WA-34-L Pyxis Drilling and Subsea Installation Environment Plan

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1 INTRODUCTION

1.1 Overview

Woodside Burrup Pty Ltd (Woodside), as Titleholder under the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth) (referred to as the Environment Regulations), proposes to undertake the following activities within Permit Area WA-34-L:

- drilling and development of two Pyxis Hub production wells
- drilling and development of two Xena infill production wells
- installation and pre-commissioning of flowlines, production manifolds, umbilical termination assemblies (UTAs), subsea distribution units (SDUs), hydraulic flying leads (HFLs), electrical flying leads (EFLs) and monoethylene glycol (MEG) jumpers
- tie-in to existing subsea infrastructure
- pre-commissioning of the new subsea infrastructure
- contingent workover activities for Pyxis, Xena and Pluto wells.

These activities will hereafter be referred to as the Petroleum Activities Program and form the scope of this Environment Plan (EP).

A more detailed description of the activities is provided in **Section 3**. Hydrocarbons from the Pyxis Hub and Xena wells will be produced through the existing Pluto platform.

This EP has been prepared as part of the requirements under the Environment Regulations, as administered by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).

1.2 Defining the Petroleum Activity

The Petroleum Activities Program to be undertaken in Permit Area WA-34-L comprises drilling and installing related subsea infrastructure, which are petroleum activities as defined in Regulation 4 of the Environment Regulations. As such an EP is required.

1.3 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 performed in a manner consistent with the principles of ecologically sustainable development (as defined in Section 3A of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (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.

1.4 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 two 'areas', the Operational Area and the Permit Area. The combination of the Operational Area and Permit Area defines the spatial boundary of the Petroleum Activities Program, as described, risk-assessed and managed by this EP. For a dynamically positioned MODU/drillship, the Operational Area encompasses a radius of 500 m from each well centre, while for a moored MODU, the Operational Area encompasses a radius of 4000 m from each well centre. For the installation activities, the Operational Area encompasses a radius of 1500 m around subsea locations.

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 the Mobile Offshore Drilling Unit (MODU), installation vessels 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 all applicable maritime regulations and other requirements and are not managed by this EP.

1.5 Environment Plan Summary

This WA-34-L Pyxis Drilling and Subsea Installation EP summary has been prepared based on the material provided in this EP. This summarises the items listed in **Table 1-1** as required by Regulation 11(4).

Table 1-1: EP summary

EP Summary material requirement	Relevant section of EP containing EP Summary material
The location of the activity	**Section 3.3**, pages 42–45
A description of the receiving environment	**Section 4**, pages 66–146
A description of the activity	**Section 3**, pages 40–66
Details of the environmental impacts and risks	**Section 6**, pages 159–322
The control measures for the activity	**Section 6**, pages 159–322
The arrangements for ongoing monitoring of the titleholder's environmental performance	**Section 7.5**, pages 329–334
Response arrangements in the oil pollution emergency plan	**Section 7.9**, pages 339–351, and **Appendix D**
Consultation already undertaken and plans for ongoing consultation	**Section 5**, pages 146–159
Details of the titleholder's nominated liaison person for the activity	**Section 1.8**, page 17

1.6 Structure of the Environment Plan

This 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 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' is applicable throughout the EP.	**Section 1** **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) to 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 3** **Section 4** **Section 5** **Section 6** **Section 7**
Regulation 10A(d): Provides for appropriate environmental performance outcomes, environmental performance standards and measurement criteria	Regulation 13(7): *Environmental performance outcomes and standards*	Environmental performance outcomes. Environmental performance standards. Measurement criteria.	**Section 6**
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: • Environmental Management System (EMS) • performance monitoring • Oil Pollution Emergency Plan (OPEP) and scientific monitoring • ongoing consultation.	**Section 7** **Appendix D**

Criteria for acceptance	Content requirements/relevant regulations	Elements	Section of EP
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 *Environment Protection and Biodiversity Conservation Act 1999* (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**
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 consultations are appropriate	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 undertaken in the preparation of this EP.	**Section 5**
Regulation 10A(h): complies with the Act and the regulations	Regulation 13(4)a: *Describe the requirements, including legislative requirements, that apply to activity and are relevant to the environmental management of the activity* *Regulation 15:* *Details of the Titleholder and liaison person* *Regulation 16(a):* *A statement of the titleholder's corporate environmental policy* *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** **Section 5** **Section 6** **Appendix A** **Appendix B**

1.7 Description of the Titleholder

The nominated Titleholder for this activity is Woodside Burrup Pty Ltd, on behalf of its Pluto LNG joint venture partners, Tokyo Gas Pluto Pty Ltd and Kansai Electric Power Australia Pty Ltd.

Woodside's mission is to deliver superior shareholder returns through realising its vision of becoming a global leader in upstream oil and gas. Wherever Woodside works, it is committed to living its values of integrity, respect, working sustainably, discipline, excellence and working together.

Woodside's operations are characterised by strong safety and environmental performance in remote and challenging locations.

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, and it remains 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 to ensure they are a partner of choice. Further information about Woodside can be found at http://www.woodside.com.au.

1.8 Details of Titleholder, Liaison Person and Public Affairs Contact

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

1.8.1 Titleholder

Woodside Burrup Pty Ltd
11 Mount Street, Perth, Western Australia
Telephone: 08 9348 4000
Fax Number: 08 9214 2777
ABN: 63 005 482 986

1.8.2 Activity Contact

Warren Wyld
Project Manager, Australia
11 Mount Street, Perth, Western Australia
Phone: 08 9348 4000
Fax Number: 08 9214 2777
warren.wyld@woodside.com.au

1.8.3 Nominated Liaison Person

Daniel Clery
Corporate Affairs Manager
11 Mount Street, Perth, Western Australia
Phone: 08 9348 4000
Fax Number: 08 9214 2777
feedback@woodside.com.au

1.8.4 Arrangements for Notifying of Change

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

1.9 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 & Policies, Expectations, Processes & Procedures, and Guidelines, outlined below (and illustrated in **Figure 1-1**):

- **Compass & 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 & Procedures:** Processes identify the set of interrelated or interacting activities which transforms inputs into outputs, to systematically achieve a purpose or specific objective. Procedures specify what steps, by whom and when to perform 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 considered, or how to use tools and systems.

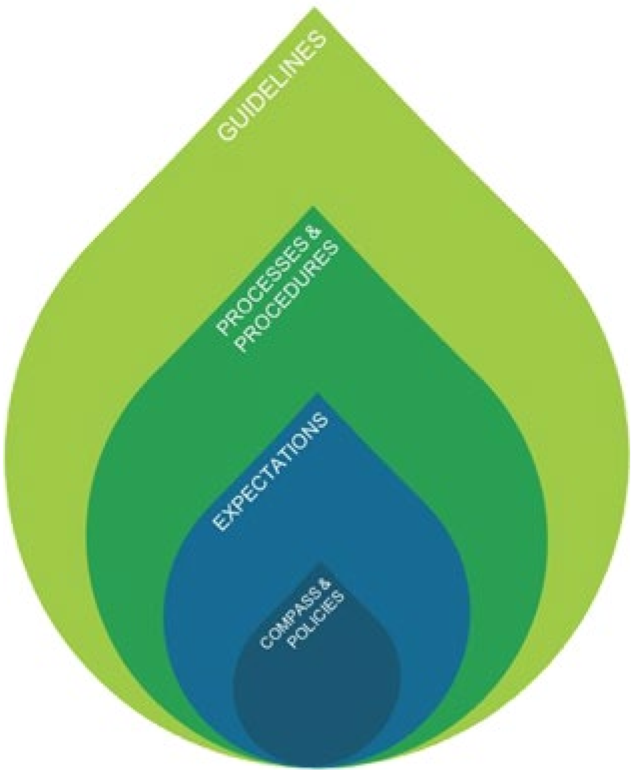


Figure 1-1: The four major elements of the WMS Seed

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 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.

