015; Kangas *et al.*, 2018).	
				Active licences/vessels:	The precise number of vessels in the Shark Bay Prawn Managed Fishery is unreported; however, about 100 people are employed in this fishery (Gaughan and Santoro, 2018). About 20 skippers and crew are employed in scallop fishing in the Shark Bay and South Coast fisheries across 18 vessels in 2015 (Sporer *et al.*, 2015).	
South Coast Crustacean Managed Fishery	-	-	-	**Management area**	The South Coast Crustacean Managed Fishery comprises four fisheries: the Windy Harbour/Augusta Rock Lobster Managed Fishery, the Esperance Rock Lobster Managed Fishery, the Southern Rock Lobster Pot Regulation Fishery and the South Coast Deep-Sea Crab Fishery.	
				Species targeted	**Fishing methods**	**Fishing depth**
				Southern rock lobster (*Jasus edwardsii*) Western rock lobster (*Panulirus cygnus*) Giant crab (*Pseudocarcinus gigas*) Crystal crab (*Chaceon albus*) Champagne crab (*Hypothalassia acerba*)	Pots.	Information not available.
				Fishing effort:	The South Coast Crustacean Managed Fishery reported a total catch of 101.2 t in 2018 season and the value of the fishery for 2017/2018 was about $5.9 million (Howe and Orme, 2020b).	
				Active licences/vessels:	The number of vessels is unknown; however, a total of 1977 pots are licensed to be used.	
	-	-	-	**Management area**	The fishery is active in coastal waters between Cape Leeuwin and the South Australia border. Landings are primarily at Albany, Bremer Bay and Esperance (Norriss and Blazeski, 2020).	

Fishery	Woodside Activity Area			Description			
	Browse	NWS/S	NW Cape				
South Coast Purse Seine Managed Fishery				**Species targeted**		**Fishing methods**	**Fishing depth**
				Small pelagic finfish such as pilchards and yellowtail scad using purse seine nets from vessels. Sandy sprat (*Hyperlophus vittatus*) Blue sprat (*Spratelloides robustus*)		Purse seine.	Information not available.
				Fishing effort:	In the 2017/18 season the total catch effort was 2,168 t (Norriss and Blazeski, 2020).		
				Active licences/vessels:	Nine active vessels in 2017/18 (Norriss and Blazeski, 2020).		
South-west Trawl Managed Fishery	-	-	-	**Management area**	The South-west Trawl Managed Fishery is a multi-species fishery and includes two of WA's smaller scallop fishing grounds at Fremantle and north of Geographe Bay (Fairclough and Walters, 2018).		
				Species targeted		**Fishing methods**	**Fishing depth**
				Scallops (*Ylistrum balloti,* formerly *Amusium balloti*) and associated by-products Western king prawn (*Penaeus latisulcatus*) In years of low scallop catches licencees may use other trawl gear to target fin-fish species.		Trawl.	Information not available.
				Fishing effort:	Effort in the fishery is highly variable and typically fluctuates in response to recruitment variability in saucer scallops and prawns. The fishery was not active in 2015 or 2016 (Fairclough and Walters, 2018).		
				Active licences/vessels:	Only one boat fished in 2018 for a total of 5 boat days for minimal catch (Fairclough and Walters, 2018).		

Fishery	Woodside Activity Area			Description			
	Browse	NWS/S	NW Cape				
The South Coast Salmon Managed Fishery	-	-	-	**Management area**	The South Coast Salmon Managed Fishery is one of two fisheries operating in the South Coast Bioregion that target nearshore and estuarine finfish.		
				Species targeted		**Fishing methods**	**Fishing depth**
				Western Australian salmon (*Arripis truttaceus*) Southern school whiting (*Sillago bassensis*) Australian herring (*Arripis georgianus*) King George whiting (*Sillaginodes punctatus*) Sea mullet (*Mugil cephalus*) Estuary cobbler (*Cnidoglanis macrocephalus*) Black bream (*Acanthopagrus butcheri*)		Beach seines, haul nets and gill nets.	Information not available.
				Fishing effort:	The total catch for 2018 was 243 t (Duffy and Blay, 2020b).		
				Active licences/vessels:	Number of vessels is unknown; however, 12 commercial fishers were employed in 2018 (Duffy and Blay, 2020b).		
West Coast Beach Bait Managed Fishery	-	-	-	**Management area**	Primarily active in the Bunbury areas in the SWMR.		
				Species targeted		**Fishing methods**	**Fishing depth**
				Whitebait		Beach-based haul nets.	Information not available.
				Fishing effort:	In recent years the fishery is primarily active in the Bunbury area. Total catch of whitebait in 2015 was 40.2 t (Duffy and Blay, 2020c).		

<table>
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<tr><th>Browse</th><th>NWS/S</th><th>NW Cape</th></tr>
<tr><td></td><td></td><td></td><td></td><td>Active licences/vessels:</td><td colspan="3">Number of vessels is unknown; however, only one license was issued (DPIRD, 2019).</td></tr>
<tr><td rowspan="5">West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery</td><td rowspan="5">-</td><td rowspan="5">-</td><td rowspan="5">-</td><td>Management area</td><td colspan="3">The West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (WCDGDLF) is part of the Temperate Demersal Gillnet and Demersal Longline Fishery (TDGDLF), which operates between 26° and 33° S, and the Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (JASDGDLF), which operates from 33° S to the WA/SA border (Braccini and Blay, 2020).</td></tr>
<tr><td colspan="2">Species targeted</td><td>Fishing methods</td><td>Fishing depth</td></tr>
<tr><td colspan="2">Gummy shark (Mustelus antarcticus)
Dusky shark (Carcharhinus obscurus)
Whiskery shark (Furgaleus macki)
Sandbar shark (C. plumbeus)</td><td>Gillnet and longline.</td><td>Information not available.</td></tr>
<tr><td>Fishing effort:</td><td colspan="3">Catch estimated annual value of the fishery was $0.2 million for 2017 to 2018 (Braccini and Blay, 2020).</td></tr>
<tr><td>Active licences/vessels:</td><td colspan="3">Vessel numbers are unknown; however, 17 interim managed fishery permits were held in 2019 (DPIRD, 2019) and between 18 and 21 skippers and crew were employed between 2016 and 2017.</td></tr>
<tr><td rowspan="3">West Coast Demersal Scalefish Fishery</td><td rowspan="3">-</td><td rowspan="3">-</td><td rowspan="3">-</td><td>Management area</td><td colspan="3">These fisheries include the West Coast Demersal Scalefish (Interim) Managed Fishery (51 boats), the West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery and the temperate Demersal Gillnet and Demersal Longline Fisheries. The West Coast Demersal Scalefish Managed Fishery is the main commercial fishery that targets demersal species in the West Coast Bioregion. It encompasses the waters from just south of Shark Bay down to just east of Augusta and extends seaward to the 200 nm boundary. The fishery is divided into four inshore management areas and one offshore management area.</td></tr>
<tr><td colspan="2">Species targeted</td><td>Fishing methods</td><td>Fishing depth</td></tr>
<tr><td colspan="2">Baldchin groper (Choerodon rubescens)
Dhufish (Glaucosoma hebraicum)
Pink snapper (Pagrus auratus)</td><td>Lines.</td><td>Inshore species – 20 to 250 m water depth.</td></tr>
</table>

Fishery	Woodside Activity Area			Description		
	Browse	NWS/S	NW Cape			
						Offshore species – more than 250 m water depth.
				Fishing effort:	In 2016, the West Coast Demersal Scalefish (interim) Managed Fishery reported a total catch of 256 t.	
				Active licences/vessels:	The precise number of vessels in the West Coast Demersal Scalefish Fisheries is unreported; however, it is restricted to 60 interim managed fishery permit holders.	
West Coast Purse Seine Managed Fishery	-	-	-	**Management area**	Located in waters from Cape Bouvard extending to Lancelin.	
				Species targeted	**Fishing methods**	**Fishing depth**
				Small pelagic finfish such as: Scaly mackerel (*Sardinella lemuru*) Pilchards (*Sardinops sagax*) Australian anchovy (*Engraulis australis*) Yellowtail scad (*Trachurus novaezelandiae*) Maray (*Etrumeus teres*)	Purse seine.	Information not available.
				Fishing effort:	Information not available	
				Active licences/vessels:	Seven vessels in 2017 (Gaughan and Santoro, 2018).	
West Coast Rock Lobster Managed Fishery			✓	**Management area**	The West Coast Rock Lobster Fishery operates from Shark Bay south to Cape Leeuwin. The fishery is managed using zones, seasons and total allowable catch. The recreational fishery targets the western rock lobsters using baited pots and by diving between North-west Cape and Augusta.	

Fishery	Woodside Activity Area			Description		
	Browse	NWS/S	NW Cape			
				Species targeted	**Fishing methods**	**Fishing depth**
				Western rock lobster (*Panulirus cygnus)*	Baited pots.	Less than 20 m.
				Fishing effort:	In 2018, 234 vessels reported a total catch of 6400 t in 2017 (de Lestang *et al*., 2018). In 2016, 226 vessels reported a total catch of 6,086 t (Gaughan and Santoro, 2018).	
				Active licences/vessels:	234 vessels operated in 2017 and 233 vessels operated in 2018 (Gaughan and Santoro, 2018).	

11.5.2 Aquaculture

Aquaculture operations in the northwest are typically restricted to inland and shallow coastal waters.

West Coast Bioregion

Aquaculture activities in the West Coast bioregion, defined by the Department of Primary Industries and Regional Development (DPIRD) (as the government body responsible management of primary industries in WA) are focused on blue mussels and edible oysters (mainly in Cockburn Sound) and marine algae for production of beta-carotene, used as a food additive and as a nutritional supplement. Offshore marine finfish production is also being developed, initially focusing on yellowtail kingfish.

There is also an emerging black pearl industry (from the *Pinctada margaritifera* oyster) in the Abrolhos Islands. As well as expansion in the production of Akoya pearls (small white pearls from *Pinctada fucata martensi*), *Pinctada albina* (small, yellow pearls) and *Pteria penguin*, which are often used to produce half (mabe) pearls in pink and bluish shades.

Aquaculture licences for producing coral and live rock (pieces of old coral reefs colonised by marine life, such as beneficial bacteria, for aquariums) at the Abrolhos Islands have also been issued and other applications are being assessed.

Gascoyne Coast Bioregion

In the Gascoyne Coast bioregion, aquaculture activities are focused on the blacklip oyster (*Pinctada margaritifera*) and Akoya pearl oyster (*Pinctada imbricata*) (Gaughan and Santoro, 2020). Several hatcheries supply *P. margaritifera* juveniles to the region's developing black pearl farms.

Other aquaculture developments in the Gascoyne Coast bioregion include emerging producers of coral and live rock species for aquariums.

North Coast Bioregion

Aquaculture activities in the North Coast bioregion is dominated by the production of pearls. A large number of pearl oysters for seeding are obtained from wild stocks and supplemented by hatchery produced oysters, with major hatcheries operating at Broome and around the Dampier Peninsula (Gaughan and Santoro, 2018). Primary spawning of the pearl oyster occurs from mid-October to December. A smaller secondary spawning occurs in February and March (Gaughan and Santoro, 2020).

Other aquaculture developments in the North Coast include emerging producers of coral and live rock species for aquariums as well as barramundi (*Lates calcarifer)* farms and microalgae culturing for Omega-3, biofuels and protein biomass (Gaughan and Santoro, 2020).

11.6 Fisheries – Traditional

Traditional or customary fisheries are typically restricted to shallow coastal waters and/or areas with structures such as reef.

Dugong, fish and marine turtles that move between coastal and Commonwealth waters are important components of the Aboriginal people's culture and diet. Aboriginal people continue to actively manage their sea country in coastal waters of WA in order to protect and manage the marine environment, its resources and cultural values.

Indonesian fishers can fish within designated areas under the Australia-Indonesia Memorandum of Understanding regarding the Operations of Indonesian Traditional Fishermen in Areas of the Australian Fishing Zone and Continental Shelf – 1974 (MoU 74). Traditional fishing is allowed within the MoU Box (**Figure 11-1)**, which encompasses: Ashmore Reef (Pulau Pasir), Cartier Island (Pulau Baru), Seringapatam Reef (Afringan), Scott Reef (Pulau Dato) and Browse Island (Berselan). Restrictions have since been introduced around Ashmore Reef and Cartier Island following their designation as Nature Reserves under the Commonwealth's *National Parks and Wildlife Conservation Act 1975* in 1983 and 2000, respectively.

The MoU allows Indonesian fishers to fish in designated areas using traditional methods only. These methods include reef gleaning, free-diving, hand lining and other non-mechanised methods. Scott Reef is currently the principal reef in the MoU 74 Box and is utilised seasonally by Indonesian fishers to harvest trepang, trochus shells and other reef species. The peak season is July to October due to more favourable wind conditions, and to allow fishers to sun dry their catch on their boat decks (ERM, 2009). Browse Island is also frequently visited by shark fishers who mostly fish along the eastern margin of the MoU 74 Box.

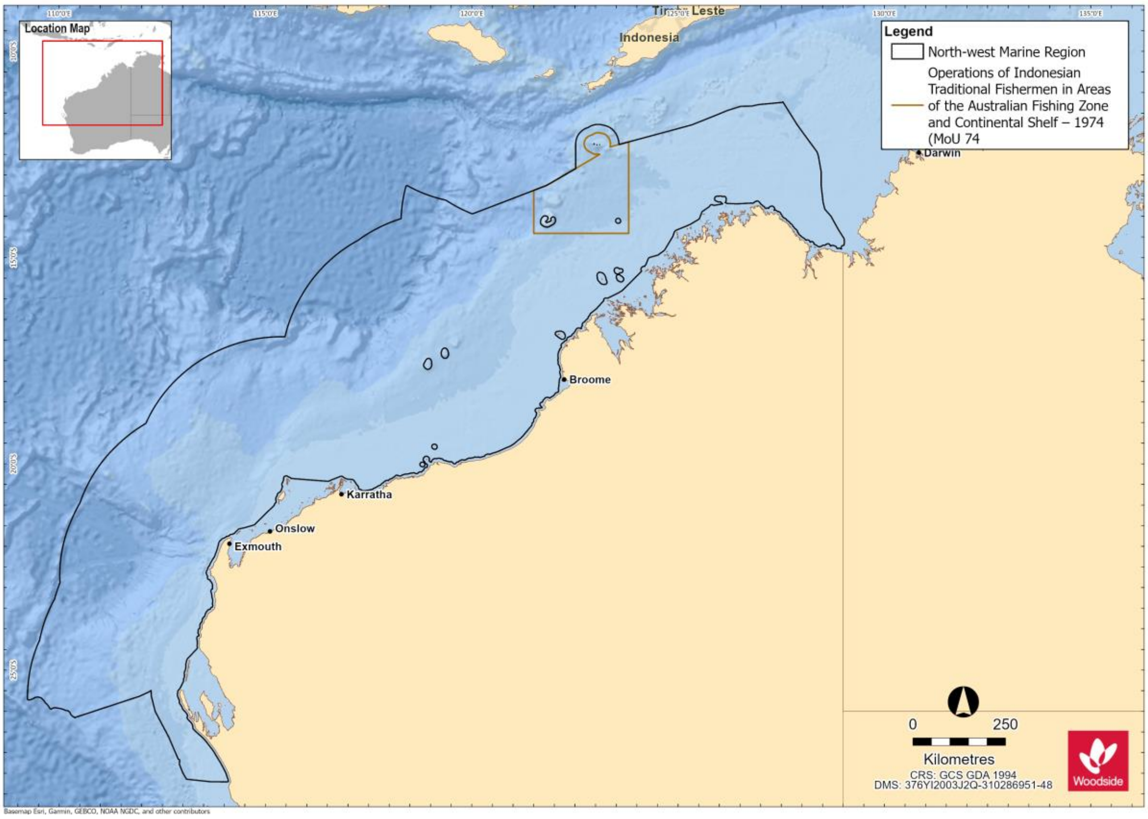

Figure 11-1 MOU 74 Box. Operations of Indonesian Traditional Fishermen in Areas of the Australian Fishing Zone and Continental Shelf – 1974

11.7 Tourism and Recreation

There are growing tourism and recreational sectors in WA. The Kimberley, Pilbara and Gascoyne regions are popular visitor destinations for Australian and international tourists. Tourism is concentrated in the vicinity of population centres including Broome, Dampier, Exmouth, Coral Bay and Shark Bay.

Recreational and tourism activities include: charter fishing, other recreational fishing, diving, snorkelling, marine fauna watching, and yachting.

11.7.1 Gascoyne Region

Outside the petroleum industry, tourism is the largest revenue earner of all the major industries of the Gascoyne region. It contributes significantly to the local economy in terms of both income and employment. In 2018 there was an average of 337,400 visitors with a visitor spend of $359 million (Gascoyne Development Commission[11]).

In 2018-19, the Ningaloo region (Ningaloo Reef and the surrounding coastal region Exmouth Gulf, communities of Exmouth and Coral Bay, and adjacent proposed southern coastal reserves and pastoral leases) contributed an estimated $110 million in value added to the WA economy (DCBA, 2020). Ningaloo's economic contribution to WA is attributed to four key types of economic activity, tourism expenditure by international, interstate and WA visitors to the Ningaloo region, commercial fishing in the Exmouth Gulf, recreation activity involving the Reef by residents of the Ningaloo region and management and research relating to the Reef (DCBA, 2020). More than 90% of this value added is attributed to the domestic and international tourists who visit Ningaloo each year (DCBA, 2020). The main marine nature-based tourist activities are concentrated around and within the Ningaloo WHA.

11.7.2 Pilbara region

Recreation and tourism activities within the Pilbara are of high social value. Tourism is a key economic driver for the Pilbara with more than 1 million visitors to the region every year, generating $413 million in gross revenue annually (Pilbara Development Commission[12]).

Recreational fishing within the Pilbara region tends to be concentrated in State waters adjacent to population centres. Recreational fishing is known to occur around the Dampier Archipelago with boats launched from boat ramps around Dampier and Karratha (Williamson *et al.*, 2006). Once at sea, charter vessels may also frequent the waters surrounding the Montebello Islands.

11.7.3 Kimberley Region

Recreation and tourism activities in the Kimberley region occur predominantly in WA State waters (extending offshore 3 nm from the mainland), adjacent to coastal population centres (e.g. Broome), with a peak in activity during the winter months (dry season). These activities include recreational fishing, diving, snorkelling, wildlife watching and boating.

Primary dive locations in the Kimberley region include the Rowley Shoals, including Mermaid Reef AMP, Scott Reef, Seringapatam Reef, Ashmore Reef AMP and Cartier Island.

11.8 Shipping

Commercial shipping traffic is high within the NWMR with vessel activities including commercial fisheries, tourism such as cruises, international shipping and oil and gas operations. There are 12 ports adjacent to the NWMR, including the major ports of Dampier, Port Hedland and Broome, which are operated by their respective port authorities. These ports handle large tonnages of iron ore and petroleum exports in addition to salt, manganese, feldspar chromite and copper (DEWHA, 2008).

Heavy vessel traffic exists within the Pilbara Port Authority management area which recorded 10,064 vessel movements in Port of Dampier 2019/20 annual reporting period (PPA, 2020). Twenty-six designated anchorages for bulk carriers, petroleum and gas tankers, drilling rigs, offshore platforms, and pipelay vessels are located offshore of Rosemary Island.

In 2012, AMSA established a network of shipping fairways off the northwest coast of Australia. The shipping fairways, while not mandatory, aim to reduce the risk of collision between transiting vessels and offshore infrastructure. The fairways are intended to direct large vessels such as bulk carriers and LNG ships trading to the major ports into pre-defined routes to keep them clear of existing and planned offshore infrastructure (AMSA, 2013).

[11] https://www.gdc.wa.gov.au/industry-profiles/tourism/
[12] https://www.pdc.wa.gov.au/our-focus/strategicinitiatives/tourism

11.9 Oil and Gas Infrastructure

The NWMR supports a number of industries including petroleum exploration and production.

Within the NWMR there are seven sedimentary petroleum basins: Northern and Southern Carnarvon basins, Perth, Browse, Roebuck, Offshore Canning and Bonaparte basins. Of these, the Northern Carnarvon, Browse and Bonaparte basins hold large quantities of gas and comprise most of Australia's reserves of natural gas (DEWHA, 2008), which is reflected by the level of development in the area. In addition to existing facilities, there are proposed developments in the region. This includes proposals to develop gas and condensate from a number of fields within the NWMR.

In addition to the oil and gas industry, other land-based industries depend upon the marine environment in the nearshore area. These include ports, salt mines such as Karratha and Onslow, LNG onshore processing facilities such as Burrup Hub, Thevenard Island, Barrow Island, Varanus Island, and small-scale desalination plants at Barrow Island, Burrup, Cape Preston, and Onslow.

11.10 Defence

Key Australian Department of Defence (DoD) operational areas and facilities areas of the NWMR for training and operational activities, include:

- An operating logistics base has been established in Dampier to support vessels patrolling the waters around offshore oil and gas facilities. A dedicated navy administrative support facility is also being constructed at the nearby township of Karratha.
- The Royal Australian Air Force currently maintains two 'bare bases' in remote areas of WA that are used for military exercises. One of these is the Royal Australian Air Force Base in Learmonth. The Royal Australian Air Force maintains the Commonwealth Heritage listed Learmonth Air Weapons Range Facility, which is located between Ningaloo Station and the Cape Range National Park. The air training area associated with the Learmonth base extends over the offshore region.
- The Royal Australian Air Force Base Curtin is located on the north coast of WA, south-east of Derby and 170 km east of Broome. It provides support for land, air and sea operations aimed to support Australia's northern approaches.
- The Naval Communications Station Harold E. Holt is located ~6 km north of Exmouth. The main role of the station is to communicate at very low frequencies (19.8 kHz) with Australian and United States submarines and ships in the eastern Indian Ocean and the western Pacific Ocean.