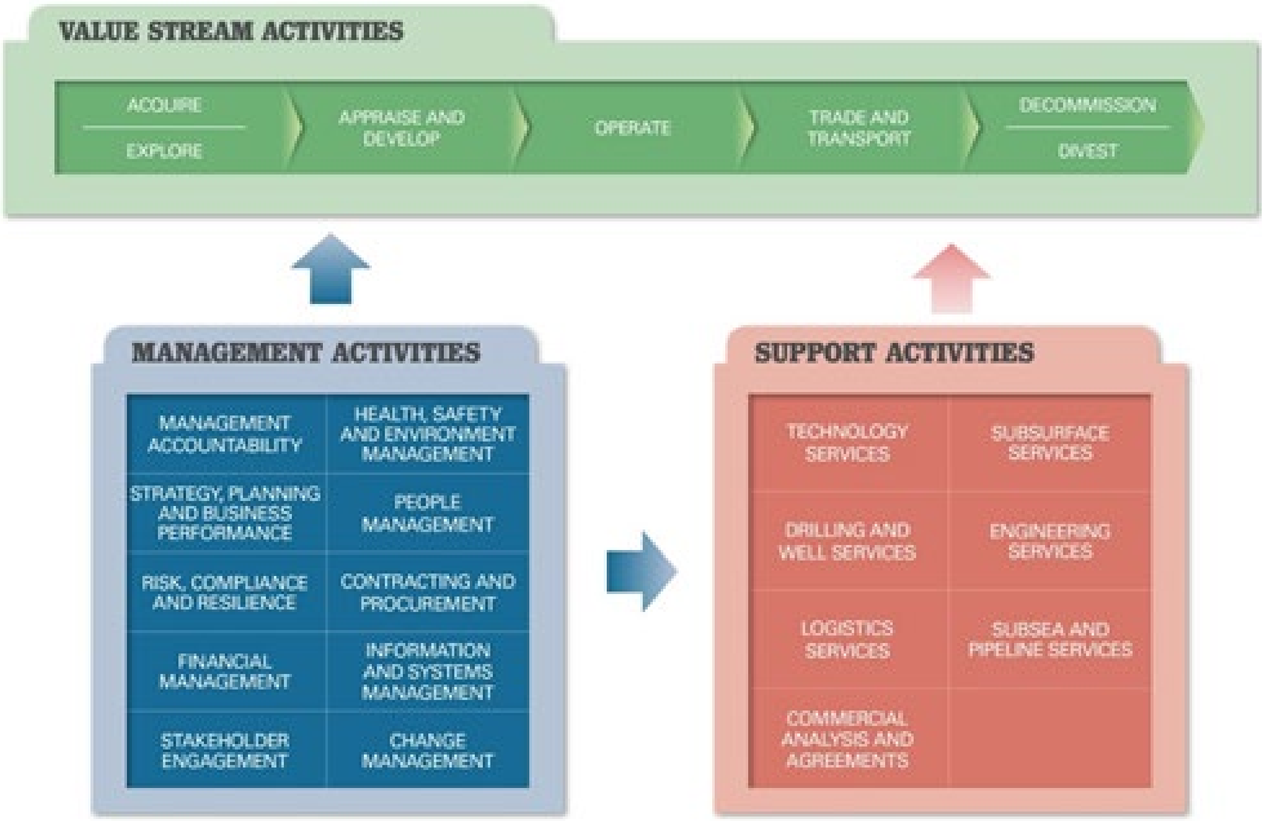


Figure 1-2: The WMS business process hierarchy

1.9.1 Health, Safety, Environment and Quality Policy

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

1.10 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**.

1.10.1 Applicable Environmental Legislation

The Commonwealth *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (OPGGS Act) controls exploration and production activities beyond three nautical miles to the outer extent of the Australian Exclusive Economic Zone at 200 nautical miles, also known as Commonwealth waters.

The Environment Regulations apply to petroleum activities in Commonwealth waters and are administered by NOPSEMA.

The objectives of the Environment Regulations include provisions to ensure petroleum activities are performed in a manner:

- consistent with the principles of ecologically sustainable development
- by which the environmental impacts and risks of the activity will be reduced to ALARP
- by which the environmental impacts and risks of the activity will be of an acceptable level.

1.10.1.1 Environmental Protection and Biodiversity Conservation Act 1999

The Petroleum Activities Program described is governed by the primary approvals for the Pluto LNG Project.

The Pluto LNG Project (including both offshore and onshore infrastructure) was referred for assessment under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC 2006/2968) and the level of assessment was set as Public Environment Report. The action was approved 12 October 2007 with conditions.

It should be noted that a Consolidated Approval Notice for EPBC 2006/2968 dated 14 June 2015 was issued to consolidate the approval conditions, and the approval conditions were subject to variation on the date of the notice. A key element to the variation relates to conditions requiring a plan for managing impacts of the action. The previous conditions required the Minister's approval of such plans, with the variation now automatically deeming the plan to have been approved by the Minister if the measures are included in an environment plan related to the action that was submitted to NOPSEMA after 27 February 2014 and is in force under the Environment Regulations.

Conditions relating to the EPBC Act approval that are considered relevant to the scope of this EP are provided in **Table 1-3**.

Table 1-3: Conditions from Pluto condensate field (EPBC 2006/2968 relevant to the Petroleum Activities Program

Condition Number	Condition	Relevant Section of EP
1 [1]	The person taking the action must submit, for the Minister's approval, a plan (or plans) for managing the offshore impacts of the action. The plan (or plans) must include measures for: b) Construction and installation: i. design and construction that allow for the decommissioning of all structures and components on the sea floor ii. impacts and management measures for reuse of any spoil ground material iii. details of the final selection of wells, anchor type and placements and flowline paths iv. hydrotest fluid type, handling and risk assessment of disposal impacts v. interaction procedures for supply vessels and aircraft that are consistent with Part 8 of the *Environment Protection and Biodiversity Conservation Regulations 2000* vi. cetacean and whale shark sightings reporting.	i. This EP (design and installation) including Section 3.11.8 and a future decommissioning EP; ii. Not applicable – only applicable to Pluto project near shore trunkline dredging scope; iii. **Sections 3.8** and **3.9** iv Sections 3.9.11, 3.10.1 and 6.6.7; v. Section 6.7.8 vi Section 7.8.5

[1] Conditions 1a), 2 and 3 (not shown) have been met through previous plans.

Condition Number	Condition	Relevant Section of EP
1	c) Operations: i. trading tanker vetting procedures ii. the monitoring and disposal of produced water (PW), including the analysis of expected PW chemistry, baseline biological and physical information at the PW outfall site, toxic impacts of PW on marine flora and fauna based on ecotoxicological, bioaccumulation and biodegradation studies, industry best practice disposal of PW, monitoring and reporting of biological and physical indicators and contingency measures if adverse impacts are indicated iii. monitoring and management of the collection, handling and disposal of naturally occurring radioactive materials iv. interaction procedures for supply vessels and aircraft that are consistent with Part 8 of the *Environment Protection and Biodiversity Conservation Regulations 2000* v. cetacean and whale shark sightings reporting. Individual offshore activities may not commence until the plan (or plans) for that specific activity has been approved. The approved plan (or plans) must be implemented.	i. Not applicable – applies to LNG carriers attending the Pluto LNG Plant; ii. Not applicable – applies to operation of Pluto A and onshore facilities; iii. Not applicable – applies to operation of the Pluto A and onshore facilities; iv. **Section 6.7.8** v. Section 7.8.5
4	The person taking the action must submit for the Minister's approval an oil spill contingency plan to mitigate the environmental effects of any hydrocarbon spills. The oil spill contingency plan must include: a) the types of dispersants, protective booms, clean up gear, and related equipment to be used in the event of an oil spill and the storage arrangements b) training of staff in oil spill response measures c) identification of sensitive areas, and specific response measures for these areas d) details of the insurance arrangements that have been made in respect of the costs associated with repairing any environmental damage arising from potential oil spills e) the reporting of oil spill incidents. Offshore construction may not commence until the plan is approved. The approved plan must be implemented.	Woodside's Emergency Preparedness and Response arrangements (refer to **Section 7.9**, Emergency Response preparation, **Appendix D** Oil Spill preparedness and response strategy selection and evaluation and associated documents).
8	At least twelve months before the expiry of the period for which this approval has effect, the person taking the action Limited must submit a decommissioning plan for approval by the Minister that considers the removal of all structures and components above the sea floor, including subsea wells, manifolds and flowlines and any other associated infrastructure and the disposal and management of any naturally occurring radioactive materials. Decommissioning may not commence until the plan is approved. The approved plan must be implemented.	Decommissioning is outside the scope of this EP.
11	If the person taking the action proposes to undertake any subsea tie-in not included in approved plans pursuant to condition 1, the person taking the action must revise such plans or submit a new plan or plans to address the activities associated with, and potential environmental impacts of, the subsea tie-in. Activities associated with subsea tie-ins may not be commenced until each such plan or revised plan has been approved by the Minister. Each plan or revised plan that has been approved by the Minister must be implemented.	The submission and subsequent implementation of this EP is considered to meet this condition (i.e. this EP is submitted as the 'revised plan' to address aspects of condition 1 applicable to the Xena and Pyxis subsea tie-in).