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APPENDIX A. PROTECTED MATTER SEARCH REPORTS FOR NWMR, SWMR AND NMR

Australian Government

Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

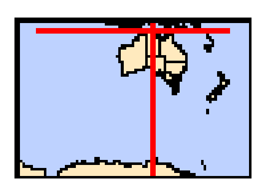
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 10/05/21 12:59:15

Coordinates

Buffer: 1.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	33
Listed Migratory Species:	70

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	127
Whales and Other Cetaceans:	25
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	15

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	2
Regional Forest Agreements:	None
Invasive Species:	1
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	8

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea
Extended Continental Shelf

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
North

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Erythrura gouldiae Gouldian Finch [413]	Endangered	Species or species habitat may occur within area
Falcunculus frontatus whitei Crested Shrike-tit (northern), Northern Shrike-tit [26013]	Vulnerable	Species or species habitat likely to occur within area
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-	Vulnerable	Species or species

Name	Status	Type of Presence
tailed Godwit [86380]		habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Notomys aquilo Northern Hopping-mouse, Woorrentinta [123]	Endangered	Species or species habitat may occur within area
Saccolaimus saccolaimus nudicluniatus Bare-rumped Sheath-tailed Bat, Bare-rumped Sheathtail Bat [66889]	Vulnerable	Species or species habitat may occur within area
Xeromys myoides Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Cryptoblepharus gurrmul Arafura Snake-eyed Skink [83106]	Endangered	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Congregation or aggregation known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area

Name	Status	Type of Presence
Glyphis garricki Northern River Shark, New Guinea River Shark [82454]	Endangered	Species or species habitat known to occur within area
Glyphis glyphis Speartooth Shark [82453]	Critically Endangered	Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Foraging, feeding or related behaviour known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat known to occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Congregation or aggregation known to occur within area
Dugong dugon Dugong [28]		Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding known to occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat likely to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Breeding known to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Migratory Terrestrial Species		
Cecropis daurica Red-rumped Swallow [80610]		Species or species habitat may occur within area
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat may occur within area
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris alba Sanderling [875]		Species or species habitat likely to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Species or species habitat likely to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Species or species habitat known to occur within area
Numenius phaeopus Whimbrel [849]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Species or species habitat known to occur within area
Pluvialis squatarola Grey Plover [865]		Species or species habitat known to occur within area
Thalasseus bergii Greater Crested Tern [83000]		Breeding likely to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Species or species

Name	Threatened	Type of Presence
		habitat known to occur within area
[Tringa nebularia](#) Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
[Tringa stagnatilis](#) Marsh Sandpiper, Little Greenshank [833]		Species or species habitat known to occur within area
[Xenus cinereus](#) Terek Sandpiper [59300]		Species or species habitat known to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat may occur within area
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Foraging, feeding or related behaviour known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Arenaria interpres Ruddy Turnstone [872]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris alba Sanderling [875]		Species or species habitat likely to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Species or species habitat known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat known to occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Species or species habitat known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Species or species habitat known to occur within area
Hirundo daurica Red-rumped Swallow [59480]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Species or species habitat likely to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Species or species habitat known to occur within area
Numenius phaeopus Whimbrel [849]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Species or species habitat known to occur within area
Pluvialis squatarola Grey Plover [865]		Species or species habitat known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Sterna albifrons Little Tern [813]		Species or species habitat may occur within area
Sterna bengalensis Lesser Crested Tern [815]		Breeding known to occur within area
Sterna bergii Crested Tern [816]		Breeding likely to occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Stiltia isabella Australian Pratincole [818]		Species or species habitat known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Species or species habitat known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Species or species habitat known to occur within area
Fish		

Name	Threatened	Type of Presence
Acentronura tentaculata Shortpouch Pygmy Pipehorse [66187]		Species or species habitat may occur within area
Bhanotia fasciolata Corrugated Pipefish, Barbed Pipefish [66188]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Corythoichthys haematopterus Reef-top Pipefish [66201]		Species or species habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area
Corythoichthys ocellatus Orange-spotted Pipefish, Ocellated Pipefish [66203]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Cosmocampus maxweberi Maxweber's Pipefish [66209]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Festucalex cinctus Girdled Pipefish [66214]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish [66220]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus macrorhynchus Whiskered Pipefish, Ornate Pipefish [66222]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys cyanospilos Blue-speckled Pipefish, Blue-spotted Pipefish [66228]		Species or species habitat may occur within area
Hippichthys heptagonus Madura Pipefish, Reticulated Freshwater Pipefish [66229]		Species or species habitat may occur within area
Hippichthys parvicarinatus Short-keel Pipefish, Short-keeled Pipefish [66230]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippichthys spicifer Belly-barred Pipefish, Banded Freshwater Pipefish [66232]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
Hippocampus zebra Zebra Seahorse [66241]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Micrognathus brevirostris thorntail Pipefish, Thorn-tailed Pipefish [66254]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Microphis brachyurus Short-tail Pipefish, Short-tailed River Pipefish [66257]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Species or species habitat known to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Congregation or aggregation known to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake [1125]		Species or species habitat may occur within area
Enhydrina schistosa Beaked Seasnake [1126]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Hydrelaps darwiniensis Black-ringed Seasnake [1100]		Species or species habitat may occur within area
Hydrophis atriceps Black-headed Seasnake [1101]		Species or species habitat may occur within area
Hydrophis caerulescens Dwarf Seasnake [1103]		Species or species habitat may occur within area
Hydrophis coggeri Slender-necked Seasnake [25925]		Species or species habitat may occur within area
Hydrophis czeblukovi Fine-spined Seasnake [59233]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis gracilis Slender Seasnake [1106]		Species or species habitat may occur within area
Hydrophis inornatus Plain Seasnake [1107]		Species or species habitat may occur within area
Hydrophis mcdowelli null [25926]		Species or species habitat may occur within area
Hydrophis melanosoma Black-banded Robust Seasnake [1109]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Hydrophis pacificus Large-headed Seasnake, Pacific Seasnake [1112]		Species or species habitat may occur within area
Hydrophis vorisi a seasnake [25927]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Lapemis hardwickii Spine-bellied Seasnake [1113]		Species or species habitat may occur within area
Laticauda colubrina a sea krait [1092]		Species or species habitat may occur within area
Laticauda laticaudata a sea krait [1093]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Breeding known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Parahydrophis mertoni Northern Mangrove Seasnake [1090]		Species or species habitat may occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area

Name	Status	Type of Presence
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat likely to occur within area
Orcaella brevirostris Irrawaddy Dolphin [45]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Breeding known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks [Resource Information]

Name	Label
Arafura	Multiple Use Zone (IUCN VI)
Arafura	Special Purpose Zone (Trawl) (IUCN VI)
Arnhem	Special Purpose Zone (IUCN VI)
Gulf of Carpentaria	National Park Zone (IUCN II)
Gulf of Carpentaria	Special Purpose Zone (Trawl) (IUCN VI)
Joseph Bonaparte Gulf	Multiple Use Zone (IUCN VI)

Name	Label
Joseph Bonaparte Gulf	Special Purpose Zone (IUCN VI)
Limmen	Habitat Protection Zone (IUCN IV)
Oceanic Shoals	Multiple Use Zone (IUCN VI)
Oceanic Shoals	Special Purpose Zone (Trawl) (IUCN VI)
Wessel	Habitat Protection Zone (IUCN IV)
Wessel	Special Purpose Zone (Trawl) (IUCN VI)
West Cape York	Habitat Protection Zone (IUCN IV)
West Cape York	National Park Zone (IUCN II)
West Cape York	Special Purpose Zone (IUCN VI)

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Anindilyakwa	NT
Marthakal	NT

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Plants		
Andropogon gayanus		
Gamba Grass [66895]		Species or species habitat likely to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
Southern Gulf Aggregation	QLD

Key Ecological Features (Marine) [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Carbonate bank and terrace system of the Van	North
Gulf of Carpentaria basin	North
Gulf of Carpentaria coastal zone	North
Pinnacles of the Bonaparte Basin	North
Plateaux and saddle north-west of the Wellesley	North
Shelf break and slope of the Arafura Shelf	North
Submerged coral reefs of the Gulf of Carpentaria	North
Tributary Canyons of the Arafura Depression	North

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-14.758882 129.178077,-13.960657 128.826514,-13.768665 128.606788,-12.484784 128.496924,-11.183724 127.563087,-10.460737 128.233253,-9.746889 129.518653,-9.660256 130.254737,-9.779371 130.935889,-9.280976 132.528907,-8.901286 133.385841,-9.411062 134.858008,-9.129149 135.473243,-10.363488 138.582374,-11.129831 139.395362,-10.190527 141.339942,-10.806262 141.317969,-10.817053 141.922217,-11.10827 142.087012,-12.527687 141.559669,-13.330764 141.515723,-13.960657 141.40586,-15.045535 141.570655,-15.945419 141.317969,-17.22994 140.823585,-17.513041 140.53794,-17.659661 140.032569,-17.429205 139.593116,-16.630864 139.966651,-16.409675 139.812842,-16.177683 139.208594,-16.820251 138.966895,-15.924291 137.165137,-15.575354 137.132178,-15.458909 136.934424,-15.289418 136.11045,-14.822615 135.45127,-14.269641 135.846778,-14.418655 136.97837,-13.608551 137.011329,-12.784952 136.780616,-12.388227 137.055274,-10.957305 136.76963,-10.957305 136.703712,-11.399198 136.407081,-11.679068 135.824805,-11.904912 135.616065,-11.947909 134.473487,-11.679068 133.869239,-11.700585 133.50669,-11.431505 133.528663,-11.442273 133.363868,-11.64679 133.254005,-11.313028 132.979346,-11.04358 133.067237,-10.90337 132.583839,-11.151389 131.221534,-11.3238 130.782081,-11.054363 130.287696,-11.474575 130.111915,-11.765126 129.958106,-11.947909 130.067969,-11.894162 130.760108,-12.119827 130.913917,-12.441874 130.474464,-12.870649 130.100928,-13.939333 129.584571,-13.971319 129.419776,-14.47185 129.28794,-14.631358 129.507667,-14.843856 129.452735,-14.769505 129.178077,-14.758882 129.178077

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- -Office of Environment and Heritage, New South Wales
- -Department of Environment and Primary Industries, Victoria
- -Department of Primary Industries, Parks, Water and Environment, Tasmania
- -Department of Environment, Water and Natural Resources, South Australia
- -Department of Land and Resource Management, Northern Territory
- -Department of Environmental and Heritage Protection, Queensland
- -Department of Parks and Wildlife, Western Australia
- -Environment and Planning Directorate, ACT
- -Birdlife Australia
- -Australian Bird and Bat Banding Scheme
- -Australian National Wildlife Collection
- -Natural history museums of Australia
- -Museum Victoria
- -Australian Museum
- -South Australian Museum
- -Queensland Museum
- -Online Zoological Collections of Australian Museums
- -Queensland Herbarium
- -National Herbarium of NSW
- -Royal Botanic Gardens and National Herbarium of Victoria
- -Tasmanian Herbarium
- -State Herbarium of South Australia
- -Northern Territory Herbarium
- -Western Australian Herbarium
- -Australian National Herbarium, Canberra
- -University of New England
- -Ocean Biogeographic Information System
- -Australian Government, Department of Defence
- Forestry Corporation, NSW
- -Geoscience Australia
- -CSIRO
- -Australian Tropical Herbarium, Cairns
- -eBird Australia
- -Australian Government – Australian Antarctic Data Centre
- -Museum and Art Gallery of the Northern Territory
- -Australian Government National Environmental Science Program
- -Australian Institute of Marine Science
- -Reef Life Survey Australia
- -American Museum of Natural History
- -Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
- -Tasmanian Museum and Art Gallery, Hobart, Tasmania
- -Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

Department of Agriculture Water and the Environment
GPO Box 858
Canberra City ACT 2601 Australia
+61 2 6274 1111

Australian Government

Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

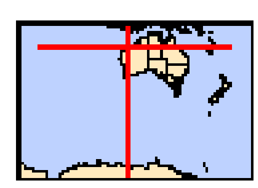
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 10/05/21 13:07:00

Coordinates

Buffer: 1.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	2
National Heritage Places:	5
Wetlands of International Importance:	2
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	1
Listed Threatened Species:	70
Listed Migratory Species:	84

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	1
Listed Marine Species:	149
Whales and Other Cetaceans:	34
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	17

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	10
Regional Forest Agreements:	None
Invasive Species:	23
Nationally Important Wetlands:	3
Key Ecological Features (Marine)	5

Details

Matters of National Environmental Significance

World Heritage Properties
[Resource Information]

Name	State	Status
Shark Bay, Western Australia	WA	Declared property
The Ningaloo Coast	WA	Declared property

National Heritage Properties
[Resource Information]

Name	State	Status
Natural		
Shark Bay, Western Australia	WA	Listed place
The Ningaloo Coast	WA	Listed place
The West Kimberley	WA	Listed place
Indigenous		
Dampier Archipelago (including Burrup Peninsula)	WA	Listed place
Historic		
Dirk Hartog Landing Site 1616 - Cape Inscription Area	WA	Listed place

Wetlands of International Importance (Ramsar)
[Resource Information]

Name	Proximity
Eighty-mile beach	Within Ramsar site
Ord river floodplain	Within 10km of Ramsar

Commonwealth Marine Area
[Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea
Extended Continental Shelf

Marine Regions
[Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
North-west

Listed Threatened Ecological Communities
[Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula	Endangered	Community likely to occur within area

Listed Threatened Species
[Resource Information]

Name	Status	Type of Presence
Birds		
Anous tenuirostris melanops		
Australian Lesser Noddy [26000]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Calidris canutus		
Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species

Name	Status	Type of Presence
		habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Erythrura gouldiae Gouldian Finch [413]	Endangered	Species or species habitat known to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat known to occur within area
Falcunculus frontatus whitei Crested Shrike-tit (northern), Northern Shrike-tit [26013]	Vulnerable	Species or species habitat likely to occur within area
Geophaps smithii blaauwi Partridge Pigeon (western) [66501]	Vulnerable	Species or species habitat likely to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat may occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432]	Critically Endangered	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Malurus leucopterus leucopterus White-winged Fairy-wren (Dirk Hartog Island), Dirk Hartog Black-and-White Fairy-wren [26004]	Vulnerable	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within

Name	Status	Type of Presence
		area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Tyto novaehollandiae kimberli Masked Owl (northern) [26048]	Vulnerable	Species or species habitat likely to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Bettongia lesueur lesueur Burrowing Bettong (Shark Bay), Boodie [66659]	Vulnerable	Species or species habitat likely to occur within area
Bettongia penicillata ogilbyi Woylie [66844]	Endangered	Species or species habitat likely to occur within area
Conilurus penicillatus Brush-tailed Rabbit-rat, Brush-tailed Tree-rat, Pakooma [132]	Vulnerable	Species or species habitat may occur within area
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat may occur within area
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Isoodon auratus auratus Golden Bandicoot (mainland) [66665]	Vulnerable	Species or species habitat likely to occur within area
Lagostrophus fasciatus fasciatus Banded Hare-wallaby, Merrnine, Marnine, Munning [66664]	Vulnerable	Translocated population known to occur within area
Leporillus conditor Wopilkara, Greater Stick-nest Rat [137]	Vulnerable	Translocated population known to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat known to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
Perameles bougainville bougainville Western Barred Bandicoot (Shark Bay) [66631]	Endangered	Translocated population known to occur within area
Petrogale concinna monastria Nabarlek (Kimberley) [87607]	Endangered	Species or species habitat known to occur within area
Phascogale tapoatafa kimberleyensis Kimberley brush-tailed phascogale, Brush-tailed Phascogale (Kimberley) [88453]	Vulnerable	Species or species habitat likely to occur within area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat may occur within area
Saccolaimus saccolaimus nudicluniatus Bare-rumped Sheath-tailed Bat, Bare-rumped Sheathtail Bat [66889]	Vulnerable	Species or species habitat likely to occur within area
Xeromys myoides Water Mouse, False Water Rat, Yirrkoo [66]	Vulnerable	Species or species habitat may occur within area
Reptiles		
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat likely to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Egernia stokesii badia Western Spiny-tailed Skink, Baudin Island Spiny-tailed Skink [64483]	Endangered	Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour known to occur within area
Lerista nevinae Nevin's Slider [85296]	Endangered	Species or species habitat known to occur within area
Liasis olivaceus barroni Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Sharks		
Carcharias taurus (west coast population) Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Glyphis garricki Northern River Shark, New Guinea River Shark [82454]	Endangered	Species or species habitat known to occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Breeding known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Listed Migratory Species

[Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna pacifica Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species

Name	Threatened	Type of Presence
		habitat likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat may occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat likely to occur within area
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Onychoprion anaethetus Bridled Tern [82845]		Breeding known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Foraging, feeding or related behaviour likely to occur within area
Sterna dougallii Roseate Tern [817]		Breeding likely to occur within area
Sternula albifrons Little Tern [82849]		Breeding known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat likely to occur within area
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Dugong dugon Dugong [28]		Breeding known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour known to occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur

Name	Threatened	Type of Presence
		within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Breeding known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Breeding known to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Migratory Terrestrial Species		
Cecropis daurica Red-rumped Swallow [80610]		Species or species habitat may occur within area
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat may occur within area
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris alba Sanderling [875]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius phaeopus Whimbrel [849]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Pluvialis squatarola Grey Plover [865]		Species or species habitat known to occur within area
Thalasseus bergii Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Species or species habitat known to occur within area
Tringa glareola Wood Sandpiper [829]		Species or species habitat known to occur

Name	Threatened	Type of Presence
		within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Species or species habitat known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
Ningaloo Marine Area - Commonwealth Waters	WA	Listed place

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Acrocephalus orientalis Oriental Reed-Warbler [59570]		Species or species habitat may occur within area
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone [872]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris alba Sanderling [875]		Species or species

Name	Threatened	Type of Presence
		habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Species or species habitat known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat may occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat likely to occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Species or species habitat known to occur

Name	Threatened	Type of Presence
		within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Species or species habitat known to occur within area
Hirundo daurica Red-rumped Swallow [59480]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Larus novaehollandiae Silver Gull [810]		Breeding known to occur within area
Larus pacificus Pacific Gull [811]		Foraging, feeding or related behaviour known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius phaeopus Whimbrel [849]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Foraging, feeding or related behaviour likely to occur within area
Pluvialis squatarola Grey Plover [865]		Species or species habitat known to occur within area
Pterodroma macroptera Great-winged Petrel [1035]		Foraging, feeding or

Name	Threatened	Type of Presence
		related behaviour known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Puffinus assimilis Little Shearwater [59363]		Foraging, feeding or related behaviour known to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Puffinus pacificus Wedge-tailed Shearwater [1027]		Breeding known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Sterna albifrons Little Tern [813]		Breeding known to occur within area
Sterna anaethetus Bridled Tern [814]		Breeding known to occur within area
Sterna bengalensis Lesser Crested Tern [815]		Breeding known to occur within area
Sterna bergii Crested Tern [816]		Breeding known to occur within area
Sterna caspia Caspian Tern [59467]		Breeding known to occur within area
Sterna dougallii Roseate Tern [817]		Breeding likely to occur within area
Sterna fuscata Sooty Tern [794]		Breeding known to occur within area
Sterna nereis Fairy Tern [796]		Breeding known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Tringa glareola Wood Sandpiper [829]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Species or species habitat known to occur within area
Fish		
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within area
Bhanotia fasciolata Corrugated Pipefish, Barbed Pipefish [66188]		Species or species habitat may occur within area
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area
Campichthys galei Gale's Pipefish [66191]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys latispinosus Muiron Island Pipefish [66196]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Doryrhamphus multiannulatus Many-banded Pipefish [66717]		Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish [66216]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish [66220]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
Lissocampus fatiloquus Prophet's Pipefish [66250]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Nannocampus subosseus Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species habitat may occur within area
Phoxocampus belcheri Black Rock Pipefish [66719]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammals		
Dugong dugon Dugong [28]		Breeding known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Aipysurus foliosquama Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat likely to occur within area
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Aipysurus pooleorum Shark Bay Seasnake [66061]		Species or species habitat may occur within area
Aipysurus tenuis Brown-lined Seasnake [1121]		Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake [1122]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus johnstoni Freshwater Crocodile, Johnston's Crocodile, Johnstone's Crocodile [1773]		Species or species habitat may occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake [1125]		Species or species habitat may occur within area
Enhydrina schistosa Beaked Seasnake [1126]		Species or species habitat may occur within area
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Hydrelaps darwiniensis Black-ringed Seasnake [1100]		Species or species habitat may occur within area
Hydrophis atriceps Black-headed Seasnake [1101]		Species or species habitat may occur within area
Hydrophis coggeri Slender-necked Seasnake [25925]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Hydrophis czeblukovi Fine-spined Seasnake [59233]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species habitat may occur within area
Hydrophis inornatus Plain Seasnake [1107]		Species or species habitat may occur within area
Hydrophis mcdowelli null [25926]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Seasnake, Ornate Reef Seasnake [1111]		Species or species habitat may occur within area
Lapemis hardwickii Spine-bellied Seasnake [1113]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within

Name	Status	Type of Presence
		area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Indopacetus pacificus Longman's Beaked Whale [72]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia simus Dwarf Sperm Whale [58]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Breeding known to occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon ginkgodens Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale [59564]		Species or species habitat may occur within area
Mesoplodon grayi Gray's Beaked Whale, Scamperdown Whale [75]		Species or species habitat may occur within area
Orcaella brevirostris Irrawaddy Dolphin [45]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Breeding known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species

Name	Status	Type of Presence
		habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks [Resource Information]

Name	Label
Abrolhos	Habitat Protection Zone (IUCN IV)
Abrolhos	Multiple Use Zone (IUCN VI)
Abrolhos	Special Purpose Zone (IUCN VI)
Argo-Rowley Terrace	Multiple Use Zone (IUCN VI)
Argo-Rowley Terrace	National Park Zone (IUCN II)
Dampier	Habitat Protection Zone (IUCN IV)
Dampier	Multiple Use Zone (IUCN VI)
Eighty Mile Beach	Multiple Use Zone (IUCN VI)
Gascoyne	Habitat Protection Zone (IUCN IV)
Gascoyne	Multiple Use Zone (IUCN VI)
Gascoyne	National Park Zone (IUCN II)
Joseph Bonaparte Gulf	Multiple Use Zone (IUCN VI)
Kimberley	Multiple Use Zone (IUCN VI)
Ningaloo	Recreational Use Zone (IUCN IV)
Oceanic Shoals	Multiple Use Zone (IUCN VI)
Roebuck	Multiple Use Zone (IUCN VI)
Shark Bay	Multiple Use Zone (IUCN VI)

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Bardi Jawi	WA
Dambimangari	WA
Dambimangari	WA
Dirk Hartog Island	WA
Faure Island	WA
Little Rocky Island	WA
Tent Island	WA
Unnamed WA36913	WA
Unnamed WA36915	WA
Uunguu	WA

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat may occur within area
Mammals		
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Andropogon gayanus Gamba Grass [66895]		Species or species habitat likely to occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Jatropha gossypifolia		
Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Lantana camara		
Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat may occur within area
Lycium ferocissimum		
African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Opuntia spp.		
Prickly Pears [82753]		Species or species habitat likely to occur within area
Parkinsonia aculeata		
Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Tamarix aphylla		
Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area
Reptiles		
Ramphotyphlops braminus		
Flowerpot Blind Snake, Brahminy Blind Snake, Cacing Besi [1258]		Species or species habitat likely to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
Exmouth Gulf East	WA
Hamelin Pool	WA
Shark Bay East	WA

Key Ecological Features (Marine) [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Carbonate bank and terrace system of the Sahul	North-west
Commonwealth waters adjacent to Ningaloo Reef	North-west
Continental Slope Demersal Fish Communities	North-west
Pinnacles of the Bonaparte Basin	North-west
Wallaby Saddle	North-west

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-11.269933 127.440005,-12.516962 128.274966,-13.416271 128.362857,-13.854015 128.406802,-14.652617 128.879214,-14.833236 128.956119,-14.737633 128.439761,-14.280288 127.769595,-13.864681 127.385074,-13.864681 127.143375,-13.67261 126.934634,-13.875347 126.418277,-13.843348 126.242496,-13.896678 125.967837,-14.077907 125.934878,-14.34416 125.836001,-14.216398 125.649234,-14.461212 125.099918,-14.641988 125.044986,-14.88633 125.143863,-14.971254 124.990054,-15.257624 124.649478,-15.268222 124.231998,-15.416549 124.16608,-15.490673 124.407779,-16.293713 124.286929,-16.072142 123.616763,-16.219884 123.429996,-16.567693 123.408023,-16.778181 123.561832,-16.914874 123.704654,-17.114478 123.397037,-16.546631 123.034488,-16.251529 123.078433,-16.704537 122.540103,-17.135476 122.144595,-17.502564 122.056705,-18.244939 122.078677,-18.432649 121.738101,-18.76585 121.551334,-19.45099 121.100894,-19.999097 119.584781,-19.906155 119.101382,-20.236365 118.727847,-20.308506 118.112613,-20.648142 117.321597,-20.555589 116.948062,-20.360014 117.01398,-20.318809 116.816226,-20.802273 116.26691,-20.822812 116.113101,-21.468342 115.377017,-21.754335 114.629947,-22.344932 114.355289,-22.202601 114.146548,-21.67268 114.245425,-21.886924 113.849918,-22.669716 113.586246,-23.003846 113.751041,-23.458145 113.696109,-24.031352 113.300601,-24.51208 113.311587,-25.893759 114.135562,-26.258875 114.003726,-25.953045 113.926822,-25.398562 113.45441,-25.686027 113.366519,-26.249022 113.641177,-26.229314 113.509341,-25.378711 112.949039,-25.557248 112.839175,-26.485263 113.256656,-27.161748 113.816959,-27.571531 114.036685,-27.552052 113.113834,-27.151972 112.981998,-25.368784 112.278873,-26.022173 110.389224,-25.893759 110.323306,-25.804776 109.872867,-25.537424 109.587222,-25.626608 109.23566,-24.582033 109.389468,-23.306884 109.872867,-22.882439 110.026675,-21.621623 110.169498,-20.945986 110.510074,-20.030065 110.949527,-19.025706 112.092105,-17.816621 112.981998,-17.271909 113.773013,-16.935895 115.442935,-15.681156 116.014224,-14.790751 116.89313,-14.056594 118.266421,-13.266614 118.42023,-13.949995 120.046207,-13.234532 121.825992,-12.838516 122.529117,-12.15205 122.51813,-11.883411 122.726871,-11.786636 123.067447,-11.926411 123.440982,-12.248693 123.583804,-11.63603 125.737125,-11.334573 126.539126,-11.280707 127.440005,-11.269933 127.440005

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

Department of Agriculture Water and the Environment
GPO Box 858
Canberra City ACT 2601 Australia
+61 2 6274 1111

Australian Government

Department of Agriculture, Water and the Environment

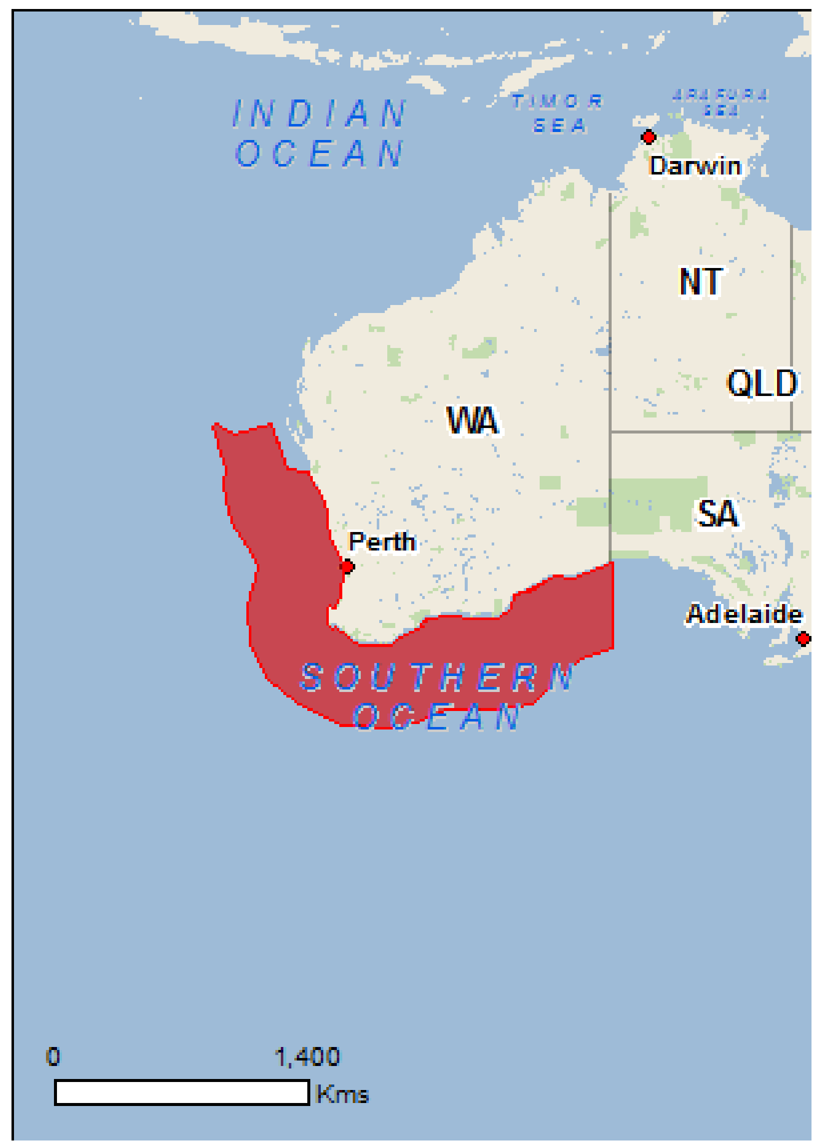
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

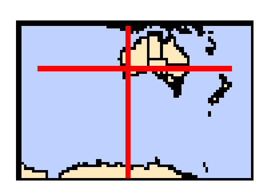
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 10/05/21 12:51:00



Coordinates

Buffer: 1.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	1
Wetlands of International Importance:	4
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	3
Listed Threatened Species:	65
Listed Migratory Species:	67

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	2
Commonwealth Heritage Places:	1
Listed Marine Species:	106
Whales and Other Cetaceans:	40
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	21

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	10
Regional Forest Agreements:	None
Invasive Species:	42
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	8

Details

Matters of National Environmental Significance

National Heritage Properties
[Resource Information]

Name	State	Status
Indigenous		
Cheetup Rock Shelter	WA	Listed place

Wetlands of International Importance (Ramsar)
[Resource Information]

Name	Proximity
Becher point wetlands	Within 10km of Ramsar
Forrestdale and thomsons lakes	Within 10km of Ramsar
Peel-yalgorup system	Within 10km of Ramsar
Vasse-wonnerup system	Within 10km of Ramsar

Commonwealth Marine Area
[Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea
Extended Continental Shelf

Marine Regions
[Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
South-west

Listed Threatened Ecological Communities
[Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community may occur within area
Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of Western Australia	Endangered	Community may occur within area
Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain ecological community	Critically Endangered	Community likely to occur within area

Listed Threatened Species
[Resource Information]

Name	Status	Type of Presence
Birds		
Anous tenuirostris melanops		
Australian Lesser Noddy [26000]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Atrichornis clamosus		
Noisy Scrub-bird, Tjimiluk [654]	Endangered	Species or species habitat known to occur within area
Botaurus poiciloptilus		
Australasian Bittern [1001]	Endangered	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat likely to occur within area
Calyptorhynchus latirostris Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area
Cereopsis novaehollandiae grisea Cape Barren Goose (south-western), Recherche Cape Barren Goose [25978]	Vulnerable	Breeding known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat may occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432]	Critically Endangered	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel	Endangered	Species or species

Name	Status	Type of Presence
[1060]		habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Pezoporus flaviventris Western Ground Parrot, Kyloring [84650]	Critically Endangered	Species or species habitat likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Bettongia penicillata ogilbyi Woylie [66844]	Endangered	Species or species habitat may occur within

Name	Status	Type of Presence
		area
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Breeding known to occur within area
Parantechinus apicalis Dibbler [313]	Endangered	Species or species habitat known to occur within area
Petrogale lateralis hacketti Recherche Rock-wallaby [66849]	Vulnerable	Species or species habitat known to occur within area
Potorous gilbertii Gilbert's Potoroo, Ngilkat [66642]	Critically Endangered	Translocated population known to occur within area
Pseudocheirus occidentalis Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Critically Endangered	Species or species habitat may occur within area
Setonix brachyurus Quokka [229]	Vulnerable	Species or species habitat known to occur within area
Plants		
Caladenia elegans Elegant Spider-orchid [56775]	Endangered	Species or species habitat may occur within area
Caladenia granitora [65292]	Endangered	Species or species habitat may occur within area
Caladenia hoffmanii Hoffman's Spider-orchid [56719]	Endangered	Species or species habitat may occur within area
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat likely to occur within area
Drummondita ericoides Morseby Range Drummondita [9193]	Endangered	Species or species habitat likely to occur within area
Eucalyptus insularis Twin Peak Island Mallee [3057]	Endangered	Species or species habitat likely to occur within area
Isopogon uncinatus Albany Cone Bush, Hook-leaf Isopogon [20871]	Endangered	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Name	Status	Type of Presence
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Egernia stokesii badia		
Western Spiny-tailed Skink, Baudin Island Spiny-tailed Skink [64483]	Endangered	Species or species habitat may occur within area
Liopholis pulchra longicauda		
Jurien Bay Skink, Jurien Bay Rock-skink [83162]	Vulnerable	Species or species habitat known to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sharks		
Carcharias taurus (west coast population)		
Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus		
Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes		
Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Breeding known to occur within area
Ardenna grisea		
Sooty Shearwater [82651]		Species or species habitat may occur within area
Ardenna pacifica		
Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Ardenna tenuirostris		
Short-tailed Shearwater [82652]		Breeding known to occur within area
Diomedea amsterdamensis		
Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea antipodensis		
Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea dabbenena		
Tristan Albatross [66471]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora		
Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Onychoprion anaethetus Bridled Tern [82845]		Breeding known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Breeding known to occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Foraging, feeding or related behaviour known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area
Calidris alba Sanderling [875]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat likely to occur within area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Thalasseus bergii Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Species or species habitat known to occur

Name	Threatened	Type of Presence
		within area
[Tringa nebularia](#) Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -
Defence - HMAS STIRLING-ROCKINGHAM ;HMAS STIRLING - GARDEN ISLAND

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
[Garden Island](#)	WA	Listed place

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
[Actitis hypoleucos](#) Common Sandpiper [59309]		Species or species habitat known to occur within area
[Anous stolidus](#) Common Noddy [825]		Species or species habitat likely to occur within area
[Anous tenuirostris melanops](#) Australian Lesser Noddy [26000]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
[Apus pacificus](#) Fork-tailed Swift [678]		Species or species habitat likely to occur within area
[Ardea ibis](#) Cattle Egret [59542]		Species or species habitat may occur within area
[Arenaria interpres](#) Ruddy Turnstone [872]		Species or species habitat known to occur within area
[Calidris acuminata](#) Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area
[Calidris alba](#) Sanderling [875]		Species or species

Name	Threatened	Type of Presence
		habitat known to occur within area
[Calidris canutus](#) Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat likely to occur within area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Species or species habitat known to occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Cereopsis novaehollandiae grisea Cape Barren Goose (south-western), Recherche Cape Barren Goose [25978]	Vulnerable	Breeding known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Species or species habitat known to occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Eudyptula minor Little Penguin [1085]		Breeding known to occur within area

Name	Threatened	Type of Presence
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat known to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Species or species habitat known to occur within area
Larus novaehollandiae Silver Gull [810]		Breeding known to occur within area
Larus pacificus Pacific Gull [811]		Breeding known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Pelagodroma marina White-faced Storm-Petrel [1016]		Breeding known to occur within area
Phalacrocorax fuscescens Black-faced Cormorant [59660]		Breeding known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma macroptera Great-winged Petrel [1035]		Breeding known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely

Name	Threatened	Type of Presence
		to occur within area
Puffinus assimilis Little Shearwater [59363]		Breeding known to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Breeding known to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat may occur within area
Puffinus pacificus Wedge-tailed Shearwater [1027]		Breeding known to occur within area
Puffinus tenuirostris Short-tailed Shearwater [1029]		Breeding known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat known to occur within area
Sterna anaethetus Bridled Tern [814]		Breeding known to occur within area
Sterna bergii Crested Tern [816]		Breeding known to occur within area
Sterna caspia Caspian Tern [59467]		Breeding known to occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sterna fuscata Sooty Tern [794]		Breeding known to occur within area
Sterna nereis Fairy Tern [796]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area
Fish		

Name	Threatened	Type of Presence
Acentronura australe Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
Campichthys galei Gale's Pipefish [66191]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus subelongatus West Australian Seahorse [66722]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus fatiloquus Prophet's Pipefish [66250]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys meraculus Western Crested Pipefish [66259]		Species or species habitat may occur within area
Nannocampus subosseus Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Breeding known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Breeding known to occur within area
Reptiles		
Aipysurus laevis Olive Seasnake [1120]		Species or species habitat may occur within area
Aipysurus pooleorum Shark Bay Seasnake [66061]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Disteira major Olive-headed Seasnake [1124]		Species or species habitat may occur within area
Ephalophis greyi North-western Mangrove Seasnake [1127]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Berardius arnuxii Arnoux's Beaked Whale [70]		Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within

Name	Status	Type of Presence
		area
[Hyperoodon planifrons] Southern Bottlenose Whale [71]		Species or species habitat may occur within area
[Kogia breviceps] Pygmy Sperm Whale [57]		Species or species habitat may occur within area
[Kogia simus] Dwarf Sperm Whale [58]		Species or species habitat may occur within area
[Lagenodelphis hosei] Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
[Lagenorhynchus obscurus] Dusky Dolphin [43]		Species or species habitat likely to occur within area
[Lissodelphis peronii] Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
[Megaptera novaeangliae] Humpback Whale [38]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
[Mesoplodon bowdoini] Andrew's Beaked Whale [73]		Species or species habitat may occur within area
[Mesoplodon densirostris] Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
[Mesoplodon ginkgodens] Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale [59564]		Species or species habitat may occur within area
[Mesoplodon grayi] Gray's Beaked Whale, Scamperdown Whale [75]		Species or species habitat may occur within area
[Mesoplodon hectori] Hector's Beaked Whale [76]		Species or species habitat may occur within area
[Mesoplodon layardii] Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
[Mesoplodon mirus] True's Beaked Whale [54]		Species or species habitat may occur within area
[Orcinus orca] Killer Whale, Orca [46]		Species or species habitat may occur within area
[Peponocephala electra] Melon-headed Whale [47]		Species or species habitat may occur within area
[Physeter macrocephalus] Sperm Whale [59]		Foraging, feeding or related behaviour known to occur within area
[Pseudorca crassidens] False Killer Whale [48]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tasmacetus shepherdi Shepherd's Beaked Whale, Tasman Beaked Whale [55]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks [Resource Information]

Name	Label
Abrolhos	Habitat Protection Zone (IUCN IV)
Abrolhos	Multiple Use Zone (IUCN VI)
Abrolhos	Special Purpose Zone (IUCN VI)
Bremer	National Park Zone (IUCN II)
Bremer	Special Purpose Zone (Mining
Eastern Recherche	National Park Zone (IUCN II)
Eastern Recherche	Special Purpose Zone (IUCN VI)
Geographe	Habitat Protection Zone (IUCN IV)
Geographe	Multiple Use Zone (IUCN VI)
Geographe	National Park Zone (IUCN II)
Geographe	Special Purpose Zone (Mining
Great Australian Bight	Special Purpose Zone (Mining
Jurien	Special Purpose Zone (IUCN VI)
South-west Corner	Habitat Protection Zone (IUCN IV)
South-west Corner	Multiple Use Zone (IUCN VI)
South-west Corner	National Park Zone (IUCN II)
South-west Corner	Special Purpose Zone (IUCN VI)
South-west Corner	Special Purpose Zone (Mining
Twilight	National Park Zone (IUCN II)
Twilight	Special Purpose Zone (Mining
Two Rocks	Multiple Use Zone (IUCN VI)

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Bald Island	WA
Boullanger, Whitlock, Favourite, Tern And Osprey Islands	WA
Eclipse Island	WA
Escape Island	WA
Flinders Bay	WA
Penguin Island	WA
Recherche Archipelago	WA
St Alouarn Island	WA
Unnamed WA44682	WA
Unnamed WA48968	WA

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Funambulus pennantii Northern Palm Squirrel, Five-striped Palm Squirrel [129]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Asparagus plumosus Climbing Asparagus-fern [48993]		Species or species habitat likely to occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Genista linifolia Flax-leaved Broom, Mediterranean Broom, Flax Broom [2800]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area

Key Ecological Features (Marine) [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Ancient coastline at 90-120m depth	South-west
Commonwealth marine environment surrounding	South-west
Commonwealth marine environment within and	South-west
Commonwealth marine environment within and	South-west
Diamantina Fracture Zone	South-west
Naturaliste Plateau	South-west
Western demersal slope and associated fish	South-west
Western rock lobster	South-west

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-25.765206 109.237891,-25.725623 109.501563,-25.992551 109.732276,-25.992551 109.875098,-26.071525 110.182716,-26.229314 110.325538,-25.656321 112.127296,-27.717513 112.984229,-27.814726 114.02793,-28.202708 114.159766,-28.483117 114.445411,-28.695347 114.577247,-28.974447 114.599219,-29.147305 114.818946,-29.530391 114.950782,-29.921554 114.89585,-30.746498 115.082618,-31.517621 115.533057,-31.863505 115.730811,-32.523601 115.67588,-32.634692 115.544044,-33.16049 115.620948,-33.619137 115.302344,-33.49096 114.994727,-33.737988 114.928809,-34.275319 114.972755,-34.46575 115.126563,-34.366055 115.269385,-34.818257 115.917579,-34.908402 116.060401,-35.106373 116.598731,-35.11536 117.389747,-35.169263 117.774268,-35.169263 118.081885,-34.980447 118.312598,-34.402321 119.663917,-34.30255 119.56504,-34.029844 119.883643,-33.938746 120.960303,-33.911398 121.399757,-34.011632 121.949073,-34.102652 122.476417,-34.038948 123.432227,-33.591687 124.091407,-33.10529 124.212257,-32.902593 125.014258,-32.319576 126.134864,-32.375265 127.123633,-31.760809 129.035255,-35.294897 129.068214,-35.634921 127.541114,-37.453004 125.157081,-37.696807 123.058692,-37.688114 120.817481,-38.46644 118.664161,-38.337294 115.697852,-37.418109 113.368751,-36.584603 112.028419,-34.998448 111.061622,-33.545916 110.973731,-31.984725 111.512061,-31.414542 111.270362,-30.026241 110.182716,-28.396173 109.798194,-27.756409 109.875098,-25.765206 109.237891,-25.765206 109.237891

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- -Office of Environment and Heritage, New South Wales
- -Department of Environment and Primary Industries, Victoria
- -Department of Primary Industries, Parks, Water and Environment, Tasmania
- -Department of Environment, Water and Natural Resources, South Australia
- -Department of Land and Resource Management, Northern Territory
- -Department of Environmental and Heritage Protection, Queensland
- -Department of Parks and Wildlife, Western Australia
- -Environment and Planning Directorate, ACT
- -Birdlife Australia
- -Australian Bird and Bat Banding Scheme
- -Australian National Wildlife Collection
- -Natural history museums of Australia
- -Museum Victoria
- -Australian Museum
- -South Australian Museum
- -Queensland Museum
- -Online Zoological Collections of Australian Museums
- -Queensland Herbarium
- -National Herbarium of NSW
- -Royal Botanic Gardens and National Herbarium of Victoria
- -Tasmanian Herbarium
- -State Herbarium of South Australia
- -Northern Territory Herbarium
- -Western Australian Herbarium
- -Australian National Herbarium, Canberra
- -University of New England
- -Ocean Biogeographic Information System
- -Australian Government, Department of Defence
- Forestry Corporation, NSW
- -Geoscience Australia
- -CSIRO
- -Australian Tropical Herbarium, Cairns
- -eBird Australia
- -Australian Government – Australian Antarctic Data Centre
- -Museum and Art Gallery of the Northern Territory
- -Australian Government National Environmental Science Program
- -Australian Institute of Marine Science
- -Reef Life Survey Australia
- -American Museum of Natural History
- -Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
- -Tasmanian Museum and Art Gallery, Hobart, Tasmania
- -Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

Department of Agriculture Water and the Environment
GPO Box 858
Canberra City ACT 2601 Australia
+61 2 6274 1111

APPENDIX B. SUPPORTING FIGURES FOR SECTION 2.3 METEOROLOGY AND OCEANOGRAPHY

Browse

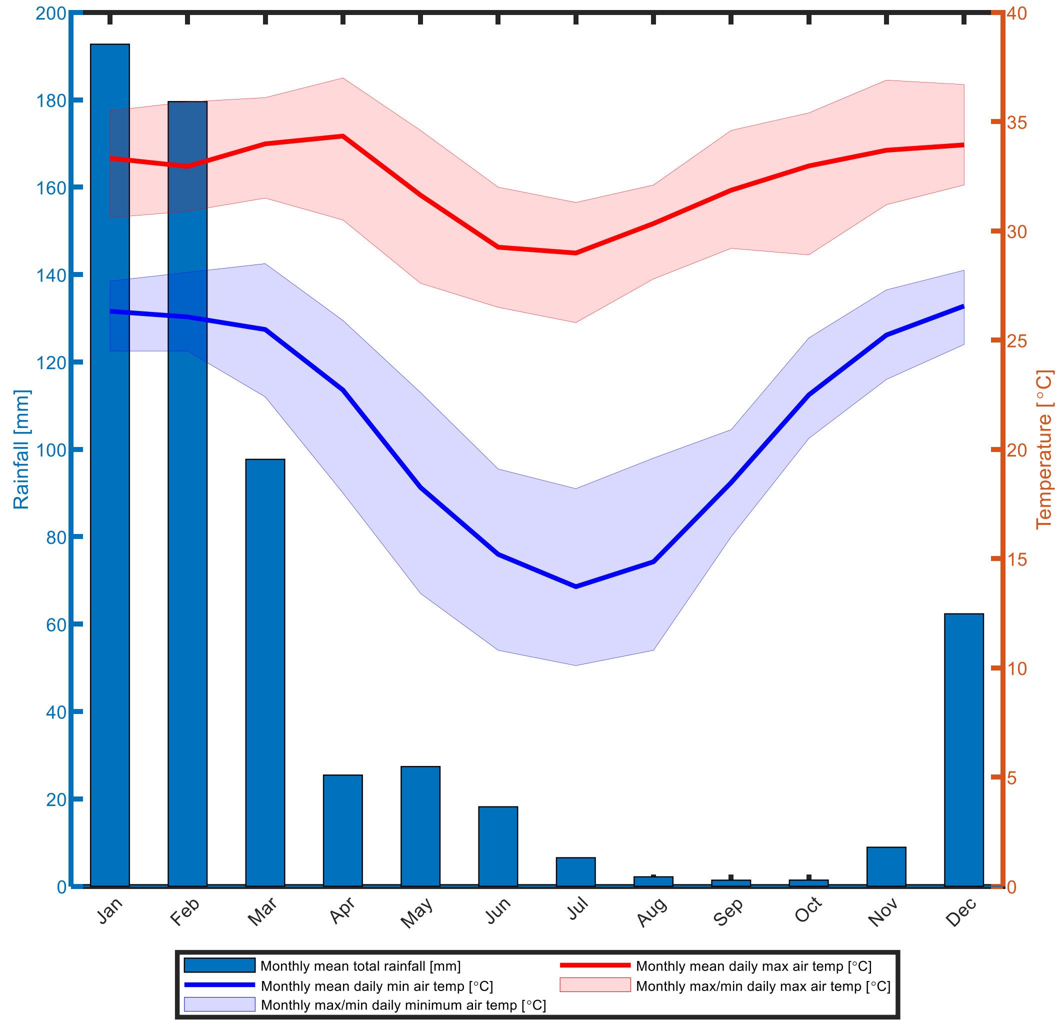
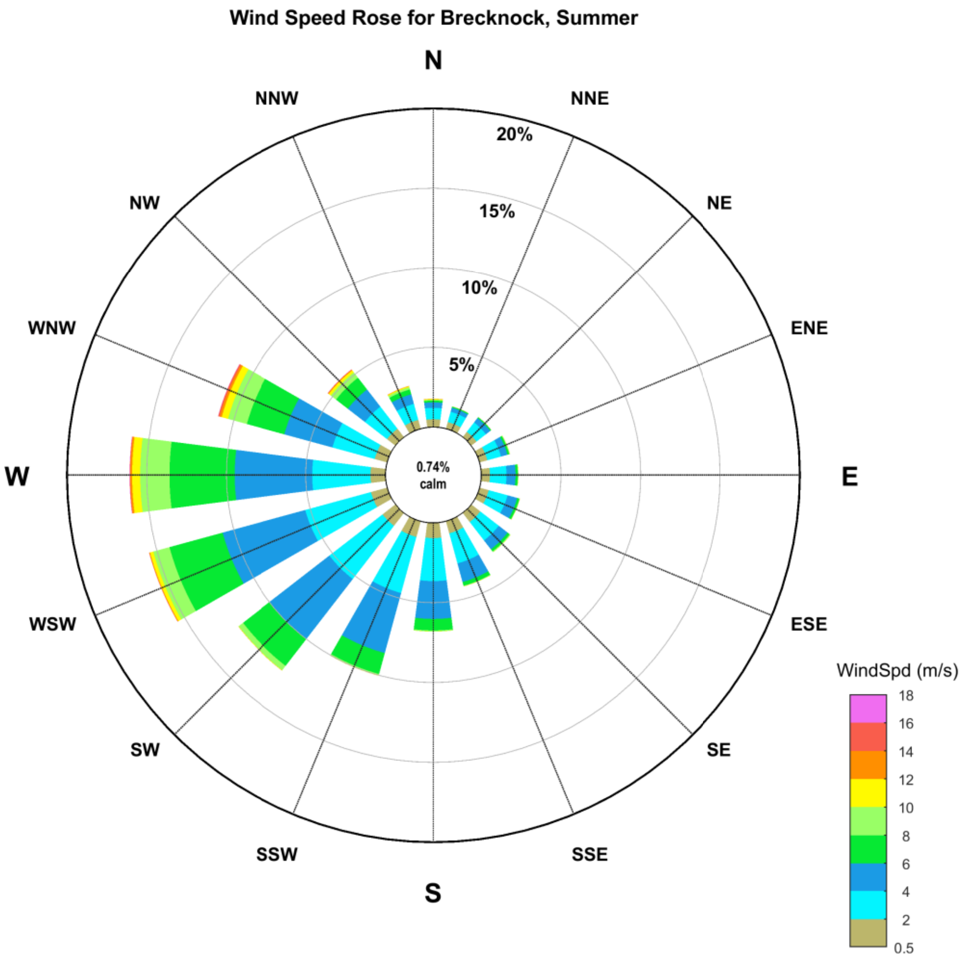


Figure 1. Monthly average total rainfall [mm] and air temperature [°C], calculated based on observations at the Broome Airport weather station from 1939-2020 (Bureau of Meteorology 2020). Bars show the monthly average total rainfall values, and thick blue and red lines denote monthly average daily minimum and maximum air temperatures, respectively. Shaded blue and red areas denote monthly recorded extremes of daily minimum and maximum air temperature, respectively.