Condition Number	Condition	Relevant Section of EP
13	If the Minister believes that it is necessary or desirable for the better protection of the environment to do so, the Minister may request the person taking the action to make specified revisions to a plan approved pursuant to conditions 1,3,4,5,6 and 8 and to submit the revised plan for the Minister's approval. The person taking the action must comply with any such request. If the Minister approves a revised plan pursuant to this condition, the person taking the action must implement that plan instead of the plan as originally approved.	The Minister retains this ability
15	A plan required by conditions 1, 4, 8, 11 or 12 is automatically deemed to have been submitted to, and approved by, the Minister if the measures (as specified in the relevant condition) are included in an environment plan (or environment plans) relating to the taking of the action that: a) was submitted to NOPSEMA after 27 February 2014, and b) either: a. is in force under the OPGGS Environment Regulations, or b. has ended in accordance with Regulation 25A of the OPGGS Environment Regulations.	The implementation of this EP is considered to meet this condition.
15A	Where a plan required by conditions 1, 4, 11 or 12 has been approved by the Minister and the measures (as specified in the relevant condition) are included in an environment plan (or environment plans) that: a) was submitted to NOPSEMA after 27 February 2014, and b) either: a. is in force under the OPGGS Environment Regulations, or b. has ended in accordance with Regulation 25A of the OPGGS Environment Regulations, the plan approved by the Minister no longer needs to be implemented.	The implementation of this EP is considered to meet this condition, and supersedes previously approved plans.
15B	Where an environment plan, which includes measures specified in the conditions referred to in conditions 15 and 15A above, is in force under the OPGGS Environment Regulations that relates to the taking of the action, the person taking the action must comply with those measures as specified in that environment plan.	The implementation of this EP is considered to meet this condition.

1.10.2 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 Marine Parks (DNP) is responsible for managing AMP's (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 in relation to these parks that are inconsistent with management plans (s.362 of the EPBC Act). Relevant AMPs are described in **Section 4.7**.The North-west Marine Parks Network Management Plan describes the requirements for management.

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 though 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.

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 **Section 1.2**). The process (**Section 2.3**) describes 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 the detailing of environmental impacts and risks, and evaluation appropriate to the nature and scale of each impact and risk associated with the Petroleum Activities Program. The objective of the risk assessment process, described in this section, is to identify risks and associated impacts of an activity so they can be assessed and appropriate control measures applied to eliminate, control or mitigate the impact/risk to ALARP and determine if the impact or risk level is acceptable.

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

- Planned activities (routine and non-routine) have the potential for inherent environmental impacts.
- An environmental risk is an unplanned event 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 impact termed potential 'consequence'.

2.2 Environmental Risk Management Methodology

2.2.1 Woodside Risk Management Processes

Woodside recognises that risk is inherent to its business and that 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 Woodside's business. Achieving this objective includes ensuring risks consider impacts across the following 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 31000:2009. 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. Three such procedures applied for environmental risk management include Woodside's:

1. Health Safety and Environment Management Procedure
2. Impact Assessment Procedure
3. 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**. A description of each step and how it is applied to the scopes of this activity is provided in **Sections 2.1** to **2.10**.

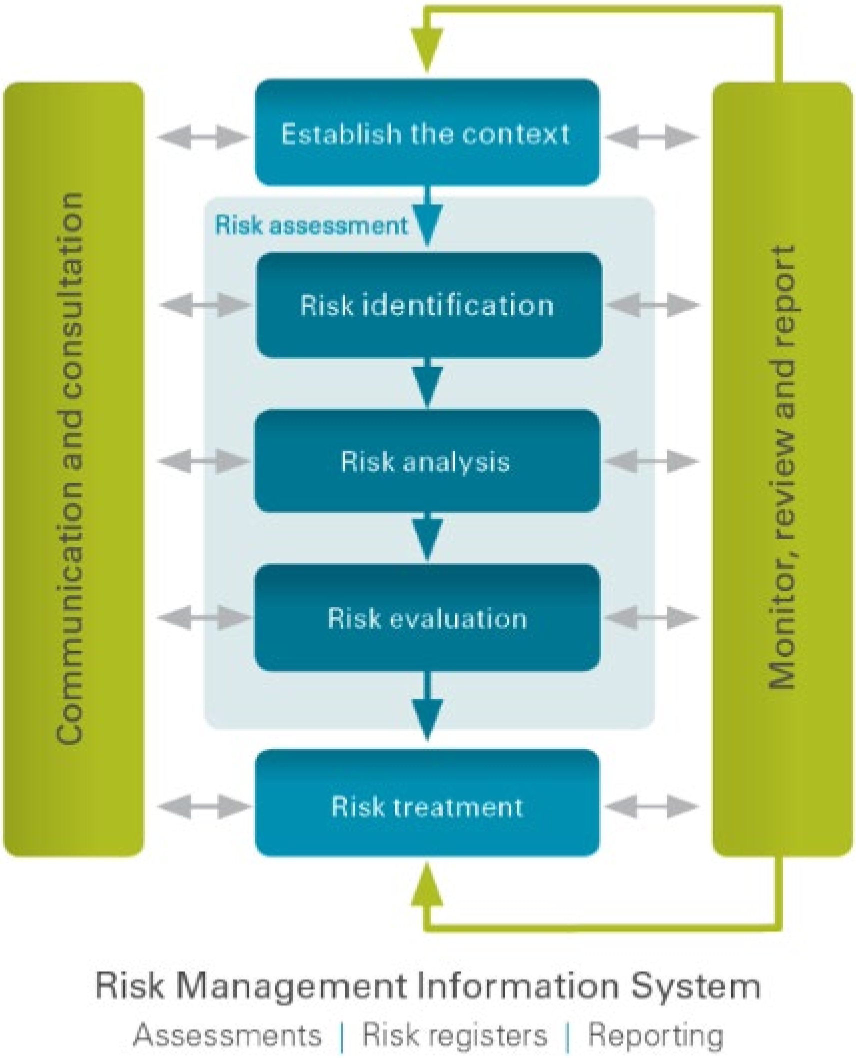


Figure 2-1: Woodside's risk management process

2.2.2 Health, 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 and defines the decision authorities for company-wide HSE management activities and deliverables, and to support continuous improvement in HSE management.

2.2.3 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.

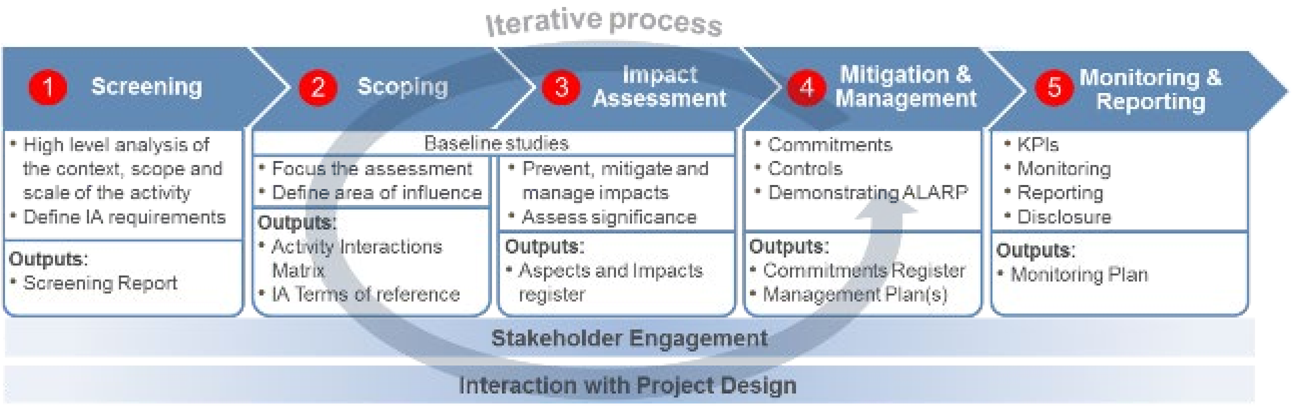


Figure 2-2: Woodside's impact assessment process

2.3 Environment Plan Process

Figure 2-3 illustrates the Environment Plan development process. Each element of this process is discussed further in **Sections 2.4** to **2.10**.

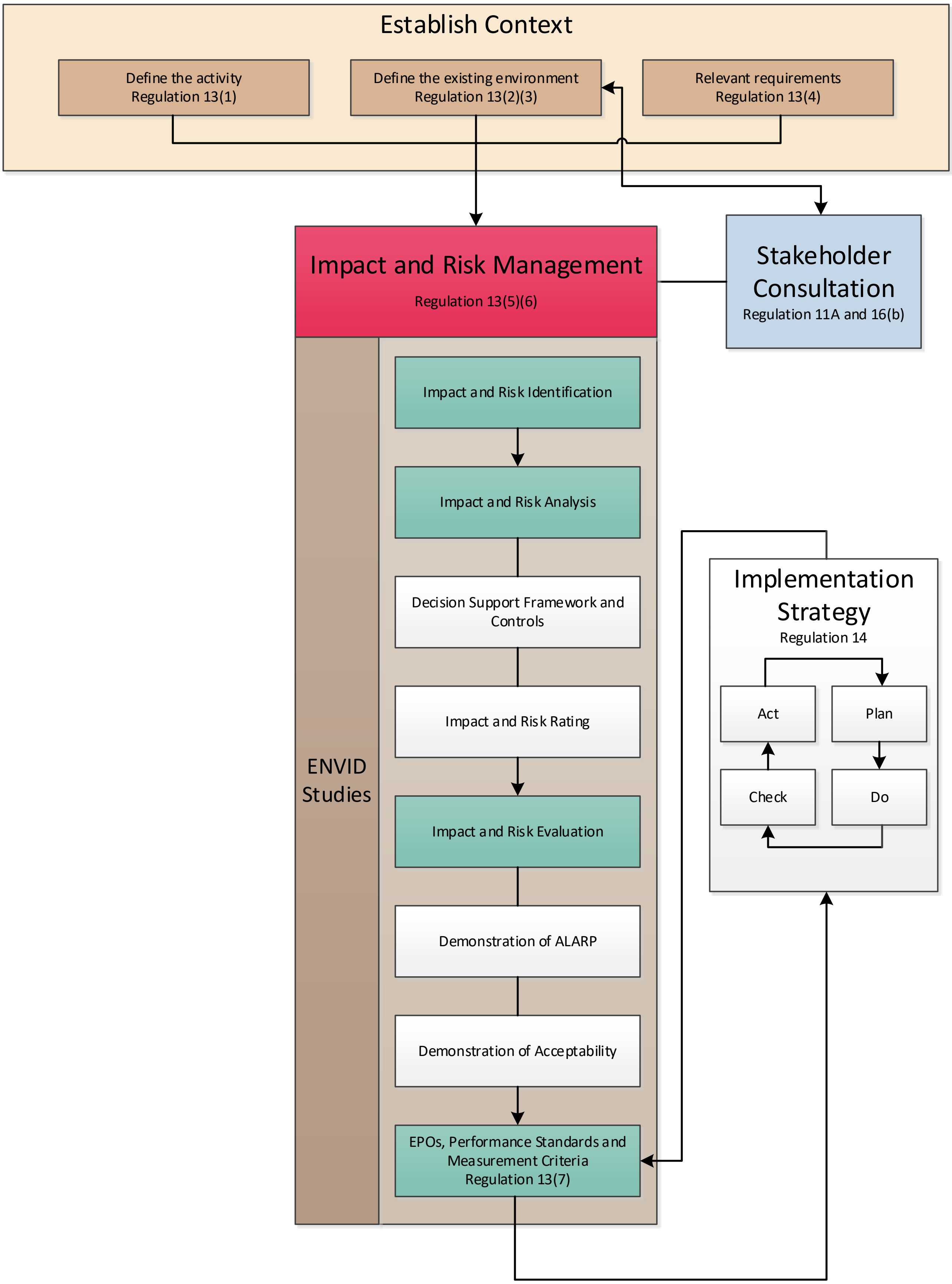


Figure 2-3: Environment plan development process

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

The ‘what’ and ‘how’ are described in the context of ‘environmental aspects’ [2] to inform the risk and impact assessment for planned (routine and non-routine) and unplanned (accidents/incidents/ emergency conditions) activities.

The activity is described in **Section 1** and referred to as the Petroleum Activities Program.

2.4.2 Defining the Existing Environment

The existing environment that may be impacted by the Petroleum Activities Program (as described in **Section 4**) is defined by considering the nature and scale of the activities (i.e. size, type, timing, duration, complexity and intensity of the activities). The existing environment may potentially be impacted directly or indirectly by planned and unplanned [3] events.

The Existing Environment section 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 values potentially impacted by the Petroleum Activities Program, which include key physical and biological attributes of the existing environment (as defined by Woodside in **Table 2-1** and **Section 2.4.2**)
- 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 within the Permit Area (planned activities) and the Environment that May Be Affected (EMBA) of unplanned events. Potential impacts to MNES as defined within the EPBC Act are addressed through Woodside’s impact and risk assessment process (**Section 2.7**).
- 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.

[2] An environmental aspect is an element of the activity that can interact with the environment.

[3] The worst-case unplanned event is considered to be an unplanned hydrocarbon release, further defined for each activity through the risk assessment process. Interpretation of stochastic oil spill modelling determines the EMBA for the release, which defines the spatial scale of the environment that may be potentially impacted by the Petroleum Activities Program, which provides context to the ‘nature and scale’ of the existing environment.

- 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 2.6**), 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.

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)*						
Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/ Habitats***	***Species***	***Socio-Economic***

The existing environment is described in **Section 4**.

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**.

Woodside's Corporate Health, Safety, Environment and Quality 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 (e.g. HAZID/ENVID) for similar activities (e.g. drilling, subsea installation) and identified project specific risks, Process Safety Risk Assessment processes, reviews and associated desktop studies associated with the Petroleum Activities Program. Impacts and Risks are identified based on planned and potential interaction with the activity (based on the description in **Section 3**), the existing environment (**Section 4**) and the outcomes of Woodside's Stakeholder Engagement process (**Section 5**). The environmental outputs of applicable impact and risk workshops and associated studies are referred to as 'ENVID' thereafter in this EP.

The WA-34-L specific ENVID workshop was conducted on 12 February 2019. Participants included Project Environmental Advisors, Environmental Engineers, Project Manager, Subsea Installation Engineer, Subsea Engineer Drilling Engineers, Corporate Affairs and Security and Emergency Management.

The workshop was specific to the Pyxis/Xena, Petroleum Activities Program and included both members of the project team and environmental advisers along with other relevant disciplines. The participants' breadth of knowledge, training and experience was sufficient to reasonably assure that the hazards that may arise in connection with the petroleum activity 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/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.

Where required to confirm the extent of impact or consequence, environmental studies are also used. Where existing studies are relevant to the proposed activity these have been used to assess impacts (e.g. Drill cutting modelling). Where impacts and risks are project specific, additional project specific studies have been undertaken (e.g. Project specific well blowout scenario and dispersion modelling.