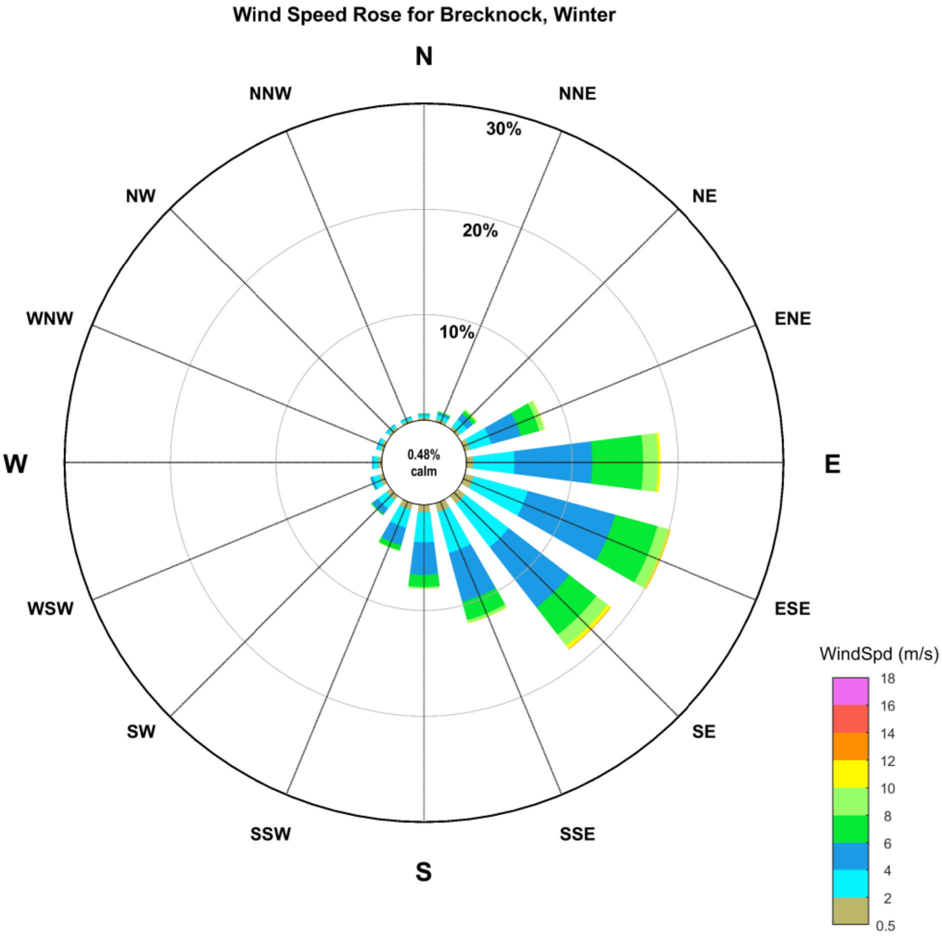


Data Information:
Project: Browse
Location: Brecknock [121.6500°E, 14.5300°S]
Data Period: Summer (01-Jan-1979 to 01-Jan-2019)
Data Source: Modelled Hindcast
Record Elevation: 10 m AMSL
Local Water Depth (m): 560
Data Summary: Summer
Number of Records: 164812
Missing Data (%): 5.80
Calm (% < 0.50m/s): 0.74
Measurement Format: 10-minute avg.

Key Statistics for Data Shown:
Max Wind Speed: 20.60 m/s
Mean Wind Speed: 4.55 m/s
StdDev. Wind Speed: 2.31 m/s

Woodside

Figure 2. Summer distributions of 10-minute average wind speeds by 22.5° directional sectors at the Brecknock site (Metocean Solutions Ltd, 2019). Note tropical cyclone events were not included in this distribution. Winds at Brecknock in summer are predominantly from the WNW to SW due to the North West Monsoon (WEL, 2019).

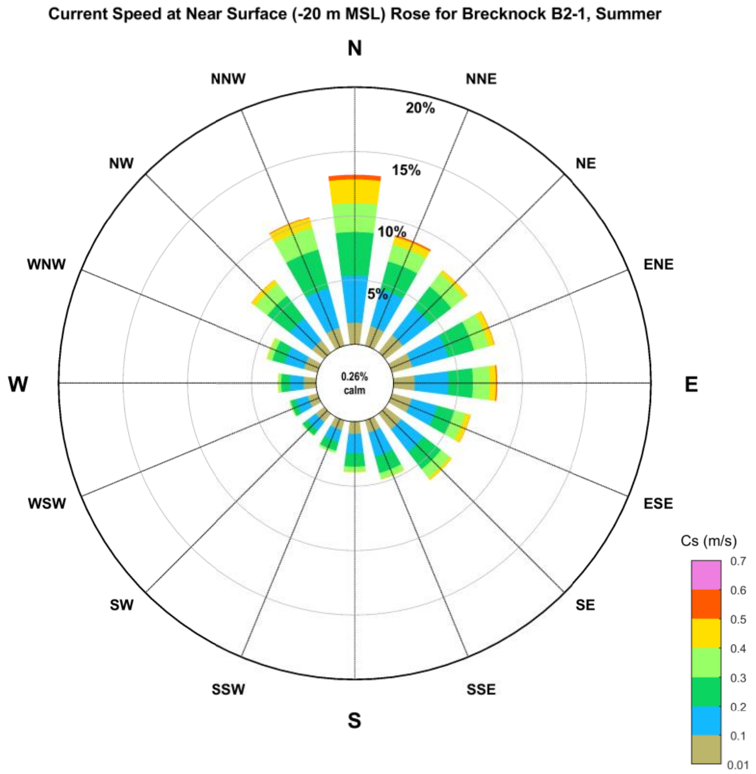


Data Information:
Project: Browse
Location: Brecknock [121.6500°E, 14.5300°S]
Data Period: Winter (01-Apr-1979 to 30-Sep-2018)
Data Source: Modelled Hindcast
Record Elevation: 10 m AMSL
Local Water Depth (m): 560
Data Summary: Winter
Number of Records: 173751
Missing Data (%): 1.10
Calm (% < 0.50m/s): 0.48
Measurement Format: 10-minute avg.

Key Statistics for Data Shown:
Max Wind Speed: 14.34 m/s
Mean Wind Speed: 4.71 m/s
StdDev. Wind Speed: 2.01 m/s

Woodside

Figure 3. Winter distributions of 10-minute average wind speeds by 22.5° directional sectors at the Brecknock site (Metocean Solutions Ltd, 2019). Note tropical cyclone events were not included in this distribution. Winds at Brecknock in winter are predominantly from the E to SE due to the South East Trade Winds coming from the Australian mainland (WEL, 2019).

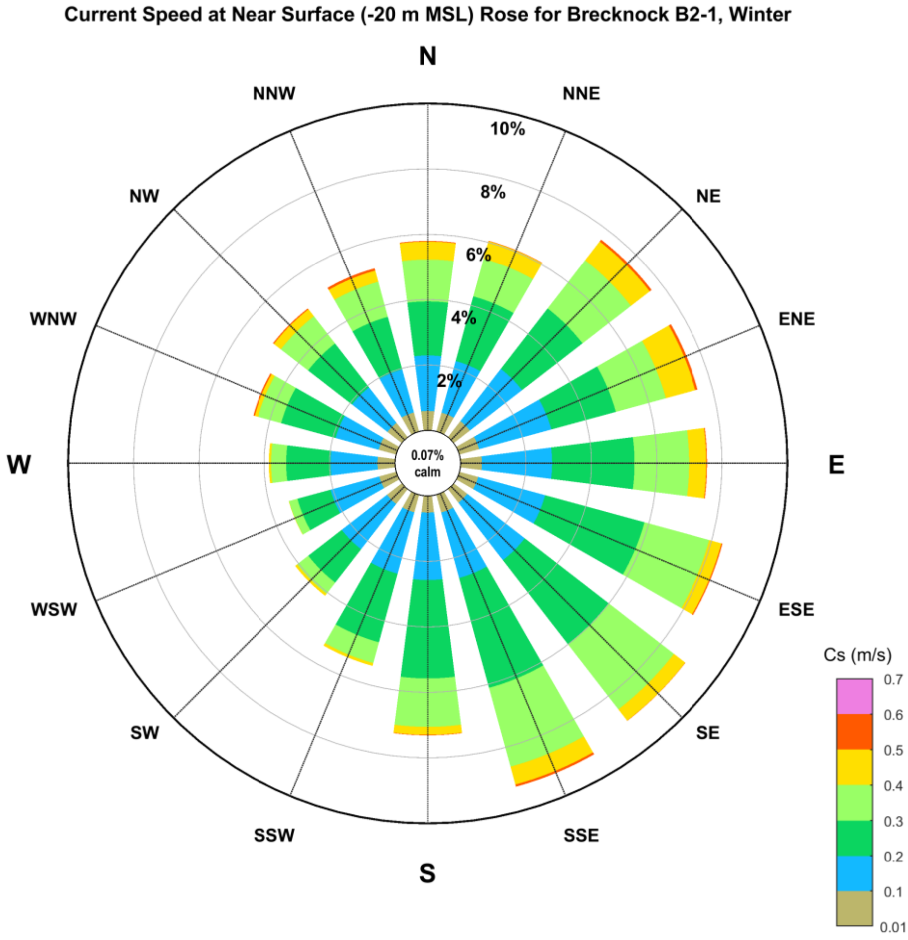


Data Information:
Project: Browse
Location: Brecknock B2-1 [121.5700°E, 14.5100°S]
Data Period: Summer (01-Oct-2006 to 31-Mar-2007)
Data Source: CM04 Measured
Record Elevation: Near Surface (-20 m MSL)
Local Water Depth (m): 560
Data Summary: Summer
Number of Records: 243472
Missing Data (%): 7.10
Calm (% < 0.01m/s): 0.26

Key Statistics for Data Shown:
Max Curr Spd: 0.63 m/s
Mean Curr Spd: 0.20 m/s
StdDev. Curr Spd: 0.11 m/s

Woodside

Figure 4. Summer (Nov-Apr) near surface combined frequency of 1-minute mean current speed and direction (towards) measured at Brecknock B2-1 location (cyclones removed) (RPS Metocean Ltd. 2008).



Data Information:
Project: Browse
Location: Brecknock B2-1 [121.5700°E, 14.5100°S]
Data Period: Winter (17-Sep-2006 to 08-Sep-2007)
Data Source: CM04 Measured
Record Elevation: Near Surface (-20 m MSL)
Local Water Depth (m): 560
Data Summary: Winter
Number of Records: 246184
Missing Data (%): 1.46
Calm (% < 0.01m/s): 0.07

Key Statistics for Data Shown:
Max Curr Spd: 0.62 m/s
Mean Curr Spd: 0.24 m/s
StdDev. Curr Spd: 0.10 m/s

Woodside

Figure 5. Winter (May-Sep) near surface combined frequency of 1-minute mean current speed and direction (towards) measured at Brecknock B2-1 location (cyclones removed) (RPS Metocean Ltd. 2008).

North-west Shelf/Scarborough

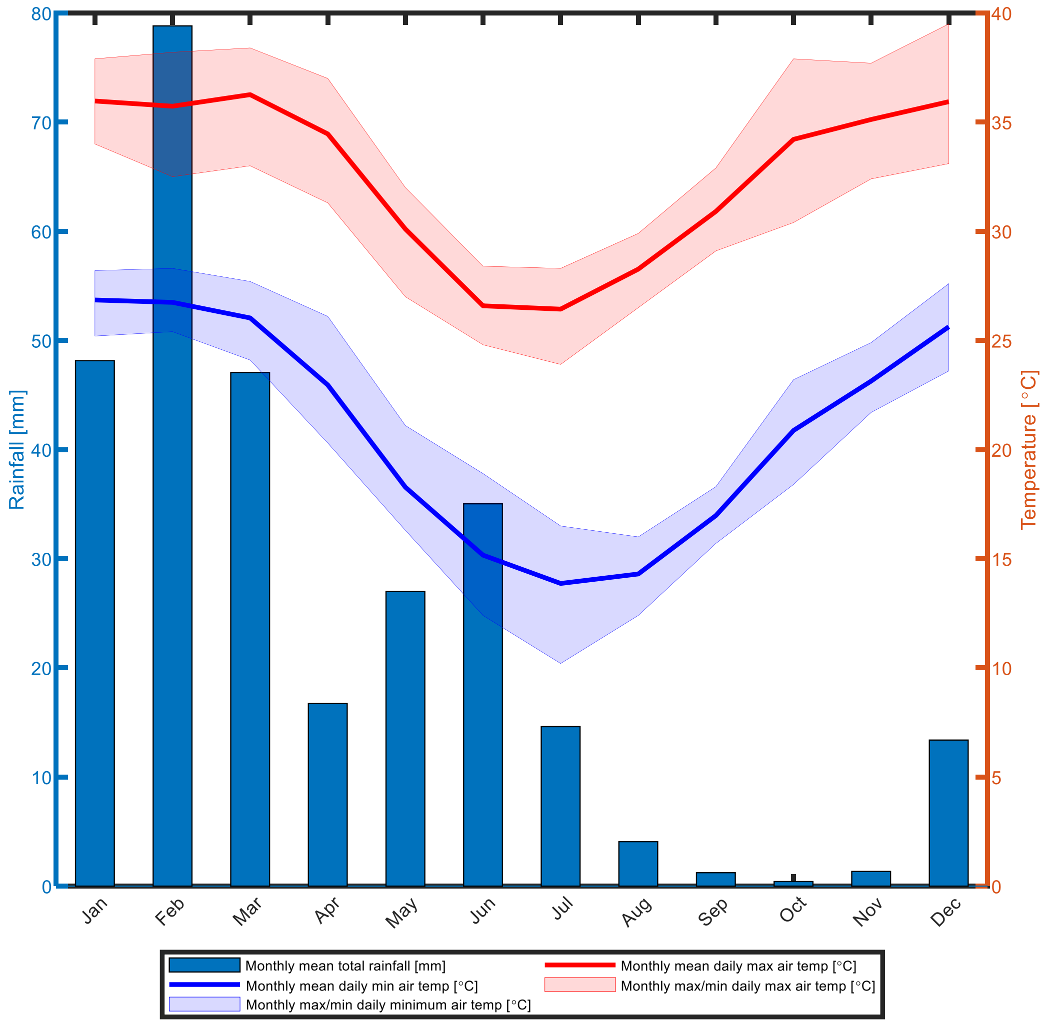


Figure 1. Monthly average total rainfall [mm] and air temperature [°C], calculated based on observations at the Karratha Aero weather station from 1972-2020 and 1993-2020 respectively (Bureau of Meteorology 2020). Bars show the monthly average total rainfall values, and thick blue and red lines denote monthly average daily minimum and maximum air temperatures, respectively. Shaded blue and red areas denote monthly recorded extremes of daily minimum and maximum air temperature, respectively.

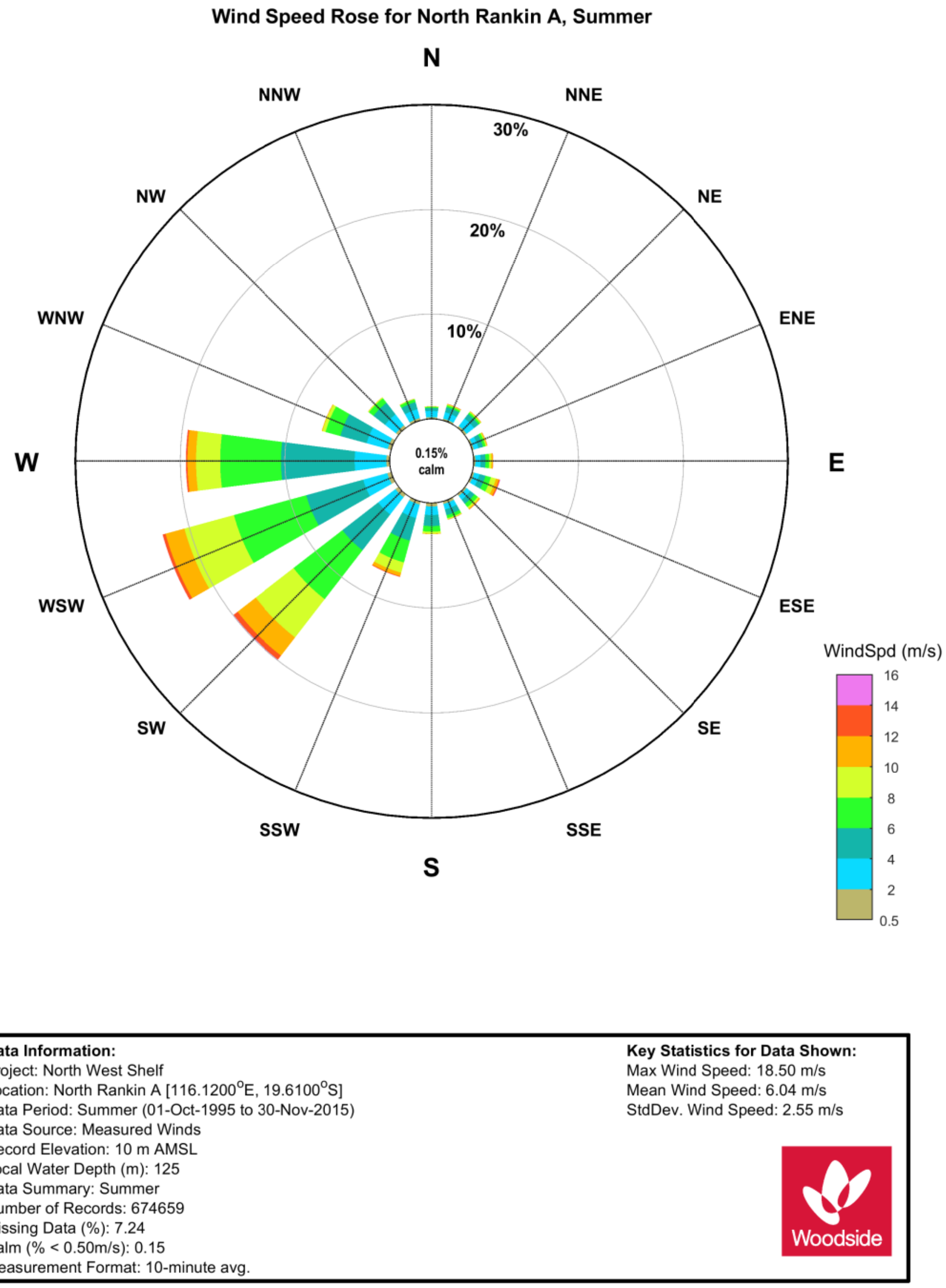
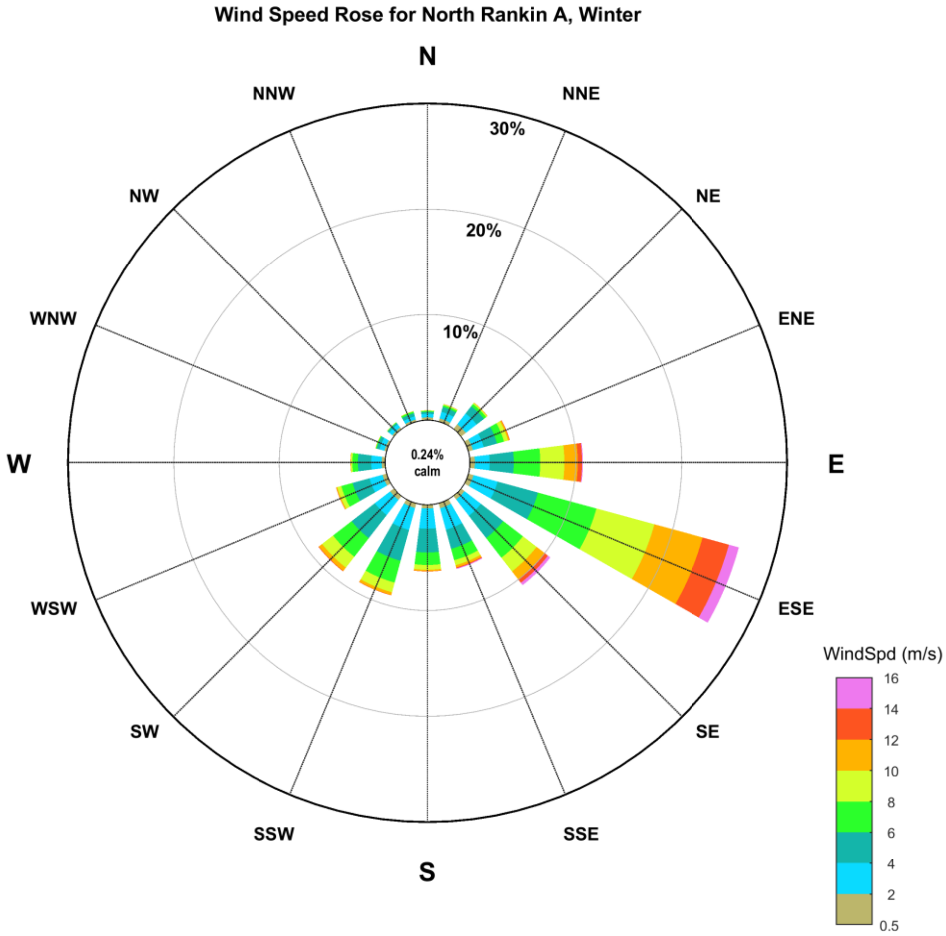


Figure 2. Summer distributions of 10-minute average wind speeds by 22.5° directional sectors at the North Rankin A site (WEL, 2015). Note tropical cyclone events were not included in this distribution. Winds at North Rankin A in summer are characterised by W to SW driven by the North West Monsoon (RPS, 2016).



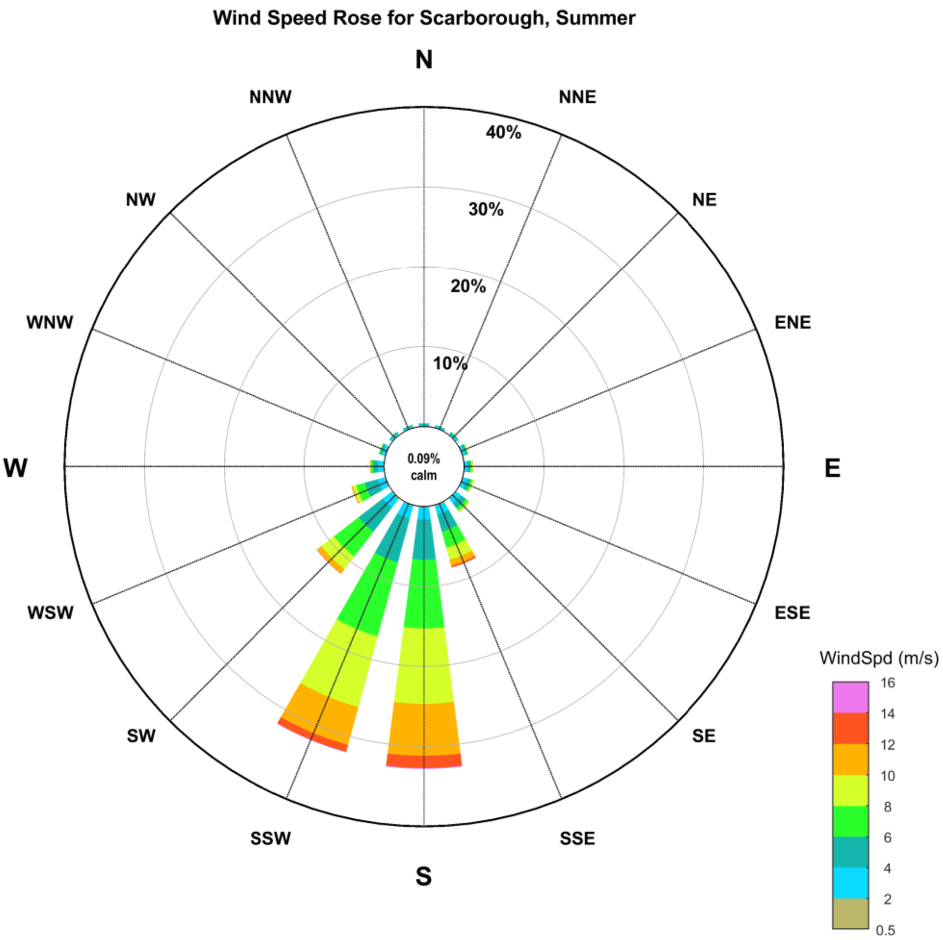
Data Information:
Project: North West Shelf
Location: North Rankin A [116.1200°E, 19.6100°S]
Data Period: Winter (22-Jun-1995 to 30-Sep-2015)
Data Source: Measured Winds
Record Elevation: 10 m AMSL
Local Water Depth (m): 125
Data Summary: Winter
Number of Records: 673213
Missing Data (%): 4.43
Calm (% < 0.50m/s): 0.24
Measurement Format: 10-minute avg.

Key Statistics for Data Shown:
Max Wind Speed: 24.23 m/s
Mean Wind Speed: 6.25 m/s
StdDev. Wind Speed: 3.16 m/s

Woodside

Figure 3. Winter distributions of 10-minute average wind speeds by 22.5° directional sectors at the North Rankin A site (WEL, 2015). Note tropical cyclone events were not included in this distribution. Winds at North Rankin in winter are predominantly influenced by the South East Trade Winds over Australia (RPS, 2016).

Scarborough

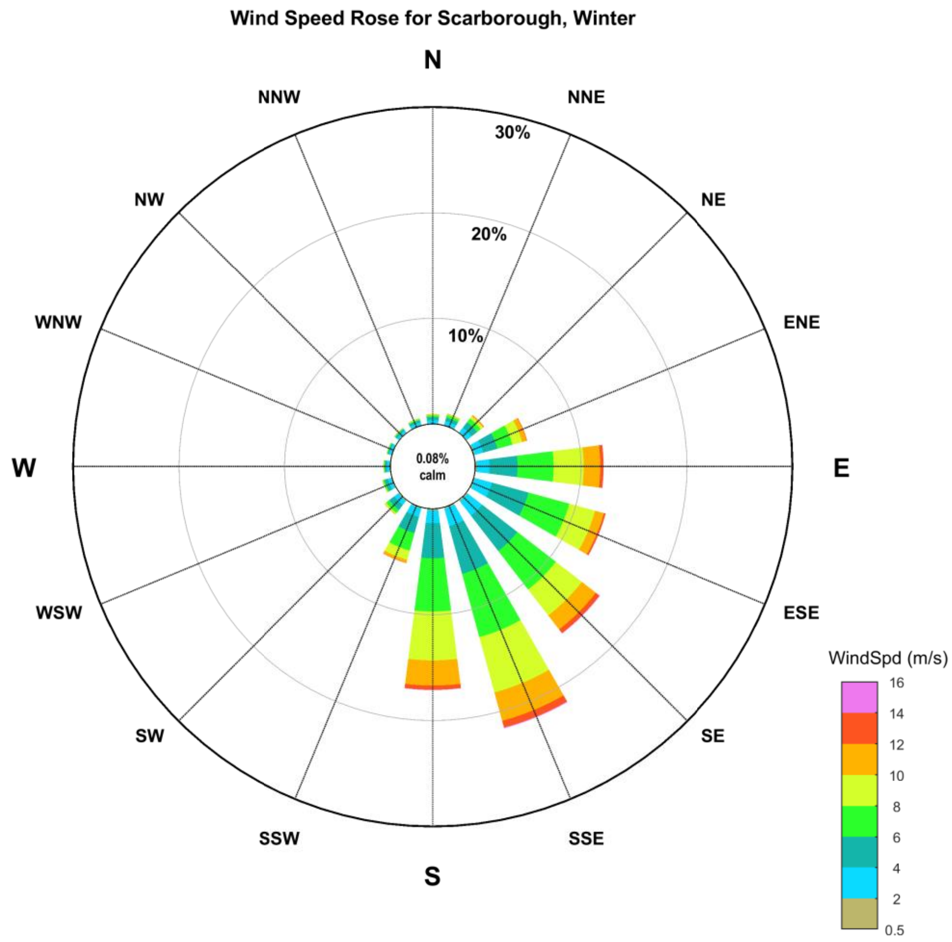


Data Information:
Project: North West Shelf
Location: Scarborough [113.2000°E, 19.8800°S]
Data Period: Summer (01-Jan-1979 to 01-Jan-2011)
Data Source: CSFR
Record Elevation: 10 m AMSL
Local Water Depth (m): 950
Data Summary: Summer
Number of Records: 129521
Missing Data (%): 7.46
Calm (% < 0.50m/s): 0.09
Measurement Format: 10-minute avg.

Key Statistics for Data Shown:
Max Wind Speed: 16.75 m/s
Mean Wind Speed: 7.23 m/s
StdDev. Wind Speed: 2.64 m/s

Woodside

Figure 4. Summer distributions of wind speeds (10-minute at 10m ASL) by 22.5° directional sectors at the Scarborough site (WEL, 2018). Note tropical cyclone events were not included in this distribution. Winds at Scarborough in summer are predominantly from the S to SSW due to a Pilbara Heat Low forming over the northwest coast of Western Australia [R8] SW winds are also experienced at this site due to the monsoon trough.



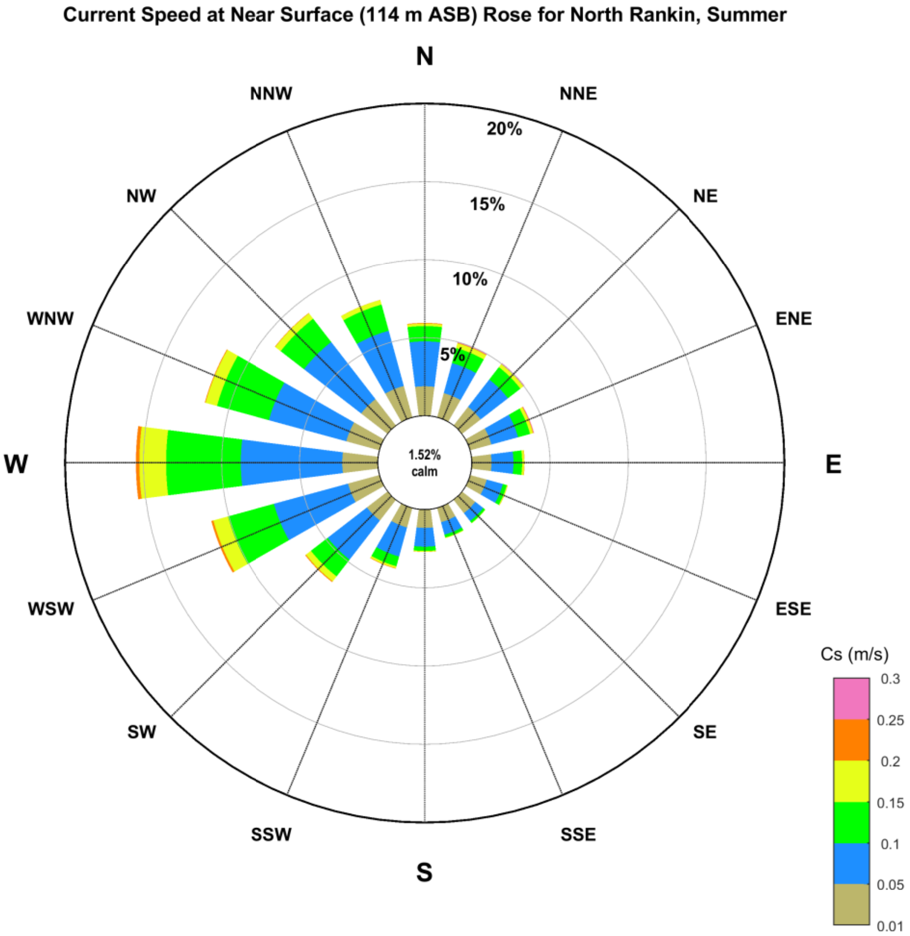
Data Information:
Project: North West Shelf
Location: Scarborough [113.2000°E, 19.8800°S]
Data Period: Winter (01-Apr-1979 to 30-Sep-2010)
Data Source: CSFR
Record Elevation: 10 m AMSL
Local Water Depth (m): 950
Data Summary: Winter
Number of Records: 138863
Missing Data (%): 1.20
Calm (% < 0.50m/s): 0.08
Measurement Format: 10-minute avg.

Key Statistics for Data Shown:
Max Wind Speed: 19.15 m/s
Mean Wind Speed: 6.90 m/s
StdDev. Wind Speed: 2.57 m/s

Woodside

Figure 5. Winter distributions of wind speeds (10-minute at 10 m ASL) by 22.5° directional sectors at the Scarborough site (WEL, 2018). Note tropical cyclone events were not included in this distribution. Winds at Scarborough in winter are predominantly from the S to E driven by the South East Trade Winds over Australia (RPS, 2016).

North-west Shelf

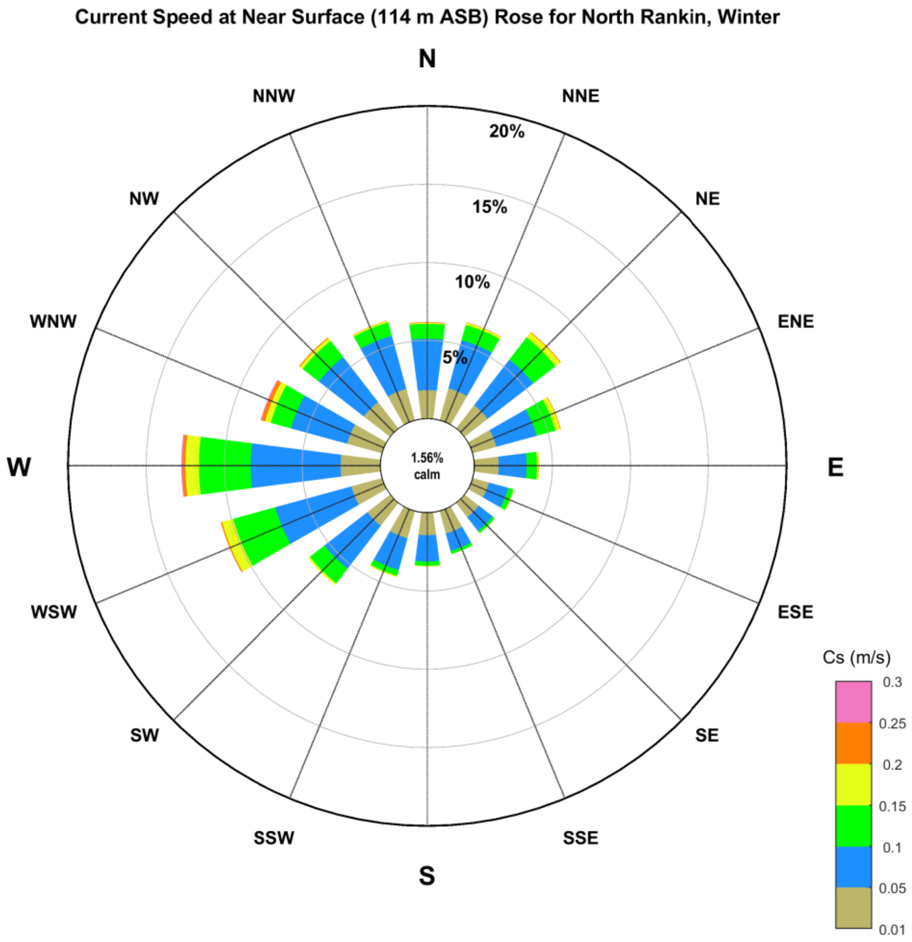


Data Information:
Project: North West Shelf
Location: North Rankin [116.1400°E, 19.5800°S]
Data Period: Summer (01-Oct-2004 to 31-Mar-2009)
Data Source: Measured Data
Record Elevation: Near Surface (114 m ASB)
Local Water Depth (m): 124.5
Data Summary: Summer
Number of Records: 496705
Missing Data (%): 6.63
Calm (% < 0.01m/s): 1.52

Key Statistics for Data Shown:
Max Curr Spd: 0.49 m/s
Mean Curr Spd: 0.08 m/s
StdDev. Curr Spd: 0.04 m/s

Woodside

Figure 6. Summer (Nov-Apr) near surface combined frequency of 1-minute mean current speed and direction (towards) measured at the North Rankin location (cyclones removed) (WEL, 2011).



Data Information:
Project: North West Shelf
Location: North Rankin [116.1400°E, 19.5800°S]
Data Period: Winter (21-Sep-2004 to 08-May-2009)
Data Source: Measured Data
Record Elevation: Near Surface (114 m ASB)
Local Water Depth (m): 124.5
Data Summary: Winter
Number of Records: 337723
Missing Data (%): 0.88
Calm (% < 0.01m/s): 1.56

Key Statistics for Data Shown:
Max Curr Spd: 0.32 m/s
Mean Curr Spd: 0.07 m/s
StdDev. Curr Spd: 0.04 m/s

Woodside

Figure 7. Winter (May-Sep) near surface combined frequency of 1-minute mean current speed and direction (towards) measured at the North Rankin location (cyclones removed) (WEL, 2011).

Scarborough

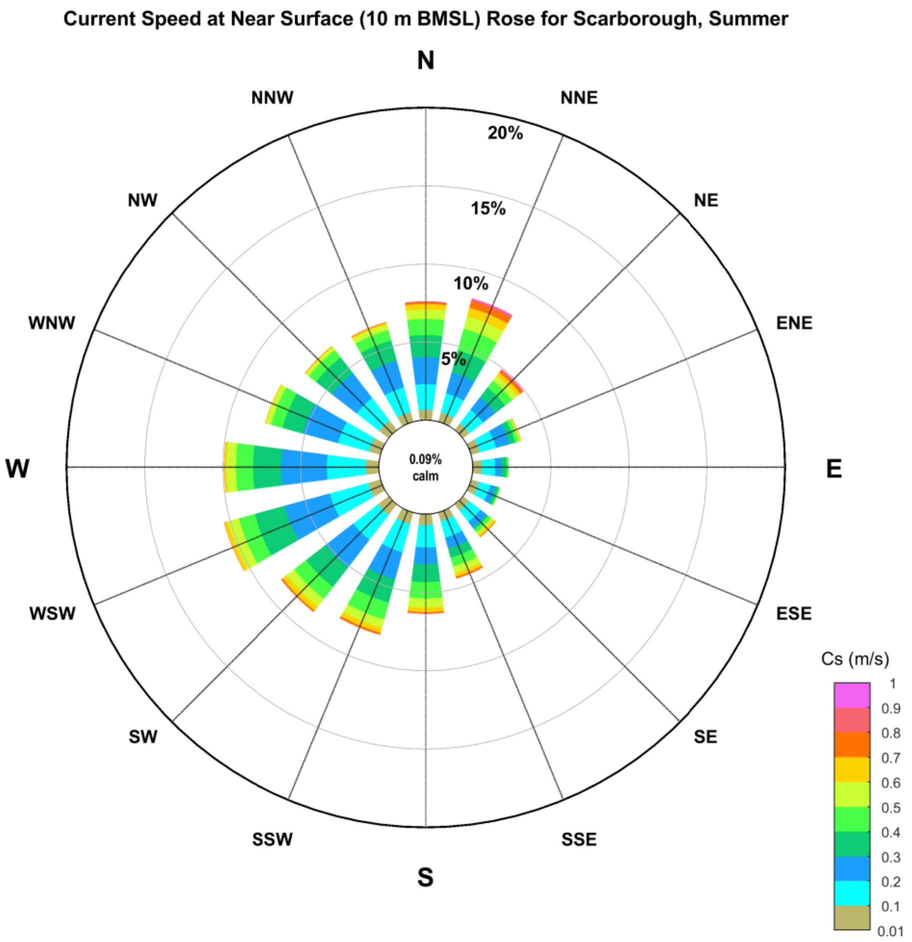


Figure 8. Summer (Nov - April) near surface combined frequency of 1-minute mean current speed and direction (towards) measured at the Scarborough location (cyclones removed) (WEL, 2018).

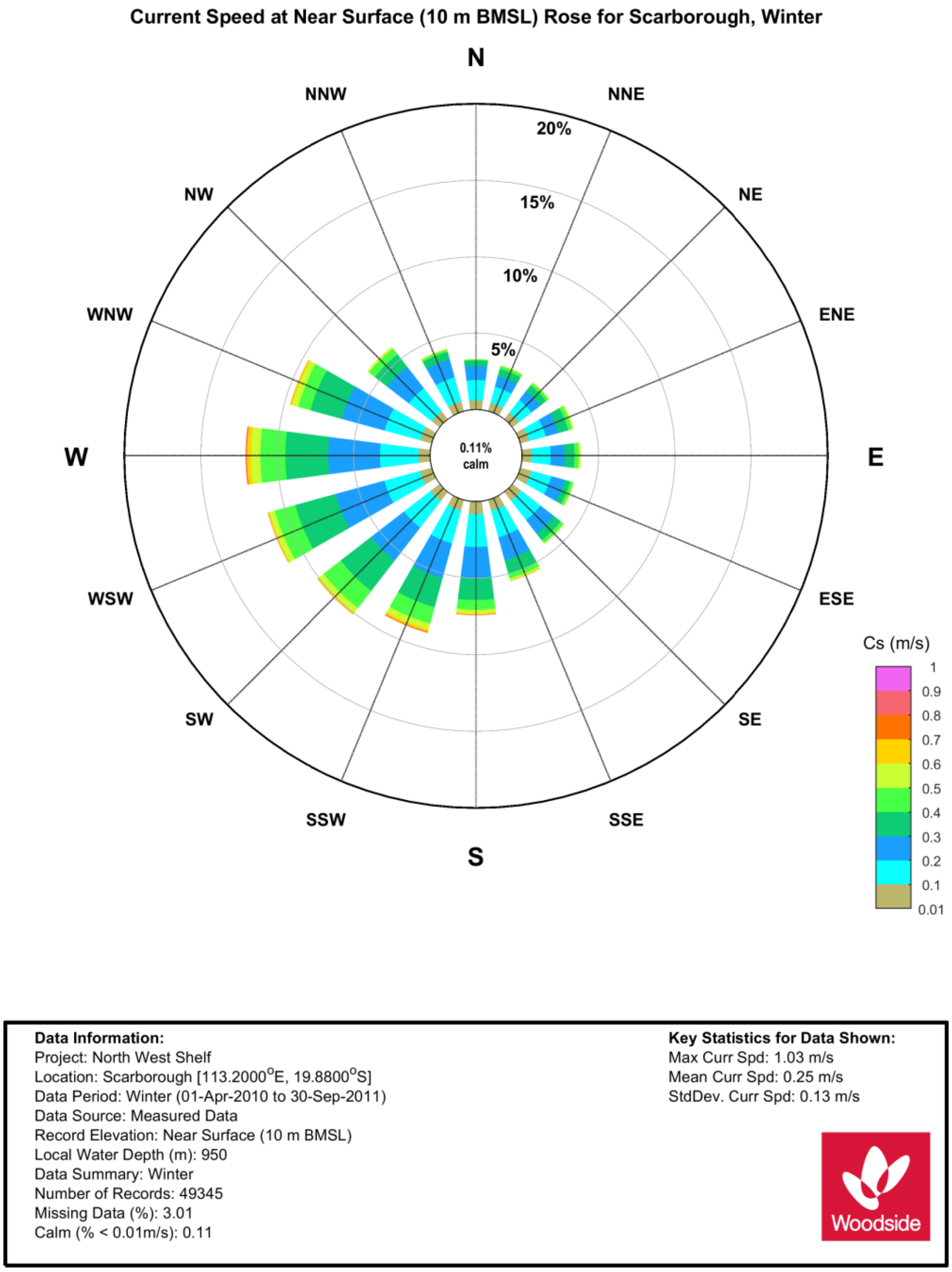


Figure 9. Winter (May-Sep) near surface combined frequency of 1-min mean current speed and direction (towards) measured at the Scarborough location (cyclones removed) (WEL, 2018).