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 measurement criteria. 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

Impacts and Risks Evaluation Summary														
Source of Risk	***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***
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.

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 has been 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 around 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 negative stakeholder concerns. For these risks, in addition to Decision Type A and B tools, company and societal values need to be considered by undertaking broader internal and external stakeholder consultation as part of the risk assessment process.

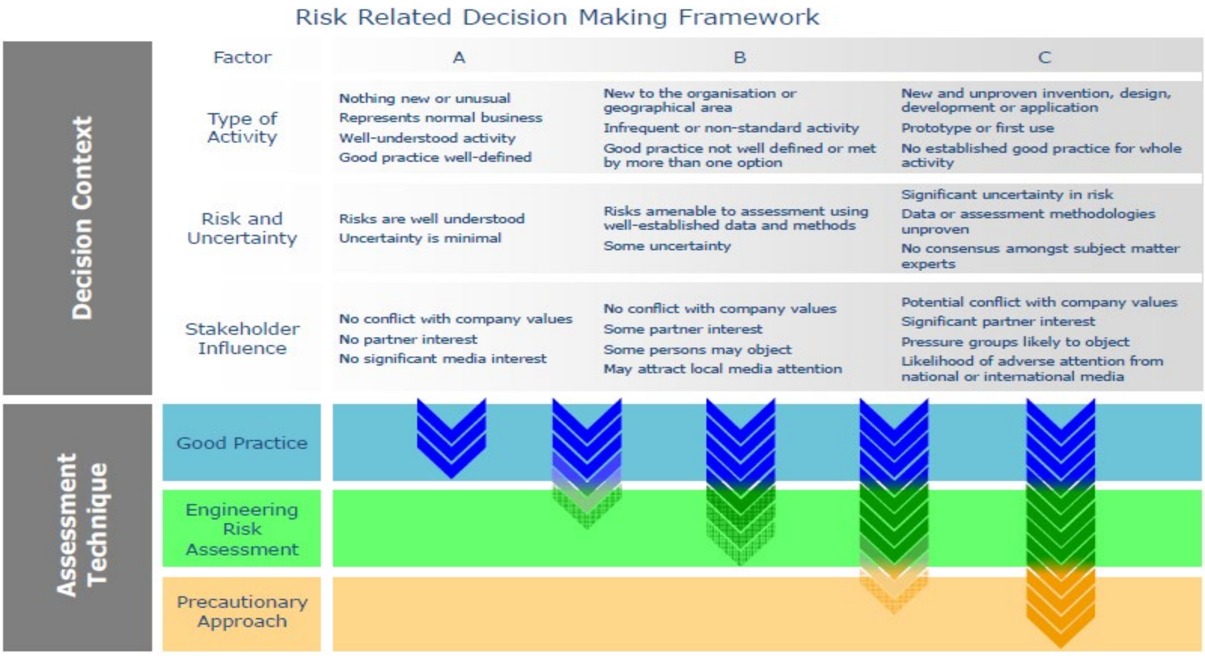


Figure 2-4: Risk related decision-making framework (Oil and Gas UK, 2014)

2.6.1.4 Decision Support Framework Tools

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

- **Legislation, Codes and Standards (LCS)** – identifies the requirements of legislation, codes and standards which are to be complied with for the activity.
- **Good Industry Practice (GP)** – identifies further engineering control standards and guidelines which may be applied by Woodside above that required to meet the legislation, codes and standards.
- **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.

2.6.1.5 Decision Calibration

To determine that the selection of alternatives 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 legislation, codes and standards and/or good industry practice.

- **Peer Review** – independent peer review of professional judgements, supported by risk-based analysis, where appropriate.
- **Benchmarking** – where appropriate, benchmark against a similar facility or activity type or situation which has been accepted to represent acceptable risk.
- **Internal Stakeholder Consultation** – consultation undertaken within Woodside to inform the decision and verify company values are met.
- **External Stakeholder Consultation** – consultation undertaken 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.

2.6.2 Control Measures (Hierarchy of Controls)

Risk reduction measures should be 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** which include design measures to prevent or reduce the frequency of the risk event, 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 should a hazardous event occur.
  - Response Equipment: Design measures or safeguards that enable clean-up/response following the realisation of a hazardous event.
- **Procedures and Administration** which include management systems and work instructions used to prevent or mitigate environmental exposure to hazards.
- **Emergency Response and Contingency Planning** which includes methods to enable recovery from the impact of an event (e.g. protection barriers deployed near to the sensitive receptor).

2.6.3 Impact and Risk Classification

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

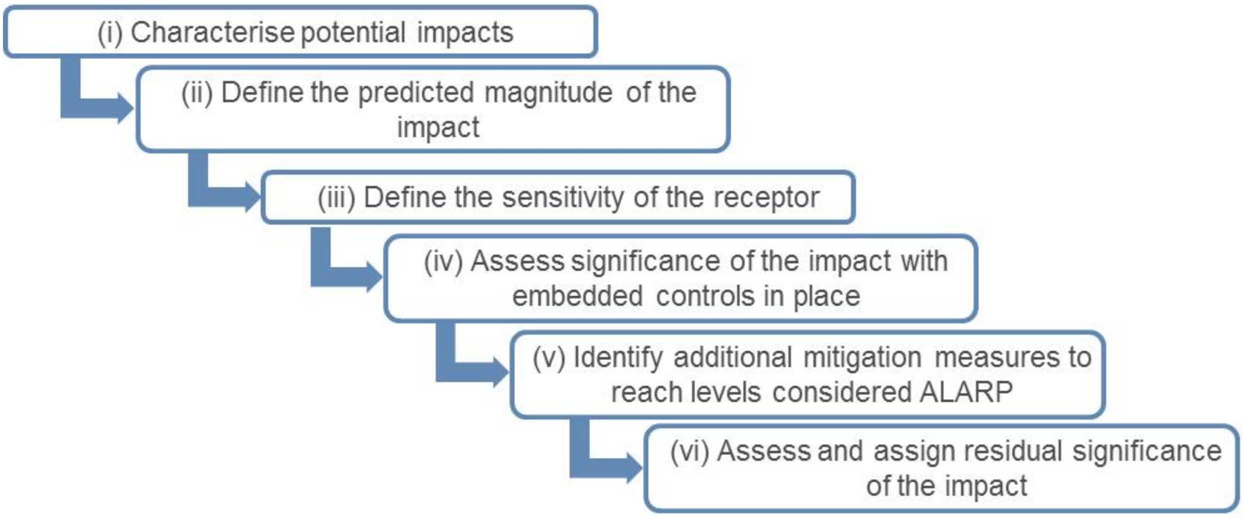


Figure 2-5: Environmental impact and risk analysis

Impacts are classified in accordance with the consequence (**Section 2.3**) 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 & Cultural	Consequence Level
Catastrophic, long-term impact (>50 years) on highly valued ecosystems, species, habitat or physical or biological attributes	Catastrophic, long-term impact (>20 years) to a community, social infrastructure or highly valued areas/items of international cultural significance	*A*
Major, long term impact (10–50 years) on highly valued ecosystems, species, habitat or physical or biological attributes	Major, long-term impact (5–20 years) to a community, social infrastructure or highly valued areas/items of national cultural significance	*B*
Moderate, medium-term impact (2–10 years) on ecosystems, species, habitat or physical or biological attributes	Moderate, medium term Impact (2–5 years) to a community, social infrastructure or highly valued areas/items of national cultural significance	*C*
Minor, short-term impact (1–2 years) on species, habitat (but not affecting ecosystems function), physical or biological attributes	Minor, short-term impact (1–2 years) to a community or highly valued areas/items of cultural significance	*D*
Slight, short-term impact (<1 year) on species, habitat (but not affecting ecosystems function), physical or biological attributes	Slight, short-term impact (<1 year) to a community or areas/items of cultural significance	*E*
No lasting effect (<1 month); localised impact not significant to environmental receptors	No lasting effect (<1 month); localised impact not significant to areas/items of cultural significance	*F*

2.6.3.1 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:

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.

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

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.