North-west Cape

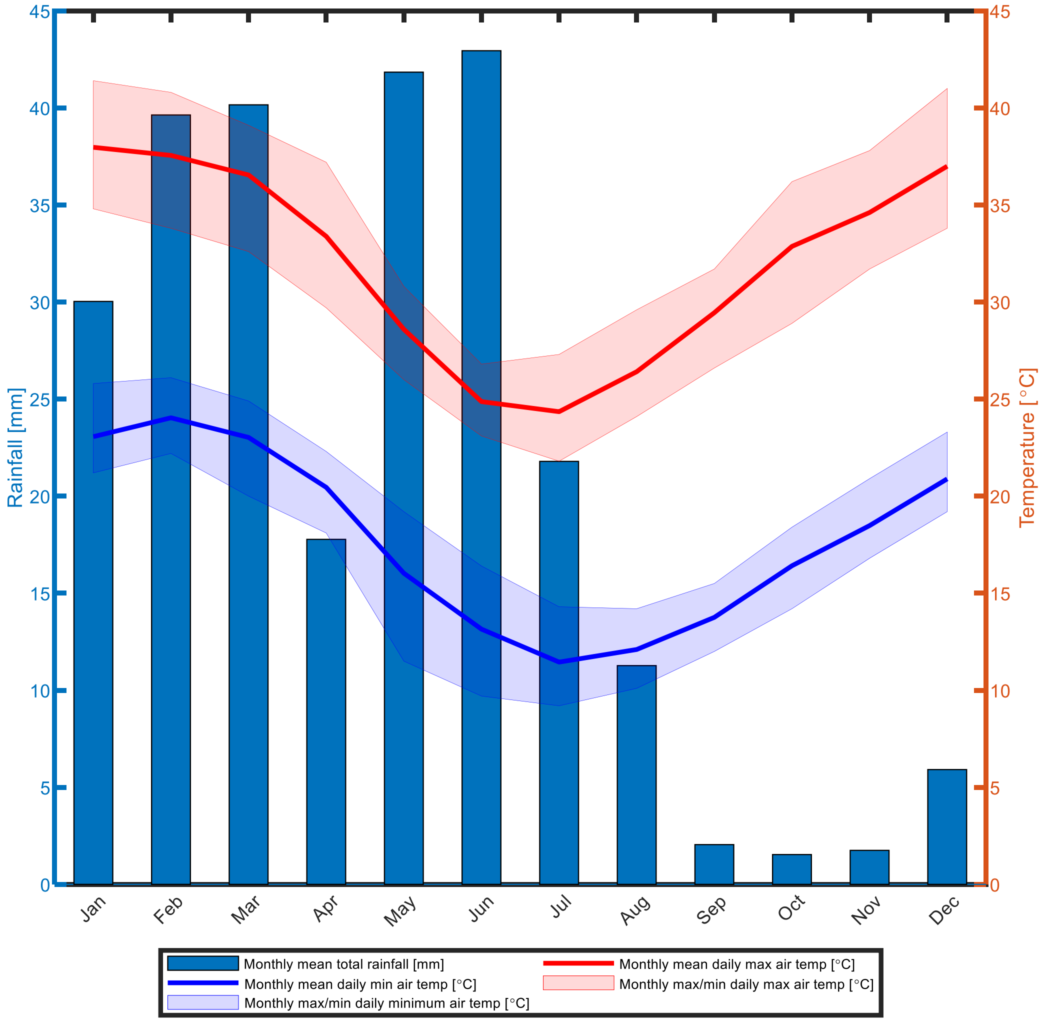
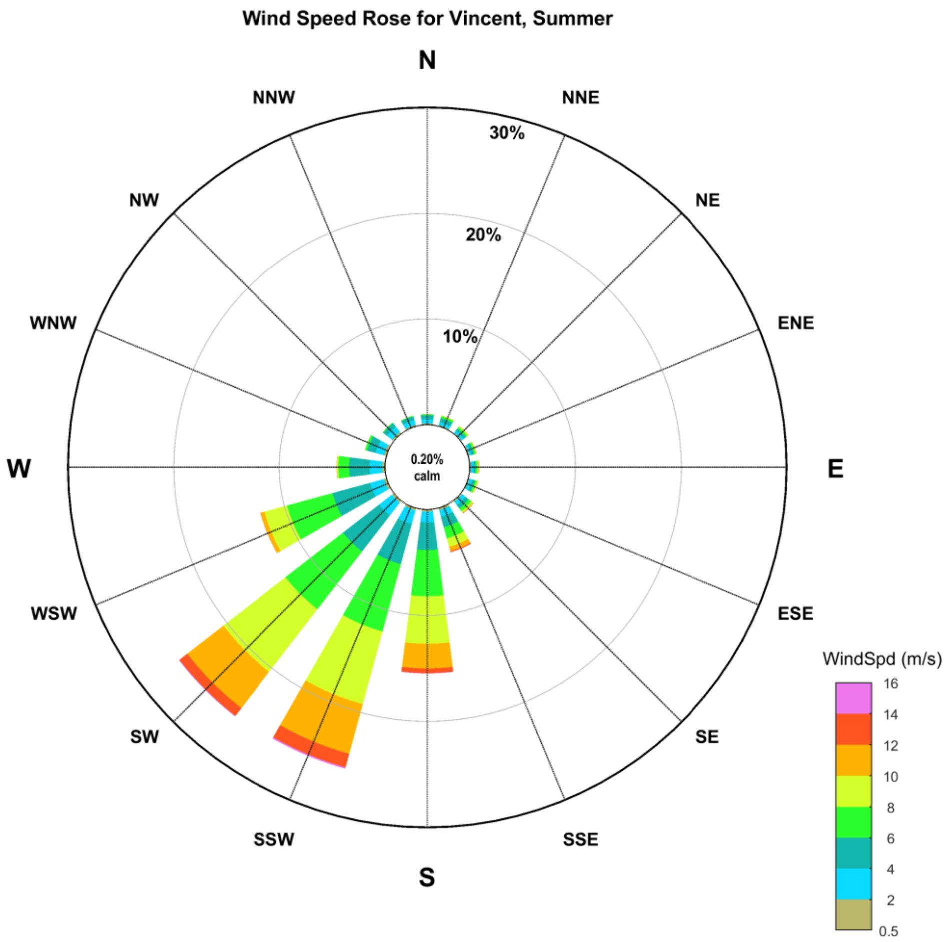


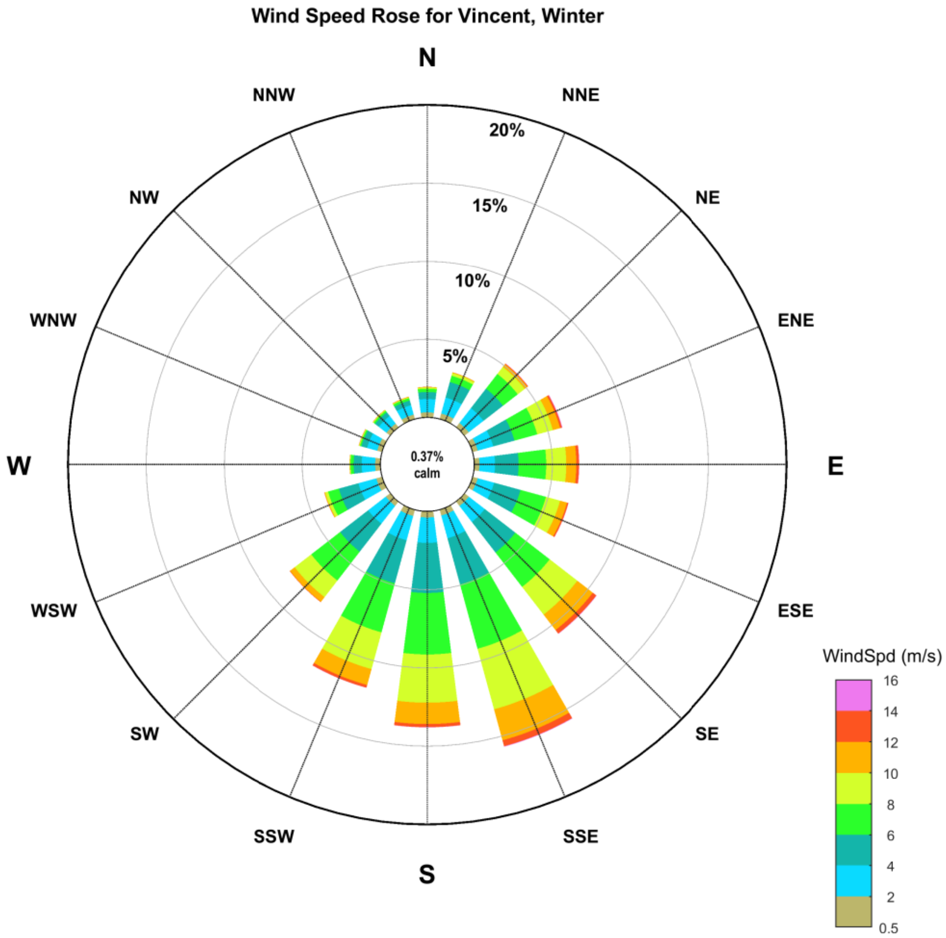
Figure 1. Monthly average total rainfall [mm] and air temperature [°C], calculated based on observations at the Learmonth Airport weather station from 1945-2020 and 1975-2020 respectively (Bureau of Meteorology 2020). Bars show the monthly average total rainfall values, and thick blue and red lines denote monthly average daily minimum and maximum air temperatures, respectively. Shaded blue and red areas denote monthly recorded extremes of daily minimum and maximum air temperature, respectively.



Data Information:
Project: North West Cape
Location: Vincent [114.0600°E, 21.4400°S]
Data Period: Summer (01-Jan-1979 to 01-Jan-2019)
Data Source: Modelled Hindcast
Record Elevation: 10 m AMSL
Local Water Depth (m): 350
Data Summary: Summer
Number of Records: 159379
Missing Data (%): 8.91
Calm (% < 0.50m/s): 0.20
Measurement Format: 10-minute avg.

Key Statistics for Data Shown:
Max Wind Speed: 18.86 m/s
Mean Wind Speed: 7.10 m/s
StdDev. Wind Speed: 2.75 m/s

Figure 2. Summer distributions of wind speeds (10-minute at 10 m ASL) by 22.5° directional sectors at the Vincent site (Vincent Metocean). Note tropical cyclone events were not included in this distribution. Winds at Vincent in summer are predominantly from the SW to SSW in summer due to the presence of the Pilbara Heat Low (MetOcean Engineers, 2005).

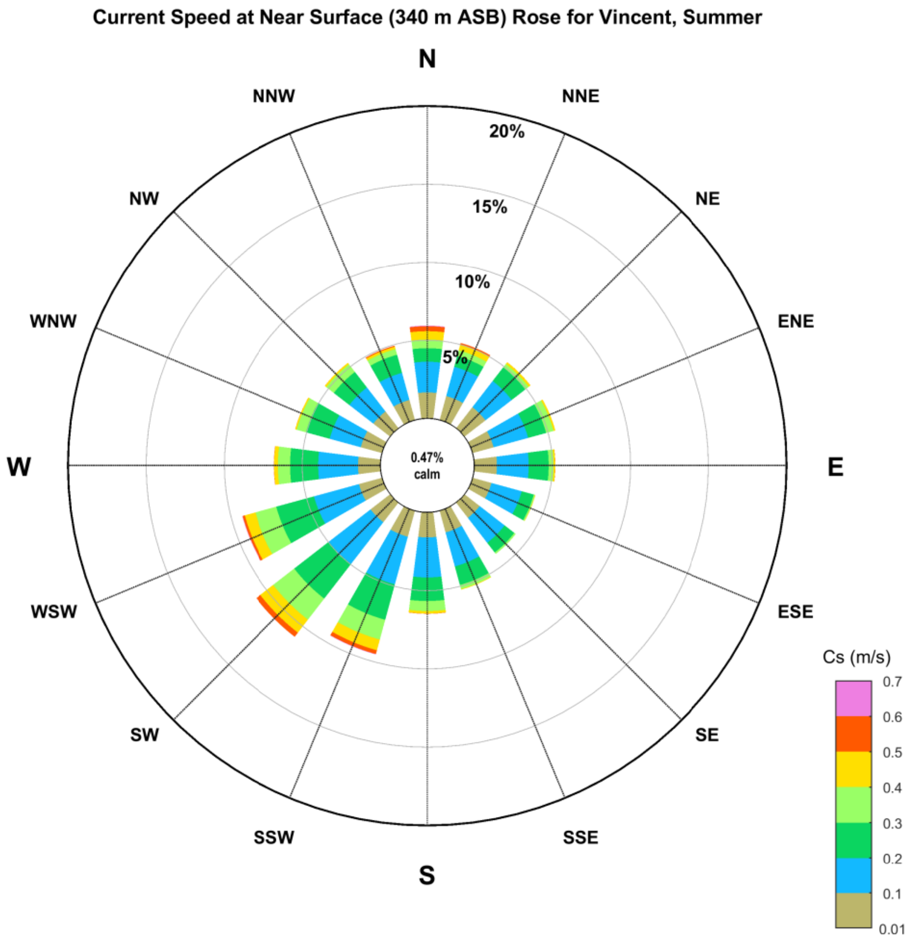


Data Information:
Project: North West Cape
Location: Vincent [114.0600°E, 21.4400°S]
Data Period: Winter (01-Apr-1979 to 30-Sep-2018)
Data Source: Modelled Hindcast
Record Elevation: 10 m AMSL
Local Water Depth (m): 350
Data Summary: Winter
Number of Records: 173626
Missing Data (%): 1.17
Calm (% < 0.50m/s): 0.37
Measurement Format: 10-minute avg.

Key Statistics for Data Shown:
Max Wind Speed: 19.39 m/s
Mean Wind Speed: 6.23 m/s
StdDev. Wind Speed: 2.78 m/s

Woodside

Figure 3. Winter distributions of wind speeds (10-minute at 10 m ASL) 22.5° directional sectors at the Vincent site (Vincent Metocean). Note tropical cyclone events were not included in this distribution. In winter, winds at are predominantly from the S to SE, associated with the South East Trades. Easterly gales are experienced at the Vincent location due to high pressure systems generating from the Great Australian Bight area to the site (MetOcean Engineers, 2005).

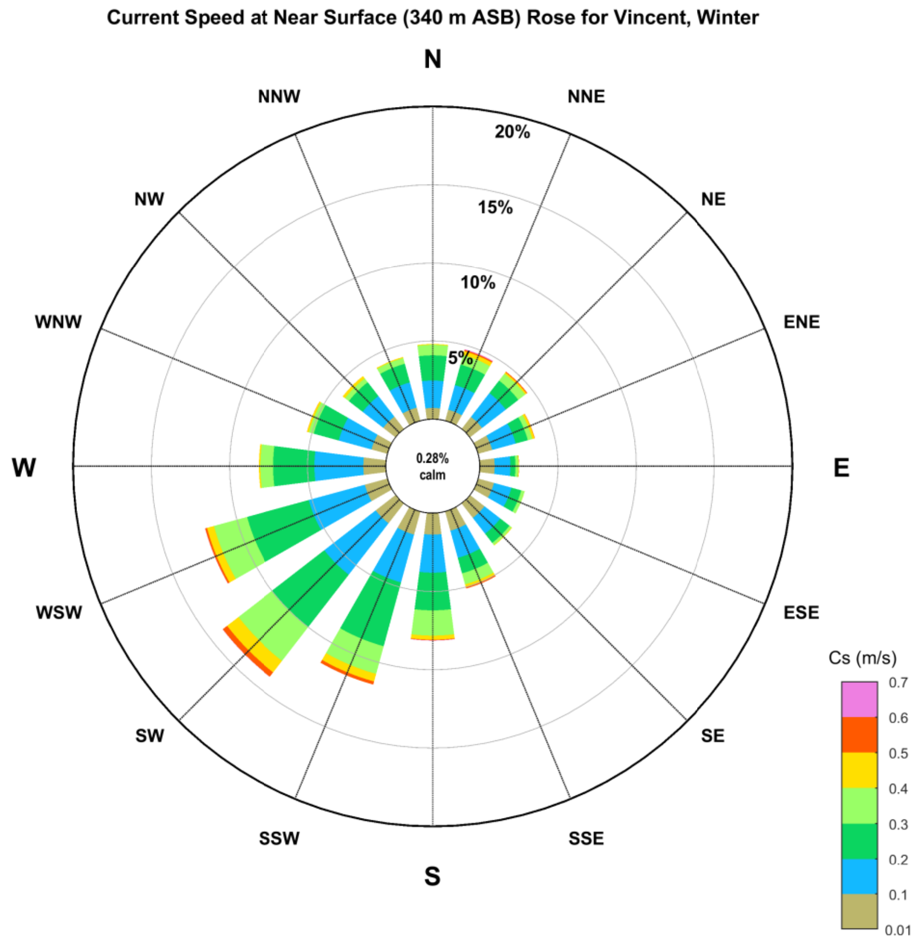


Data Information:
Project: North West Cape
Location: Vincent [114.0600°E, 21.4400°S]
Data Period: Summer (21-Nov-2000 to 13-Dec-2001)
Data Source: Measured Data
Record Elevation: Near Surface (340 m ASB)
Local Water Depth (m): 350
Data Summary: Summer
Number of Records: 144668
Missing Data (%): 1.59
Calm (% < 0.01m/s): 0.47

Key Statistics for Data Shown:
Max Curr Spd: 0.75 m/s
Mean Curr Spd: 0.19 m/s
StdDev. Curr Spd: 0.11 m/s

Woodside

Figure 4. Summer (May – Sep) near surface combined frequency of 1-minute mean current speed and direction (towards) measured at the Vincent location (cyclones removed) (WEL, 2016).



Data Information:
Project: North West Cape
Location: Vincent [114.0600°E, 21.4400°S]
Data Period: Winter (01-Apr-2001 to 30-Sep-2001)
Data Source: Measured Data
Record Elevation: Near Surface (340 m ASB)
Local Water Depth (m): 350
Data Summary: Winter
Number of Records: 126313
Missing Data (%): 4.13
Calm (% < 0.01m/s): 0.28

Key Statistics for Data Shown:
Max Curr Spd: 0.64 m/s
Mean Curr Spd: 0.20 m/s
StdDev. Curr Spd: 0.11 m/s

Woodside

Figure 5. Winter (Nov – Apr) near surface combined frequency of 1-minute mean current speed and direction (towards) measured at the Vincent location (cyclones removed) (WEL, 2016).

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APPENDIX I FIRST STRIKE PLAN

Scarborough 4D Baseline (B1) Marine Seismic Survey (MSS) Oil Pollution First Strike Plan

Security & Emergency Management
Hydrocarbon Spill Preparedness

August 2021
Revision 0

TABLE OF CONTENTS

SCARBOROUGH FOUR-DIMENSIONAL MARINE SEISMIC SURVEY OIL POLLUTION FIRST STRIKE PLAN

SPILL FROM VESSEL

(Note: Shipboard Oil Pollution Emergency Plan should be implemented in conjunction with this document)

LEVEL 1

CONTROL AGENCY:	**Australian Marine Safety Authority**
INCIDENT CONTROLLER:	**VESSEL MASTER (with response assistance from Woodside)**

LEVEL 2 & 3

CONTROL AGENCY:	**Australian Marine Safety Authority (Commonwealth waters)** **Department of Transport (State waters)**
INCIDENT CONTROLLER:	**Australian Marine Safety Authority / Department of Transport (with response assistance from Woodside)**

Guidance to Oil Spill Incident Levels

The most significant characteristic of the below guidance should be considered when determining level or escalation potential.

Characteristic	Level 1 Indicators	Level 2 Indicators	Level 3 Indicators
General Description	Generally able to be resolved within 24-48 hours.	Generally a response is required beyond 48 hours.	Response may extend beyond weeks.
Woodside Emergency Management (EM)/ EM)/Crisis Management Team (CMT) Activation	Onsite Incident Controller (IC) activated. Use of ICC support may be required.	Handover of Control from Onsite IC Corporate Incident Coordination Center (CICC) Duty Manager (DM) in Peth.	Includes Perth based CMT activation.
Number of Agencies	First-response agency and Incident Management Team (IMT).	Multi-agency response.	Agencies from across government and industry.
Environment	Isolated impacts or with natural recovery expected within weeks.	Significant impacts and recovery may take months.	Significant area and recovery may take months. Remediation required.
Economy	Business level disruption (i.e. Woodside).	Business failure or 'Channel' impacts.	Disruption to a sector.
Public Affairs	Local and regional media coverage (WA).	National media coverage.	International media coverage.

For guidance on credible spill scenarios and hydrocarbon characteristics refer to APPENDIX A.

For Spills Entering State Waters

If the spill impacts State waters/shorelines and is a Level 1, AMSA will remain the Control Agency. If the spill is a Level 2/3 then DoT will become the Control Agency for the response in State waters/shorelines only. In the event DoT become the Control Agency they will appoint an Incident Controller and form a separate Incident Management Team to manage the State waters/shorelines response only. The coordination structure for a concurrent hydrocarbon spill in both Commonwealth and State waters/shorelines is shown in APPENDIX E – Coordination Structure for a Concurrent Hydrocarbon Spill in Both Commonwealth And State Waters/Shorelines.

Initially Woodside will be required to make available an appropriate number of suitably qualified persons to work in the DoT IMT (see APPENDIX G). DoT's role as the Controlling Agency for Level 2 and 3 spills in State waters/shorelines does not negate the requirement for Woodside to have appropriate plans and resources in place to adequately respond to a Marine Hydrocarbon Spill incident in State waters/shorelines or to commence the initial response actions to a spill prior to DoT establishing incident control in line with DoT Offshore Petroleum Industry Guidance Note - Marine Oil Pollution: Response and Consultation Arrangements (July 2020):

https://www.transport.wa.gov.au/mediaFiles/marine/MAC_P_Westplan_MOP_OffshorePetroleumIndGuidance.pdf

Woodside's Incident Management Structure for a Hydrocarbon Spill, including Woodside Liaison Officer's command structure within DoT can be seen at APPENDIX F.

Response Process Overview

Use the below to determine which parts of this plan are relevant to the incident.

For guidance on credible scenarios and hydrocarbon characteristics, refer to APPENDIX A.

Vessel Incident

Level 1

Implement Section 1, 2 & 4

Notify the WCC on [redacted]

Make relevant notifications in Table 1-1 of this Oil Pollution First Strike Plan.

Coordinate pre-identified tactics in Table 2-1 of this Oil Pollution First Strike Plan.

If the spill escalates such that the site cannot manage the incident inform the WCC on [redacted] and escalate to a level 2/3 incident.

Handover control to AMSA.

Level 2/3

Implement Section 1

Notify the WCC on [redacted] to stand up the CICC.

CICC DM to coordinate relevant notifications in Table 1-1 of this Oil Pollution First Strike Plan.

If requested by AMSA implement sections 3 & 4 (continue below)

Undertake quick revalidation of the recommended strategies on Table 3-1 taking into consideration seasonal sensitivities and current situational awareness.

Undertake validated strategies.

Create an IAP for all ongoing operational periods

The content of the IAP should reflect the selected response strategies based on current situational awareness.

There are no RPA's and therefore no pre-operational NEBA has been prepared. A simplified NEBA was conducted and can be found in the Scarborough 4D B1 MSS OSPRMA at Appendix A.

1. NOTIFICATIONS (ALL LEVELS)

The Incident Controller or delegate must ensure the below notifications **(Table 1-1)** are completed within the designated timeframes.

For other environmental notifications required refer to the Scarborough 4D B1 MSS Environment Plan.

Table 1-1: Immediate Notifications

Notification timing	Responsibility	Authority /Company	Name	Contact Number	Instruction	Form/ Template	Mark Complete (✓)
Notifications to be made for ALL LEVELS of spill *(For spills from a vessel the following notifications must be undertaken by a WEL representative).*							
Immediately	Vessel master/ Woodside Site Rep (WSR)	Woodside Communication Centre (WCC)	GTO Duty Manager	[redacted] or Sat phone: [redacted]	Verbally notify WCC of event and estimated volume and hydrocarbon type.	Verbal	
Within 2 hours	GTO Duty Manager	National Offshore Petroleum Safety Environmental Management Authority (NOPSEMA[1])	Incident notification office	[redacted]	Verbally notify NOPSEMA for spills >80L. Record notification using Initial Verbal Notification Form or equivalent and send to NOPSEMA as soon as practicable (cc to NOPTA and DMIRS).	App B Form 1	
Within 3 days	WSR, CICC DM or Delegate				Provide a written NOPSEMA Incident Report Form as soon as practicable (no later than 3 days after notification) (cc to NOPTA and DMIRS) NOPSEMA: [redacted] NOPTA: [redacted]	App B Form 2	

[1] Notification to NOPSEMA must be from a Woodside Representative.

Notification timing	Responsibility	Authority /Company	Name	Contact Number	Instruction	Form/ Template	Mark Complete (✓)
					DMIRS: [redacted]		
As soon as practicable	CICC DM or Delegate	Woodside	Environment Duty Manager	As per roster	Verbally notify Duty Environment of event and seek advice on relevant performance standards from EP	Verbal	
As soon as practicable	CICC DM or Delegate	Department of Agriculture, Water and the Environment (Director of National Parks)	Marine Park Compliance Duty Officer	[redacted]	The Marine Park Compliance Duty Officer is notified in the event of oil pollution within a marine park, or where an oil spill response action must be taken within a marine park, so far as reasonably practicable, prior to response action being taken. This notification should include: • titleholder details • time and location of the incident • proposed response arrangements and locations as per the OPEP • contact details for the response coordinator.	Verbal	
Without delay as per protection of the Sea Act, part II, section 11(1)	Vessel Master	Australian Maritime Safety Authority (AMSA)	Response Coordination Centre (RCC)	[redacted]	Verbally notify AMSA RCC of the hydrocarbon spill. Follow up with a written Marine Pollution Report (POLREP) as soon as practicable following verbal notification.	App B Form 3	
ADDITIONAL LEVEL 2/3 NOTIFICATIONS							
As soon as practicable	CICC DM or Delegate	AMOSC	AMOSC Duty Manager	[redacted]	Notify AMOSC that a spill has occurred and follow-up with an email from the **IC/CICC DM, CMT Leader or Oil Spill Preparedness**	App B Form 4	

Notification timing	Responsibility	Authority /Company	Name	Contact Number	Instruction	Form/ Template	Mark Complete (✓)
					Manager to formally activate AMOSC. Determine what resources are required consistent with the AMOSPlan and detail in a Service Contract that will be sent to Woodside from AMOSC upon activation.		
As soon as practicable	CICC DM or Delegate	Oil Spill Response Limited (OSRL)	OSRL Duty Manager	[redacted]	Contact OSRL duty manager and request assistance from technical advisor in Perth. Send the notification form to OSRL as soon as practicable. For mobilisation of resources, send the Mobilisation Form to OSRL as soon as practicable.	Notification: App B Form 6a Mobilisation: App B Form 6b	
As soon as practicable or if spill is likely to extend into WA State waters.	CICC DM or Delegate	WA Department of Transport	DoT Duty Manager	[redacted]	Marine Duty Manager to verbally notify DoT that a spill has occurred and request use of equipment stored in the Karratha supply shed. Follow up with a written POLREP as soon as practicable following verbal notification. Additionally DoT to be notified if spill is likely to extend into WA State waters. Request DoT to provide Liaison to WEL IMT.	App B Form 5	
As soon as practicable if there is potential for oiled wildlife or the spill is expected to contact land or waters managed by WA Department of	CICC DM or Delegate	WA Department of Biodiversity, Conservation and Attractions (DBCA)	Duty Officer	[redacted]	Phone call notification	Verbal	

Notification timing	Responsibility	Authority /Company	Name	Contact Number	Instruction	Form/ Template	Mark Complete (✓)
Biodiversity, Conservation and Attractions							
As soon as practicable	CICC DM or Delegate	Marine Spill Response Corporation (MSRC)	MSRC Response Manager	[redacted]	Activate the contract with MSRC (in full) for the provision of up to 30 personnel depending on what skills are required. Please note that provision of these personnel from MSRC are on a best endeavours basis and are not guaranteed.	Verbal	

2. LEVEL 1 RESPONSE

2.1 Mobilisation of Response Techniques

For the relevant hydrocarbon type, undertake quick revalidation of the recommended techniques and pre-identified tactics indicated with a ‘Yes’ in **Table 2-1.** Undertake all validated pre-identified tactics immediately. These tactics should be carried out using the associated plan identified under **Table 2-1** Operational Plan column.

All response techniques and pre-identified tactics have been identified from the pre-operational Net Environmental Benefits Analysis (NEBA) presented in the Scarborough 4D B1 MSS Environment Plan Appendix D (Woodside’s Oil Spill Preparedness and Response Mitigation Assessment).

Table 2-1: Level 1 Response Summary

Response Techniques	Hydrocarbon Type Marine Diesel Oil	Pre- Identified Tactics	Responsible	ALARP Commitment Summary	Complete ✓	Link to Operational Plans for notification numbers and actions
Monitor and evaluate – tracking buoy (OM02)	Yes	Tracking buoy to be deployed from onsite vessel.	Chief Officer/ Marine Crew	**DAY 1:** Tracking buoy deployed within two hours.		Surveillance and Reconnaissance to Detect Hydrocarbons and Resources at Risk (OM02 of The Operational Monitoring Operational Plan.
Please consider instructing the CICC DM to activate or implement any of the following Pre-Identified tactics. The following tactics will assist in answering the '7 Questions of Spill Assessment' identified in Appendix C to increase situational awareness.						
Monitor and evaluate – predictive modelling (OM01)	Yes	Undertake initial modelling using the Rapid assessment oil spill tool and weathering fate analysis using ADIOS (or refer to the hydrocarbon information in Appendix A).	Intelligence or Environment	**DAY 1:** Initial modelling within six hours using the Rapid Assessment Tool.		Predictive Modelling of Hydrocarbons to Assess Resources at Risk (OM01 of The Operational Monitoring Operational Plan. *Planning to download immediately and follow steps*
	Yes	Send Oil Spill Trajectory Modelling (OSTM) form (Appendix B Form 7) to RPS APASA response team (email [redacted]) and call RPS Response Duty Officer Phone [redacted]	Intelligence	**DAY 1:** Detailed modelling within four hours of APASA receiving information from Woodside.		
Monitor and evaluate – aerial surveillance (OM02)	Yes	Instruct Aviation Duty Manager to commence aerial observations in daylight hours. Aerial surveillance observer to complete log in Appendix B Form 8.	Logistics - Aviation	**DAY 1:** Two trained aerial observers. One aircraft available.		Surveillance and Reconnaissance to Detect Hydrocarbons and Resources at Risk (OM02 of The Operational Monitoring Operational Plan). *Planning to download immediately and follow steps*
Monitor and evaluate – satellite	Yes	The Intelligence duty manager should be instructed to stand up KSAT to provide	Intelligence	**DAY 1:** Service provider will		

Response Techniques	Hydrocarbon Type Marine Diesel Oil	Pre- Identified Tactics	Responsible	ALARP Commitment Summary	Complete ✓	Link to Operational Plans for notification numbers and actions
tracking (OM02)		satellite imagery of the spill. [redacted]		confirm availability of an initial acquisition within two hours. Data received to be uploaded into Woodside Common Operating Picture.		
Monitor and evaluate – monitoring hydrocarbons in water (OM03)	Yes	Consider the need to mobilise resources to undertake water quality monitoring (OM03).	Planning or Environment	**DAY 3:** Water quality assessments access and capability.		Detecting and Monitoring for the Presence and Properties of Hydrocarbons in the Marine Environment (OM03 of The Operational Monitoring Operational Plan).
Monitor and evaluate – pre-emptive assessment of receptors at risk (OM04)	Yes	Consider the need to mobilise resources to undertake pre-emptive assessment of sensitive receptors at risk (OM04).	Planning or Environment	**DAY 2:** In agreement with WA DoT, deployment of two specialist fo reach of the Response Protection Areas (RPA) with predicted impacts.		Pre-emptive Assessment of Sensitive Receptors (OM04 of The Operational Monitoring Operational Plan).
Monitor and evaluate – shoreline assessment (OM05)	Yes	Consider the need to mobilise resources to undertake shoreline assessment surveys (OM05).	Planning or Environment	**DAY 2:** In agreement with WA DoT, deployment of two specialists		Shoreline Assessment (OM05 of The Operational Monitoring Operational Plan).

Response Techniques	Hydrocarbon Type Marine Diesel Oil	Pre- Identified Tactics	Responsible	ALARP Commitment Summary	Complete ✓	Link to Operational Plans for notification numbers and actions
				in SCAT for each of the RPAs with predicted impacts.		

3. LEVEL 2/3 RESPONSE

3.1 Mobilisation of Response Techniques

For the relevant hydrocarbon type, undertake quick revalidation of the recommended techniques and pre-identified tactics indicated with a 'Yes' in **Table 3-1.** Undertake all validated pre-identified tactics immediately. These tactics should be carried out using the associated plan identified under **Table 3-1** Operational Plan column.

All response techniques and pre-identified tactics have been identified from the pre-operational Net Environmental Benefits Analysis (NEBA) presented in the Scarborough 4D B1 MSS Environment Plan Appendix D (Woodside's Oil Spill Preparedness and Response Mitigation Assessment).

Table 3-1: Level 2/3 Response Summary

Response Techniques	Hydrocarbon Type Marine Diesel Oil	Pre- Identified Tactics	Responsible	ALARP Commitment Summary	Complete ✓	Link to Operational Plans for notification numbers and actions
Monitor and evaluate – tracking buoy (OM02)	Yes	If a vessel is on location, consider the need to deploy the oil spill tracking buoy. If no vessel is on location, consider the need to mobilise oil spill tracking buoys from the King Bay Supply Base (KBSB) Stockpile. If a surface sheen is visible from the facility, deploy the satellite tracking buoy within two hours.	Chief Officer/ Marine Crew	**DAY 1:** Tracking buoy deployed within two hours.		Surveillance and Reconnaissance to Detect Hydrocarbons and Resources at Risk (OM02) of The Operational Monitoring Operational Plan. Deploy tracking buoy in accordance with **Error! Reference source not found.**.
Monitor and evaluate – predictive modelling (OM01)	Yes	Undertake initial modelling using the Rapid assessment oil spill tool and weathering fate analysis using ADIOS (or refer to the hydrocarbon information in Appendix A).	Intelligence or Environment	**DAY 1:** Initial modelling within six hours using the Rapid Assessment Tool. Detailed modelling within four hours of APASA receiving information from Woodside.		Predictive Modelling of Hydrocarbons to Assess Resources at Risk (OM01 of The Operational Monitoring Operational Plan).
	Yes	Send Oil Spill Trajectory Modelling (OSTM) form (Appendix B Form 7) to RPS APASA ([redacted]).	Intelligence	**DAY 1:** Detailed modelling within 4 hours of APASA receiving information from Woodside.		
Monitor and evaluate – aerial surveillance (OM02)	Yes	Instruct Aviation Duty Manager to commence aerial observations in daylight hours. Aerial surveillance observer to complete log in Appendix B Form 8.	Logistics - Aviation	**DAY 1:** Two trained aerial observers. One aircraft available.		Surveillance and Reconnaissance to Detect Hydrocarbons and Resources at Risk (OM02 of The Operational Monitoring Operational Plan). *Planning to download immediately and follow steps*
Monitor and evaluate – satellite tracking (OM02)	Yes	The Intelligence duty manager should be instructed to stand up Kongsberg Satellite Services (KSAT) to provide satellite imagery of the spill. [redacted]	Intelligence	**DAY 1:** Service provider will confirm availability of an initial acquisition within two hours. Data received to be uploaded into Woodside Common Operating Picture.		

Response Techniques	Hydrocarbon Type Marine Diesel Oil	Pre- Identified Tactics	Responsible	ALARP Commitment Summary	Complete ✓	Link to Operational Plans for notification numbers and actions
Monitor and evaluate – monitoring hydrocarbons in water (OM03)	Yes	Consider the need to mobilise resources to undertake water quality monitoring (OM03).	Planning or Environment	**DAY 3:** Water quality assessment access and capability Daily fluorometry reports will be provided to IMT.		Detecting and Monitoring for the Presence and Properties of Hydrocarbons in the Marine Environment (OM03 of The Operational Monitoring Operational Plan).
Monitor and evaluate – pre-emptive assessment of receptors at risk (OM04)	Yes	Consider the need to mobilise resources to undertake pre-emptive assessment of sensitive receptors at risk (OM04).	Planning or Environment	**DAY 2:** In agreement with WA DoT, deployment of two specialists for each of the Response Protection Areas (RPA) with predicted impacts.		Pre-emptive Assessment of Sensitive Receptors (OM04 of The Operational Monitoring Operational Plan).
Monitor and evaluate – shoreline assessment (OM05)	Yes	Consider the need to mobilise resources to undertake shoreline assessment surveys (OM05).	Planning or Environment	**DAY 2:** In agreement with WA DoT, deployment of two specialists in SCAT for each of the RPAs with predicted impacts.		Shoreline Assessment (OM05 of The Operational Monitoring Operational Plan).
Surface Dispersant	No	This response strategy is not recommended.				
Mechanical Dispersion	No	This response strategy is not recommended.				
Containment and Recovery	No	This response strategy is not recommended.				
In-situ Burning	No	This response strategy is not recommended.				
Shoreline Protection and Deflection	No	This response strategy is not recommended.				

Response Techniques	Hydrocarbon Type Marine Diesel Oil	Pre- Identified Tactics	Responsible	ALARP Commitment Summary	Complete ✓	Link to Operational Plans for notification numbers and actions
Shoreline Clean Up	No	This response strategy is not recommended.				
Oiled Wildlife Response	Yes	If oiled wildlife is a potential impact, request AMOSC to mobilise containerised oiled wildlife first strike kits and relevant personnel. Refer to relevant Tactical Response Plan for potential wildlife at risk. Mobilise AMOSC Oiled Wildlife Containers. Consider whether additional equipment is required from local suppliers.	Logistics and Planning	**DAY 5:** Contracted capability to treat up to an additional 250 individual fauna within a five-day period. Facilities for oiled wildlife rehabilitation are operational 24/7		Oiled Wildlife Response Operational Plan
Scientific Monitoring (Type II)	Yes	Notify Woodside science team of spill event.	Environment			Oil Spill Scientific Monitoring Programme – Operational Plan Link

4. PRIORITY RECEPTORS

Based on hydrocarbon spill risk modelling results the sensitive receptors outlined in **Table 4-2** are identified as priority protection areas, as they have the potential to be contacted by hydrocarbon at or above impact threshold levels within 48 hours of a spill. Please note that impact thresholds (10 g/m^2 surface hydrocarbon concentration, 100 g/m^2 shoreline accumulation, and 100 ppb entrained hydrocarbon concentration) are used to determine the Zone of Consequence (ZoC) identified in the Environment Plan and are lower than response thresholds (**Table 4-1**).

Table 4-1 Response Thresholds

Surface Hydrocarbon (g/m^2)	Description
>10	Predicted minimum threshold for commencing operational monitroing
50	Predicted minimum floating oil threshold for containment and recovery and surface dispersant application [2]
100	Predicted optimum floating oil threshold for containment and recovery and surface dispersant application
100	Predicted minimum shoreline accumulation threshold for shoreline assessment operations
250	Predicted minimum threshold for commencing shoreline clean-up operations

Table 4-2 Receptors for Priority Protection with Potential Impact within 48 Hours (Credible Scenario-01)

Receptor	Distance and Direction from Operational Area (km)	Minimum time to shoreline contact (above 100g/m^2) in days	Maximum shoreline accumulation (above 100g/m^2) in m^3	Tactical Response Plans (also available within the Data Directory DRIMS#9542566)
Open Ocean – Commonwealth Waters	Overlaps	N/A	N/A	N/A

Hydrocarbon spill modelling results indicate the sensitive receptors listed below have the potential to be contacted by hydrocarbons beyond 48 hours of a spill:

- Open Commonwealth waters
- Gascoyne AMP (surface hydrocarbon concentrations ≥10 g/m^2 and entrained hydrocarbon concentrations ≥100 ppb)
- Carnarvon Canyon AMP (entrained hydrocarbon concentrations ≥100 ppb)
- Abrolhos AMP (entrained hydrocarbon concentrations ≥100 ppb)

Tactical Response Plans are prepared by Woodside for shoreline locations and can be accessed via the Oil Spill Portal - Tactical Response Plans[3]. These contain the details of potential forward operating bases and staging areas that may be used in the event that an offshore oiled wildlife response is required, or if operational monitoring indicates that additional response techniques are required. Tactical Response Plans are not available for offshore locations.

[2] At 50g/m^2 containment and recovery and surface dispserant application operations are not expected to be particularly effective. This threshold represents a conservative approach to planning response capability and displaying the spread of surface oil.

[3] The Tactical Response Plans for the RPA's idenitifed contain the details of potential forward operating bases and staging areas. Incident Command Centre: For Level 1 incidents the in-field team and asset operator will lead the response on-scene. For level 2/3 Incident the Incident command centre will be located in Perth at Woodside's Building. The Woodside CICC is fully equipped with communications equipment and technology to ensure the coordination of response activities for the overall response.

Oil Spill Trajectory Modelling specific to the spill event will be required to determine the regional sensitive receptors to be contacted beyond 48 hours of a spill.

Figure 4-1 illustrates the location of regional sensitive receptors in relation to the Scarborough 4D B1 MSS operational area and identifies priority protection areas.

Consideration should be given to other stakeholders (including mariners) in the vicinity of the spill location. There are no oil and gas facilities located within 50 km of the Operational Area.

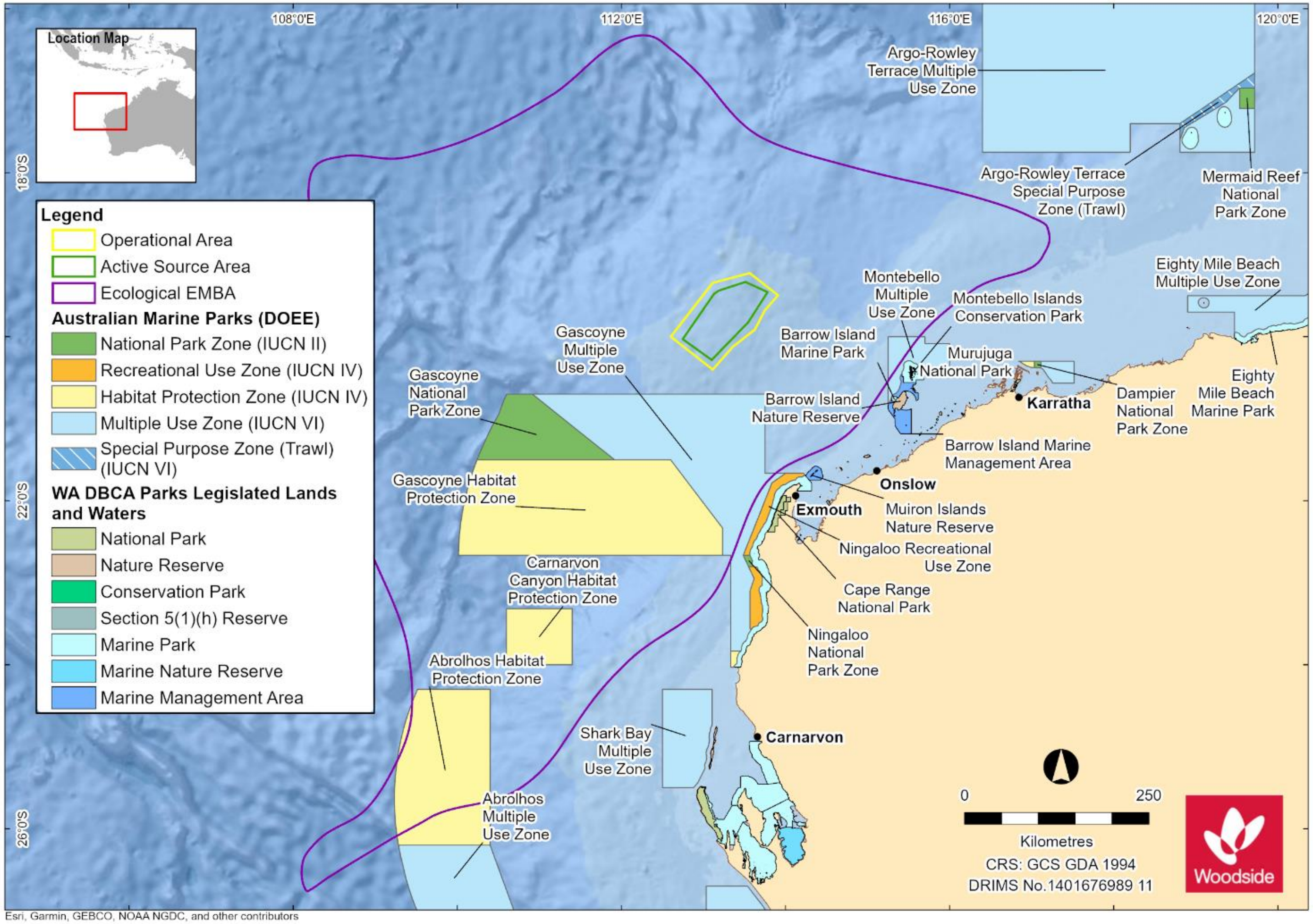


Figure 4-1 Regional Sensitive Receptors – Scarborough 4D B1 MSS

5. DISPERSANT APPLICATION

Dispersant is not considered an appropriate response strategy for this activity as described in the Scarborough 4D B1 MSS Environment Plan Appendix D (Woodside's Oil Spill Preparedness and Response Mitigation Assessment).

APPENDIX A – CREDIBLE SPILL SCENARIOS AND HYDROCARBON INFORMATION

For more detailed hydrocarbon information see the
Hydrocarbon Data Directory (DRIMS#9542566)

Credible Spill Scenarios

Scenario	Product	Maximum Volumes	Suggested ADIOS2 Analogue*
CS-01 Unplanned hydrocarbon release caused by marine vessel collision (survey vessel)	Marine diesel (API 37.2°)	1062 m^3	Diesel Fuel Oil (API 37.2°)
CS-02 Unplanned hydrocarbon release caused by marine vessel collision (Project support vessel)	Marine diesel (API 37.2°)	250 m^3	Diesel Fuel Oil (API 37.2°)
CS-03 Loss of containment caused by refuelling hose failure, coupling failure or operator error.	Marine diesel (API 37.2°)	8 m^3	Diesel Fuel Oil (API 37.2°)

*Initial screening of possible ADIOS2 analogues was done by considering hydrocarbons with similar APIs. Suggested selection was based on the closest distillation cut to WEL hydrocarbon. Only hydrocarbons with distillation cuts that showed results for > 380°C were included in selection process.

Marine Diesel (Group 2 Oil)

Marine diesel is a mixture of volatile and persistent hydrocarbons, with approximately 45% by mass predicted to evaporate over the first 24h under low wind speeds (5 kn), with further evaporation slowing over time. Under variable windspeeds, where the winds are of greater strength, the proportion of evaporation would be lower. The heavier components of diesel have a strong tendency to entrain into the upper water column due to wind waves, but can refloat to the surface if wind waves abate.

A series of model weather tests were conducted to illustrate the potential behaviour of marine diesel when exposed to idealised and representative environmental conditions:

- Instantaneous release (1-hour discharge) onto the water surface at a discharge rate of 50 m^3/hr under calm wind conditions (constant 5 knots), assuming low seasonal water temperature (27 °C) and average air temperature (25 °C). Slick also subject to ambient tidal and drift currents (Figure A-1).
- Instantaneous release (1-hour discharge) onto the water surface at a discharge rate of 50 m^3/hr under variable wind conditions (4-19 knots, drawn from representative data files), assuming low seasonal water temperature (27 °C) and average air temperature (25 °C). Slick also subject to ambient tidal and drift currents (Figure A-2).

The first case is indicative of cumulative weathering rates under calm conditions that would not generate entrainment, while the second case may represent conditions that could cause a minor degree of entrainment. Both scenarios provide examples of potential behaviour during periods of a spill event.

The mass balance forecast for the 5 kn constant-wind case (Figure A-1) for marine diesel shows that approximately 45% of the oil is predicted to evaporate within 24 hours. Under these calm conditions the majority of the remaining oil on the water surface will weather at a slower rate due to being comprised of the longer-chain compounds with higher boiling points. Evaporation of the residual compounds will slow significantly, and they will then be subject to more gradual decay through biological and photochemical processes.

Under the variable-wind case (Figure A-2), where the winds are of greater strength, entrainment of marine diesel into the water column is indicated to be significant. Approximately 24 hours after the spill, around 45% of the oil mass is forecast to have entrained and a further 35% is forecast to have evaporated, leaving only a small proportion of the oil floating on the water surface (<1%). The residual compounds will tend to remain entrained beneath the surface under conditions that generate wind waves (approximately >6m/s).

The increased level of entrainment in the variable-wind case will result in a higher percentage of biological and photochemical degradation, where the decay of the floating slicks and oil droplets in the water column occurs at an approximate rate of 1.8% per day with an accumulated total of ~13% after 7 days, in comparison to a rate of ~0.2% per day and an accumulated total of 1.5% after 7 days in the constant-wind case. Given the large proportion of entrained oil and the tendency for it to remain mixed in the water column, the remaining hydrocarbons will decay and/or evaporate over time scales of several weeks to a few months. This long weathering duration will extend the area of potential effect, requiring the break-up and dispersion of the slicks and droplets to reduce concentrations below the thresholds.

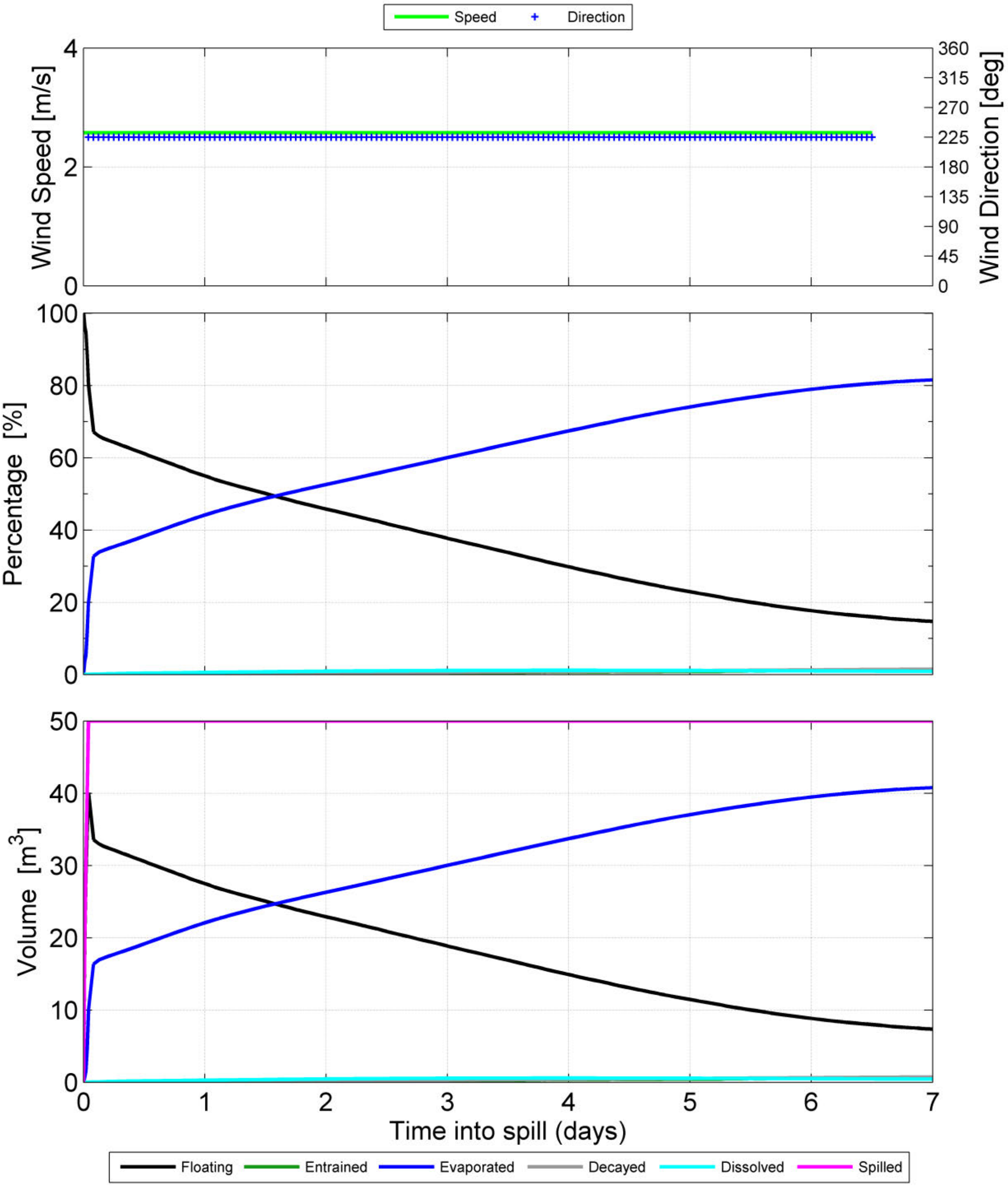


Figure A-1: Mass balance plot representing, as proportion (middle panel) and volume (bottom panel), the weathering of marine diesel spilled onto the water surface as a one-off release (50 m^3 over 1-hour) and subject to a constant 5kn (2.6 /s) wind at 27°C water temperature and 25°C air temperature.