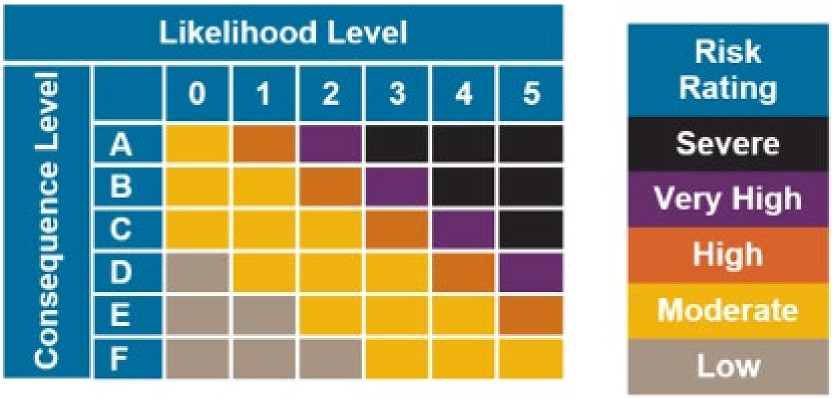


Figure 2-6: Woodside risk matrix: risk level

In support of 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 wide range of issues, affected by differing species, persistence, reversibility, resilience, cumulative effects and variability in severity. Determining the degree of environmental risk and the corresponding threshold for whether an impact or risk has been reduced to ALARP and is acceptable, is evaluated to a level appropriate to the nature and scale of each impact or risk. The evaluation considers:

- the Decision Type
- the Principles of Ecologically Sustainable Development as defined under the EPBC Act
- the internal context – the proposed controls and risk level are consistent with Woodside policies, procedures and standards (**Section 6** and **Appendix A**)
- the external context – the environment consequence (**Section 6**) and stakeholder acceptability (**Section 5**) are considered
- other requirements – the proposed controls and risk level are consistent with national and international standards, laws and policies.

In accordance with Regulations 10A(a), 10A(b), 10A(c) and 13(5)(b) of the Environment Regulations, Woodside applies the following process 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 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	***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	***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. (Please also refer to **Figure 2-7** for a visual representation against Woodside's risk matrix).

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 risks, impacts and decision types are 'Broadly Acceptable' if they meet legislative requirements, industry codes and standards, applicable company requirements and industry guidelines. Further effort towards risk reduction (beyond employing opportunistic measures) is not reasonably practicable without sacrifices grossly disproportionate to the benefit gained.		
High, Very High or Severe	***Moderate and above (A, B or C)***	***B and C***
Woodside demonstrates these higher order risks, impacts and decision types are 'Acceptable if ALARP' if it can be demonstrated using good industry practice and risk-based analysis, if legislative requirements are met and societal concerns are accounted for, and the alternative control measures are grossly disproportionate to the benefit gained. In undertaking this process for Moderate and High current risks, Woodside evaluates: • the Principles of Ecological Sustainable Development as defined under the EPBC Act • the internal context – the proposed controls and consequence/risk level are consistent with Woodside policies, procedures and standards • the external context – the environment consequence (**Section 6**) and stakeholder acceptability (**Section 5**) are considered • other requirements – the proposed controls and consequence/ risk level are consistent with national and international industry standards, laws and policies. Additionally, Very High and Severe risks require 'Escalated Investigation' and mitigation to reduce the risk to a lower and more acceptable level. If after further investigation the risk remains in the Very High or Severe category, the risk requires appropriate business engagement in accordance with Woodside's Risk Management Procedure to accept the risk. This includes due consideration of regulatory requirements.		

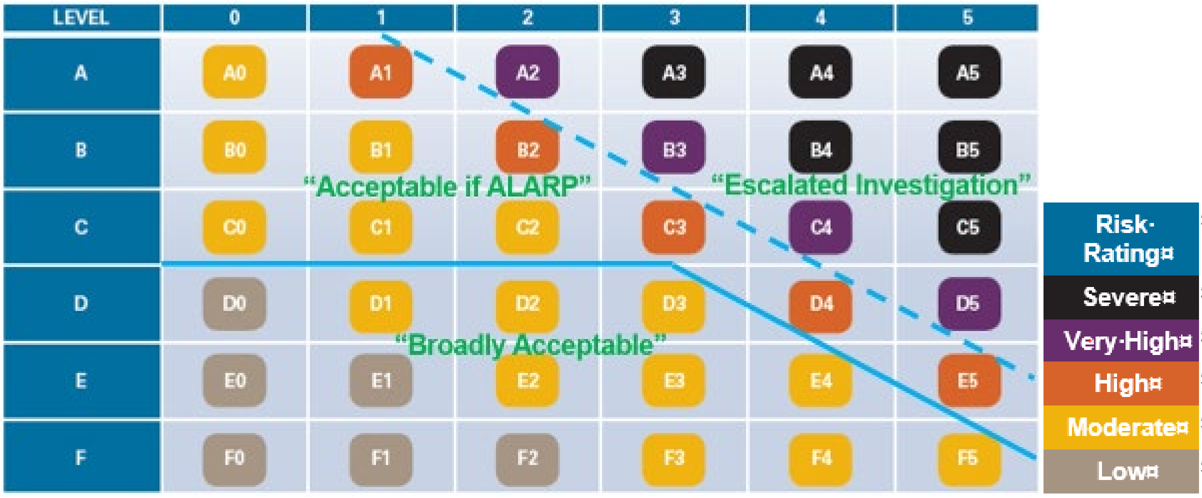


Figure 2-7: Environmental risk evaluation

2.8 Environmental Performance Objectives/Outcomes, Standards and Measurement Criteria

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

2.9 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 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
- environmental performance outcomes 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 for oil pollution emergencies to respond to and monitor impacts
- environmental reporting requirements, including 'reportable incidents', are met
- appropriate stakeholder consultation is undertaken throughout the activity.

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

2.10 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 to relevant stakeholders electronically 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**.

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

Woodside proposes to develop and produce hydrocarbons from the Pyxis field, and further develop the Pluto and the Xena fields in Permit Area WA-34-L.

The Petroleum Activities Program will involve drilling and developing one Pyxis production well (PYA01), one Pluto infill production well (PL-PYA02) and two Xena infill production wells (XNA02 and XNA03), and performing subsea installation and pre-commissioning to enable hydrocarbons from these wells to be produced through the existing nearby Pluto field flowlines. If required, Woodside may also need to intervene, workover or re-drill the existing Pluto and Xena production wells (PLA01 to PLA07 and XNA01) and proposed production wells within Permit Area WA-34-L to monitor and maintain their integrity, and/or mechanically alter them as required.

An overview of the Petroleum Activities Program is provided in **Table 3-1**, with a generalised schematic of the Pyxis Hub development provided in **Figure 3-1**.

Table 3-1: Petroleum Activities Program overview

Item	Description
Permit Area	WA-34-L
Location	North West Shelf
Water depth	About 170 m to 990 m
Number of wells	• Pyxis Hub wells: one production well (PYA01); one infill production well (PL-PYA02) • Xena wells: two infill production wells (XNA02 and XNA03) • existing or approved wells: eight existing wells (PLA01, PLA02, PLA03, PLA04, PLA05, PLA06, PLA07 and XNA01)
Subsea infrastructure	***Pyxis Hub development*** • two production manifolds (PYA and XNA) • two subsea xmas trees • an approximately 14 km long, 12” flexible flowline • an approximately 10 km long, 10” flexible flowline • tie-in of flexible flowlines/jumpers between trees, production manifold and the Pluto flowline A tie-in point • approximately 24 km of control umbilical sections and associated subsea distribution units (SDUs) termination assemblies • interconnecting MEG supply jumpers • interconnecting HFLs and EFLs to provide hydraulic and electrical controls to the xmas trees. ***Xena Phase 2 and Phase 3 development*** • two subsea xmas trees • tie-in of flexible flowlines/jumpers between trees, production manifold and the Pluto flowline tie-in point • incremental control umbilical sections and associated SDUs complete with UTAs to support infill xmas trees • interconnecting HFLs and EFLs, to provide hydraulic and electrical controls to the xmas trees.
MODU	Options include a semi-submersible moored MODU, dynamically positioned (DP) drillship or DP MODU, depending on availability and suitability for the well locations.
Vessels	• installation vessels for installing the subsea infrastructure • light well intervention vessel as an option for well intervention, subsea installation or contingent activities • support vessels including barge(s), heavy lift vessel(s), multi-service construction vessel(s), anchor handling vessel(s) and general supply/support vessels.
Key activities	• development drilling, completions and unloading • installation and pre-commissioning of flowlines, production manifolds, UTAs, SDUs, HFLs, EFLs and MEG jumpers • tie-in to existing subsea infrastructure • pre-commissioning of the new subsea infrastructure • contingent intervention, workover, or re-drill for existing wells and new wells.

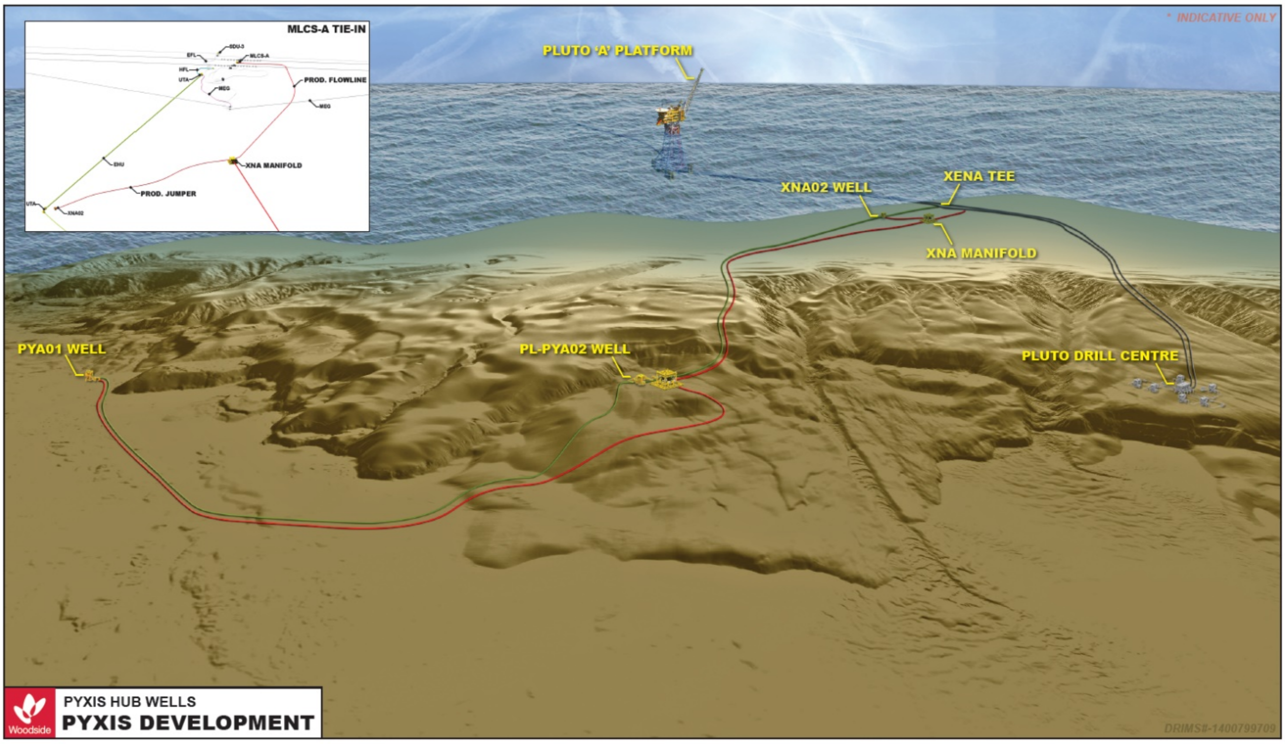


Figure 3-1: Generalised schematic of Pyxis Hub development (noting XNA03 not illustrated)

3.3 Location

The Petroleum Activities Program is located in Permit Area WA-34-L in Commonwealth waters about 175 km north-west of Dampier. The closest landfall to the Petroleum Activities Program is the Montebello Islands, about 50 km south-east at their closest point (**Figure 3-2**). Approximate location details for the Petroleum Activities Program are provided in **Table 3-2** with connections via subsea infrastructure (e.g. flowlines, umbilicals etc.). Proposed infrastructure locations are subject to refinement during detailed engineering but will be within defined Operational Area (**Section 3.3.1**).

Table 3-2: Approximate location for the Petroleum Activities Program

Activity	Water Depth (Approx. m LAT)	Latitude	Longitude
New wells			
PYA01 well	985 m	19°49'40.371”S	115°10'34.956”E
PL-PYA02 well	862 m	19°52'34.908”S	115°09'00.666”E
XNA02 well*	178 m	19°57'38.1659”S	115°13'10.1676”E
XNA03 well*	189 m	19°56'48.80”S	115°13'32.39”E
Subsea infrastructure			
PYA manifold**	844 m	19°52'46.2896”S	115°09’00.0179”E
XNA manifold**	182 m	19°57'52.6141”S	115°12’54.6816”E
Existing or approved wells			
PLA01 well	830 m	19°54'49.220”S	115°07'54.497”E
PLA02 well	830 m	19°54'48.226”S	115°07'54.151”E
PLA03 well	830 m	19°54'48.200”S	115°07'54.765”E
PLA04 well	830 m	19°54'48.566”S	115°07'55.798”E
PLA05 well	830 m	19°54'48.694”S	115°7'56.3530”E
PLA06 well	830 m	19°54'48.686”S	115°07'55.577”E
PLA07 well	830 m	19°54’47.584”S	115°07’55.000”E
XNA01 well	180 m	19°58'13.579”S	115°12'46.195”E

**The exact location of XNA02 and XNA03 infill wells are to be determined, although assumed to be within 2 km of the coordinates provided.*
*** The locations of the PYA and XNA Manifolds are approximate and subject to construction related optimisations.*