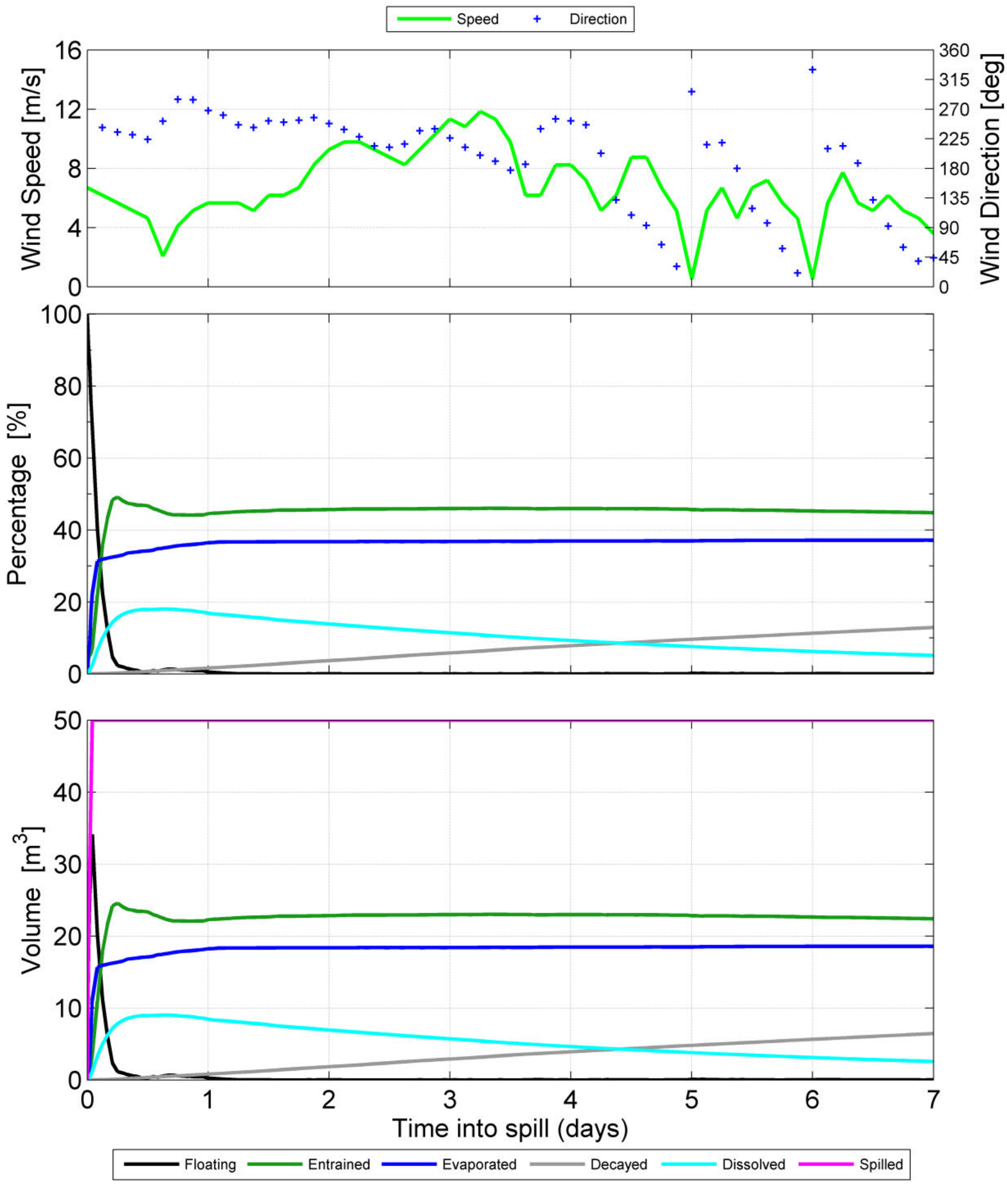


Figure A-2 Mass balance plot representing, as proportion (middle panel) and volume (bottom panel), the weathering of marine diesel spilled onto the water surface as a one-off release (50 m^3 over 1 hour) and subject to variable wind at 27°C water temperature and 25°C air temperature.

APPENDIX B – FORMS

Form No.	Form Name	Link
1	Record of Verbal Notification to Regulator Template	Link
2	NOPSEMA Notification Template	Link
3	Marine Pollution Report (POLREP – AMSA)	Link
4	AMOSC Service Contract Note	Link
5	Marine Pollution Report (POLREP – DoT)	Link
6a	OSRL Initial Notification Form	Link
6b	OSRL Mobilisation Activation Form	Link
7	RPS Response Oil Spill Trajectory Modelling Request	Link
8	Aerial Surveillance Observer Log	Link

FORM 1

Record of initial verbal notification to NOPSEMA

(NOPSEMA ph: [redacted])

Date of call	
Time of call	
Call made by	
Call made to	

Information to be provided to NOPSEMA:

Date and Time of incident/time caller became aware of incident	
Details of incident	1. **Location** ________ 2. **Title**________ 3. **Hydrocarbon source** □ **Platform**________ □ **Pipeline**________ □ **FPSO**________ □ **Exploration drilling**________ □ **Well**________ □ **Other (please specify)** ________ 4. **Hydrocarbon type**________ 5. **Estimated volume of hydrocarbon** ________ 6. **Has the discharge ceased?**________ 7. **Fire, explosion or collision?** ________ 8. **Environment Plan(s)** ________ 9. **Other Details**________
Actions taken to avoid or	

mitigate environmental impacts	
Corrective actions taken or proposed to stop, control or remedy the incident	

After the initial call is made to NOPSEMA, please send this record as soon as practicable to:

1. **NOPSEMA** [redacted]
2. **NOPTA** [redacted]
3. **DMIRS** [redacted]

FORM 2

[insert NOPSEMA Notification Template when printing]

Link

FORM 3

[insert Marine Pollution Report (POLREP – AMSA) when printing]

Link

FORM 4

[insert AMOSC Service Contract note when printing]
Link

FORM 5

[insert Marine Pollution Report (POLREP – DoT) when printing]

Link

FORM 6a

[insert OSRL Initial Notification Form when printing]
Link

FORM 6b

[insert OSRL Mobilisation Activation Form when printing]
Link

FORM 7

[insert RPS Response Oil Spill Trajectory Modelling Request form when printing]
Link

FORM 8

[insert Aerial Surveillance Observer Log when printing]
Link

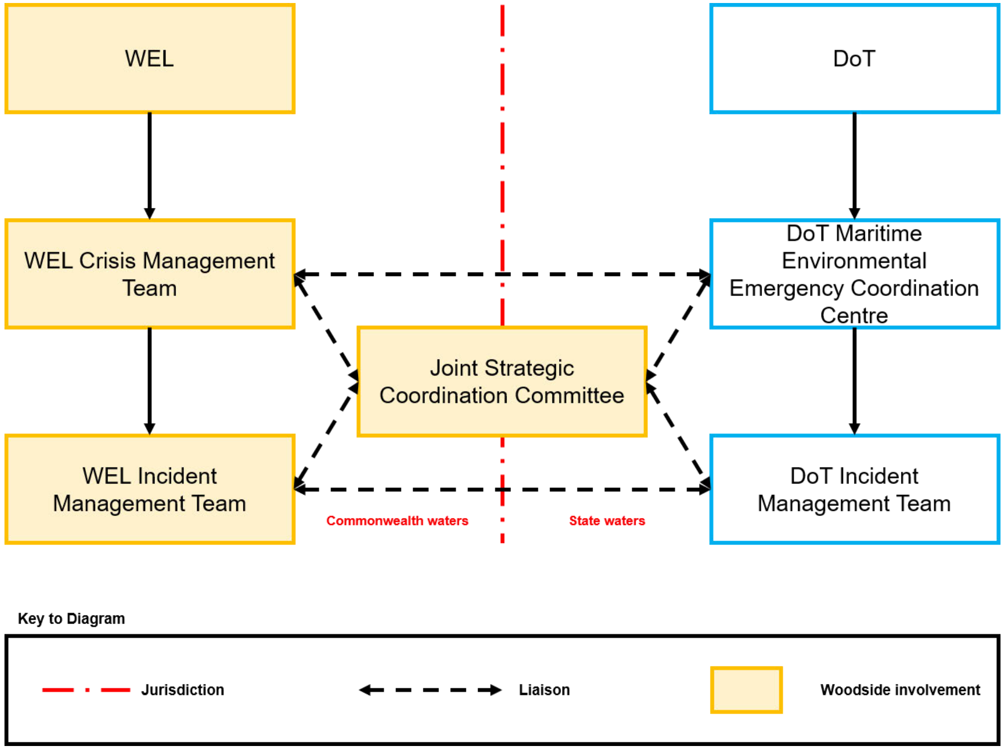
APPENDIX C – 7 QUESTIONS OF SPILL ASSESSMENT

WHAT IS IT? **Oil Type/name** **Oil properties** **Specific gravity / viscosity / pour point / asphphaltines / wax content / boiling point**	
WHERE IS IT? Lat/Long Distance and bearing	
HOW BIG IS IT? Area Volume	
WHERE IT IS GOING? Weather conditions Currents and tides	
WHAT IS IN THE WAY? Resources at risk	
WHEN WILL IT GET THERE? Weather conditions Currents and tides	
WHAT'S HAPPENING TO IT? Weathering processes	

APPENDIX D – TRACKING BUOY DEPLOYMENT INSTRUCTIONS

(Insert Link when printing)

APPENDIX E – COORDINATION STRUCTURE FOR A CONCURRENT HYDROCARBON SPILL IN BOTH COMMONWEALTH AND STATE WATERS/SHORELINES[4]

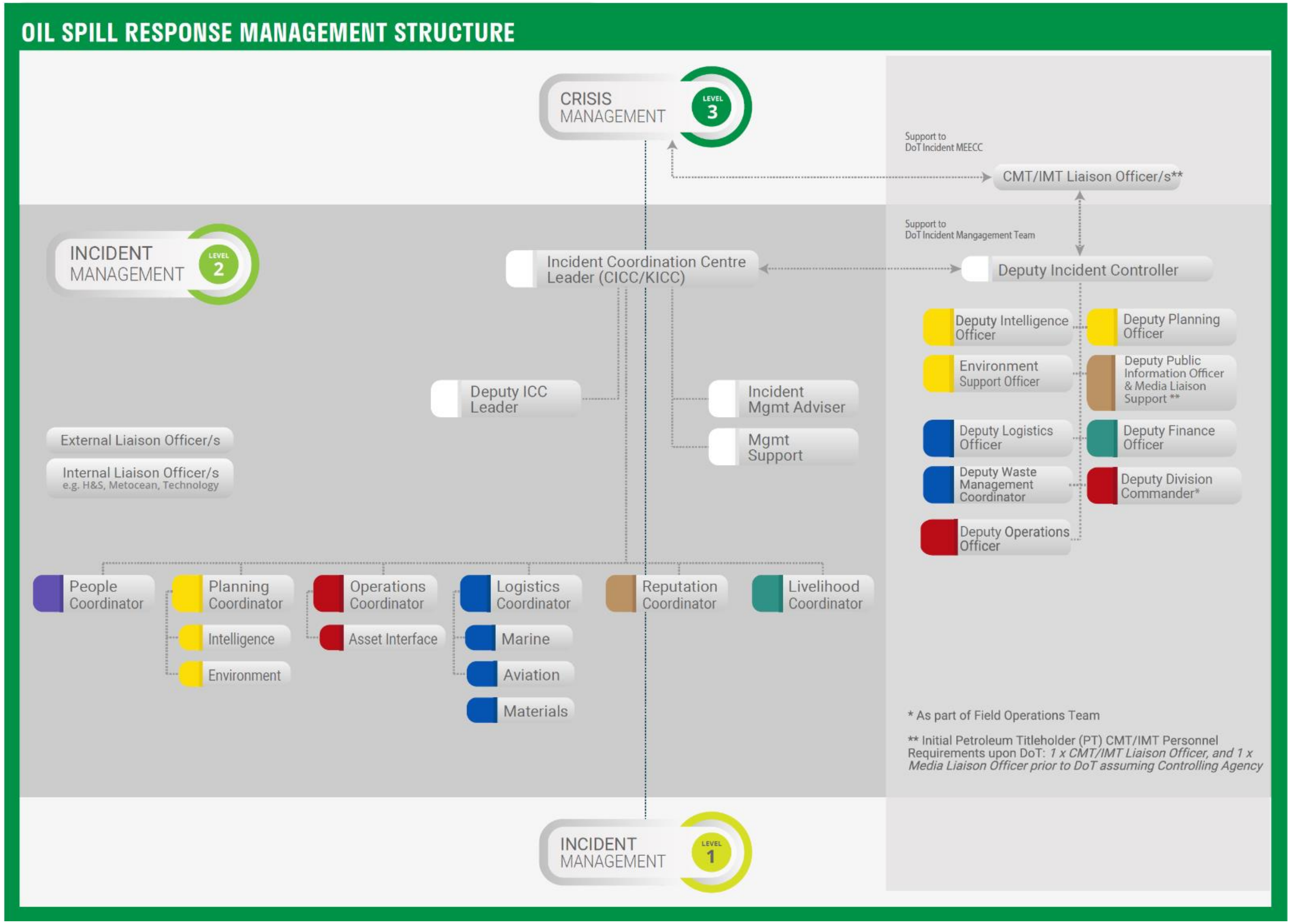


The Control Agency for a hydrocarbon spill in Commonwealth waters resulting from an offshore petroleum activity is AMSA.
The Control Agency for a hydrocarbon spill in State waters/shorelines resulting from an offshore petroleum activity in Commonwealth waters is DoT for a Level 2/3 spill. DoT will appoint an Incident Controller and form a separate IMT to only manage the spill within State waters/shorelines.

[4]Adapted from DoT Offshore Petroleum Industry Guidance Note, Marine Oil Pollution: Response and Consultation Arrangements July 2020. Note: For full structure up to Commonwealth Cabinet/Minister refer to Marine Oil Pollution: Response and Consultation Arrangements Section 6.5, Figure 3.

APPENDIX F – WOODSIDE INCIDENT MANAGEMENT STRUCTURE

Woodside Incident Management Structure for Hydrocarbon Spill (including Woodside Liaison Officers Command Structure within DoT IMT if required).



APPENDIX G – WOODSIDE LIASON OFFICER RESOURCES TO DOT

Once DoT activates a State waters/shorelines IMT, Woodside will make available the following roles to DoT.

Area	WEL Liaison Role	Personnel Sourced from[5]:	Key Duties	#
DoT MEECC	CMT Liaison Officer	CMT Leader Roster	• Provide a direct liaison between the CMT and the MEECC. • Facilitate effective communications and coordination between the CMT Leader and State Marine Pollution Coordinator (SMPC). • Offer advice to SMPC on matters pertaining to PT crisis management policies and procedures.	1
DoT IMT Incident Control	WEL Deputy Incident Controller	CICC Leader Reserve List Roster	• Provide a direct liaison between the PT IMT and DoT IMT. • Facilitate effective communications and coordination between the PT IC and the DoT IC. • Offer advice to the DoT IC on matters pertaining to PT incident response policies and procedures. • Offer advice to the Safety Coordinator on matters pertaining to PT safety policies and procedures, particularly as they relate to PT employees or contractors operating under the control of the DoT IMT.	1
DoT IMT Intelligence	Intelligence Support Officer/ Deputy Intelligence Officer	AMOSC Staff Member or AMOSC Core Group	• As part of the Intelligence Team, assist the Intelligence Officer in the performance of their duties in relation to situation and awareness. • Facilitate the provision of relevant modelling and predications from the PT IMT. • Assist in the interpretation of modelling and predictions originating from the PT IMT. • Facilitate the provision of relevant situation and awareness information originating from the DoT IMT to the PT IMT. • Facilitate the provision of relevant mapping from the PT IMT. • Assist in the interpretation of mapping originating from the PT IMT. • Facilitate the provision of relevant mapping originating from the DoT IMT to the PT IMT.	1
DoT IMT Intelligence – Environment	Environment Support Officer	CMT Environmental FST Duty Managers Roster	• As part of the Intelligence Team, assist the Environment Coordinator in the performance of their duties in relation to the provision of environmental support into the planning process. • Assist in the interpretation of the PT OPEP and relevant TRP plans. • Facilitate in requesting, obtaining and interpreting environmental monitoring data originating from the PT IMT. • Facilitate the provision of relevant environmental information and advice originating from the DoT IMT to the PT IMT.	1
DoT IMT Planning-Plans/ Resources	Deputy Planning Officer	AMOSC Core Group/CICC Planning	• As part of the Planning Team, assist the Planning Officer in the performance of their duties in relation to the interpretation of existing response plans and the development of incident action plans and related sub plans. • Facilitate the provision of relevant IAP and sub plans from the PT IMT.	1

[5] See [redacted]

Area	WEL Liaison Role	Personnel Sourced from[5]:	Key Duties	#
		Coordinator Reserve List and Planning Group 3	• Assist in the interpretation of the PT OPEP from the PT. • Assist in the interpretation of the PT IAP and sub plans from the PT IMT. • Facilitate the provision of relevant IAP and sub plans originating from the DoT IMT to the PT IMT. • Assist in the interpretation of the PT existing resource plans. • Facilitate the provision of relevant components of the resource sub plan originating from the DoT IMT to the PT IMT. **(Note this individual must have intimate knowledge of the relevant PT OPEP and planning processes)**	
DoT IMT Public Information-Media/ Community Engagement	Public Information Support and Media Liaison Officer/ Deputy Public Information Officer	Reputation (Media) FST Duty Manager Roster	• As part of the Public Information Team, provide a direct liaison between the PT Media team and DoT IMT Media team. • Facilitate effective communications and coordination between the PT and DoT media teams. • Assist in the release of joint media statements and conduct of joint media briefings. • Assist in the release of joint information and warnings through the DoT Information and Warnings team. • Offer advice to the DoT Media Coordinator on matters pertaining to PT media policies and procedures. • Facilitate effective communications and coordination between the PT and DoT Community Liaison teams. • Assist in the conduct of joint community briefings and events. • Offer advice to the DoT Community Liaison Coordinator on matters pertaining to the PT community liaison policies and procedures. • Facilitate the effective transfer of relevant information obtained from through the Contact Centre to the PT IMT.	1
DoT IMT Logistics	Deputy Logistic Officer	Services FST Logistics Team 2 Roster	• As part of the Logistics Team, assist the Logistics Officer in the performance of their duties in relation to the provision of supplies to sustain the response effort. • Facilitate the acquisition of appropriate supplies through the PTs existing OSRL, AMOSC and private contract arrangements. • Collects Request Forms from DoT to action via PT IMT. **(Note this individual must have intimate knowledge of the relevant PT logistics processes and contracts)**	1
DoT IMT Finance-Accounts/ Financial Monitoring	Deputy Finance Officer	CICC Finance Coordinator Roster	• As part of the Finance Team, assist the Finance Officer in the performance of their duties in relation to the setting up and payment of accounts for those services acquired through the PTs existing OSRL, AMOSC and private contract arrangements. • Facilitate the communication of financial monitoring information to the PT to allow them to track the overall cost of the response. • Assist the Finance Officer in the tracking of financial commitments through the response, including the supply contracts commissioned directly by DoT and to be charged back to the PT.	1

Area	WEL Liaison Role	Personnel Sourced from[5]:	Key Duties	#
DoT IMT Operations	Deputy Operations Officer	CICC Operations Coordinator Roster	• As part of the Operations Team, assist the Operations Officer in the performance of their duties in relation to the implementation and management of operational activities undertaken to resolve an incident. • Facilitate effective communications and coordination between the PT Operations Section and the DoT Operations Section. • Offer advice to the DoT Operations Officer on matters pertaining to PT incident response procedures and requirements. • Identify efficiencies and assist to resolve potential conflicts around resource allocation and simultaneous operations of PT and DoT response efforts.	1
DoT IMT Operations – Waste Management	Facilities Support Officer/ Deputy Waste Management Coordinator	Services FST Logistics Team 2 and WEL Waste Contractor Roster	• As part of the Operations Team, assist the Waste Management Coordinator in the performance of their duties in relation to the provision of the management and disposal of waste collected in State waters. • Facilitate the disposal of waste through the PT's existing private contract arrangements related to waste management and in line with legislative and regulatory requirements. • Collects Request Forms from DoT to action via PT IMT.	1
DoT FOB Operations Command	Deputy On-Scene Commander/ Deputy Division Commander	AMOSC Core Group	• As part of the Field Operations Team, assist the Division Commander in the performance of their duties in relation to the oversight and coordination of field operational activities undertaken in line with the IMT Operations Section's direction. • Provide a direct liaison between the PT FOB and DoT FOB. • Facilitate effective communications and coordination between the PT Division Commander and the DoT Division Commander. • Offer advice to the DoT Division Commander on matters pertaining to PT incident response policies and procedures. • Assist the Safety Coordinator deployed in the FOB in the performance of their duties, particularly as they relate to PT employees or contractors. • Offer advice to the Safety Coordinator deployed in the FOB on matters pertaining to PT safety policies and procedures.	1
			Total Woodside personnel initially required in DoT IMT	11

DoT Liaison Officer Resources to Woodside

Once DoT activates a State waters/shorelines IMT, DoT will make available the following roles to Woodside.

Area	DoT Liaison Role	Personnel Sourced from:	Key Duties	#
WEL CMT	DoT Liaison Officer (prior to DoT assuming Controlling Agency) / Deputy Incident Controller – State waters (after DoT assumes Controlling Agency)	DoT	• Facilitate effective communications between DoT's SMPC/ Incident Controller and the Petroleum Titleholder's appointed CMT Leader / Incident Controller. • Provide enhanced situational awareness to DoT of the incident and the potential impact on State waters. • Assist in the provision of support from DoT to the Petroleum Titleholder. • Facilitate the provision technical advice from DoT to the Petroleum Titleholder Incident Controller as required.	1
WEL Reputation FST (Media Room)/ Public Information – Media	DoT Media Liaison Officer	DoT	• Provide a direct liaison between the PT Media team and DoT IMT Media team. • Facilitate effective communications and coordination between the PT and DoT media teams. • Assist in the release of joint media statements and conduct of joint media briefings. • Assist in the release of joint information and warnings through the DoT Information & Warnings team. • Offer advice to the PT Media Coordinator on matters pertaining to DoT and wider Government media policies and procedures.	1
			Total DoT Personnel Initial Requirement to Woodside	2