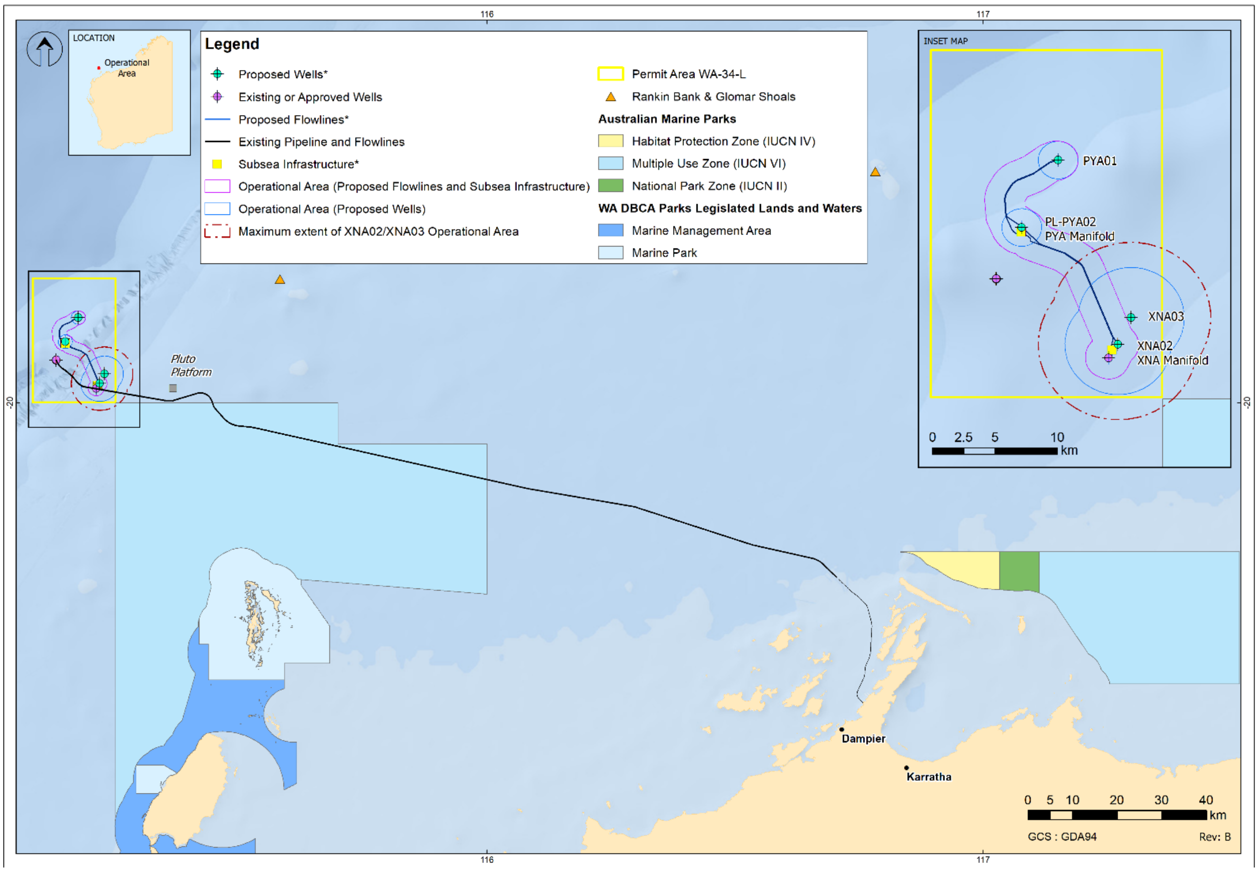


Figure 3-2: Location of Petroleum Activities Program

3.3.1 Permit Area and Operational Area

The spatial boundary of the Petroleum Activities Program has been described and assessed using two 'areas', the Operational Area and the Permit Area. The combination of the Operational Area and Permit Area defines the spatial boundary of the Petroleum Activities Program, as described, risk-assessed and managed by this EP, including vessel-related petroleum activities[4]

For the purposes of this EP, the following operational areas apply, which are referred to as a single Operational Area:

- For a dynamically positioned MODU/drillship, the Operational Area encompasses a radius of 500 m from each well centre, in which drilling-related petroleum activities will take place and will be managed under this EP.
- For a moored MODU, the Operational Area encompasses a radius of 4000 m from each well centre, in which drilling related petroleum activities will take place and will be managed under this EP. This increased Operational Area allows for temporary installation of moorings. An additional radius of 2000 m has been included around the proposed Xena well locations to allow for potential refinement of locations following detailed engineering design and optimisation of tophole locations.
- For the installation activities, the Operational Area encompasses a radius of 1500 m around subsea locations, in which subsea installation and pre-commissioning petroleum

[4] *Vessels supporting the Petroleum Activities Program operating outside of the Operational Area (e.g. transiting to and from port) are subject to all applicable maritime regulations and other requirements, which are not managed under this EP*

activities will take place and will be managed under this EP. The proposed route is subject to refinement following detailed engineering design but will be managed within the defined Operational Area.

The Operational Area for drilling activities includes a 500 m petroleum safety zone around the MODU to manage vessel movements. The 500 m petroleum safety zone is under the control of the MODU Person in Charge. The 1500 m (radius) Operational Area around subsea installation allows for the movement and positioning of large vessels.

The Permit Area for the purposes of this EP comprises the WA-34-L Permit Area plus a buffer of 4 km to incorporate the portion of the Operational Area that extends beyond the south east boundary of the Permit Area **(Figure 3-2**). The existing environment of the entire Permit Area plus the defined buffer is considered to provide context for the risk assessment. This approach facilitates assessing environmental risks and impacts for the entire scope, including development drilling, subsea installation and contingent activities on existing wells.

Although the maximum extent of the XNA02/XNA03 Operational Area (**Figure 3-2**) overlaps the north western corner of the Montebello Marine Park no petroleum activities will be undertaken within Australian Marine Parks.

3.4 Timing

The Petroleum Activities Program is planned to commence in Q1 2020 with the drilling of the Pyxis well (PYA01) and Pluto well (PL-PYA02) and related subsea installation. Drilling operations for the four production wells are expected to take about 70 days per well to complete, including mobilisation, demobilisation and contingency. Installation of subsea infrastructure and pre-commissioning is anticipated to commence when the relevant Pyxis Hub wells have been drilled, and is expected to have a cumulative duration of about 240 days (including mobilisation, demobilisation and contingency), and may be performed over multiple campaigns.

When underway, activities will be 24 hours per day, seven days per week. There are no planned concurrent drilling activities under the EP. Simultaneous Operations (SIMOPS) activities with subsea installation may occur. Timing and duration of all activities is subject to change due to project schedule requirements, MODU/vessel availability, unforeseen circumstances and weather.

The EP has risk-assessed drilling activities, subsea infrastructure installation, pre-commissioning activities and intervention, workover, or re-drilling activities throughout the year (all seasons) to provide operational flexibility for requirements and schedule changes and vessel/MODU availability.

3.5 Project Vessels

Several vessel types will be required to complete the activities associated with the Petroleum Activities Program. These are discussed in further detail in the following section and will include:

- MODU – In this EP, the term MODU refers to any mobile offshore drilling unit; options include a semi-submersible moored MODU, DP drillship or DP MODU, depending on availability and suitability for the well location (e.g. water depth). All MODU options are risk-assessed and managed under this EP.
- installation vessels for installing and pre-commissioning the flowlines, umbilical, MEG lines and other subsea infrastructure and hardware
- subsea support vessel for light well intervention (LWI) operations associated with contingent well intervention, subsea installation and other activities
- support vessels including:
  - Anchor Handling Vessels (AHVs) required to set anchors and support the MODU and the installation vessels during operations

- Heavy Lift Vessels (HLVs) for providing floating storage facilities to the installation vessels
- Activity Support Vessels for transporting hardware from port/staging area to the Operational Area and installation vessels, and for general re-supply and support for the MODU, HLV and installation vessels.

All project vessels, are subject to the Marine Offshore Assurance process and review of the Offshore Vessel Inspection Database (OVID). All required audits and inspections will assess compliance with the laws of the international shipping industry, which includes safety and environmental management requirements, and maritime legislation including *International Convention for the Prevention of Pollution from Ships 1973* as modified by the Protocol of 1978 (MARPOL) and other International Maritime Organization (IMO) standards.

A description and assessment of support vessel environmental impacts and risks, credible spill scenarios and environmental sensitivities for the activities within the scope of this EP are included in **Section 4**. Some support vessels may be required ad hoc to support periods of high activity and will be subject to the above processes.

For power generation, vessels may use diesel-powered generators and/or LNG. All vessels will display navigational lighting and external lighting, as required for safe operations. Lighting levels will be determined primarily by operational safety and navigational requirements under relevant legislation, specifically the *Navigation Act 2012*. The MODU and support vessels will be lit to maintain operational safety on a 24-hour basis.

3.5.1 MODU

The Petroleum Activities Program will be drilled by a MODU. This may be a moored or DP semi-submersible MODU. Typical specifications for these MODU types are provided in **Table 3-3** and **Table 3-4** respectively. These are collectively referred to as MODU for the remainder of the document, unless specific risks for different MODU types have been identified. Due to variabilities such as contractual and operational matters, the MODU used may be subject to change.

Table 3-3: Typical DP MODU specifications ranges for *Ensco DPS-1*

Component	Specification Range
Rig Type/Design/Class	Ultra deepwater semi-submersible MODU
Accommodation	200 persons (maximum persons on board)
Station Keeping	Dynamically positioned
Bulk Mud and Cement Storage Capacity	1000 m³
Liquid Mud Storage Capacity	2663 m³
Fuel Oil Storage Capacity	3640 m³
Drill Water Storage Capacity	3482 m³

Table 3-4: Typical moored MODU specifications ranges for *Ocean Apex*

Component	Specification Range
Rig Type/Design/Class	Semi-submersible MODU
Accommodation	120 to 200 persons (maximum persons on board)
Station Keeping	Minimum eight-point mooring system
Bulk Mud and Cement Storage Capacity	283 to 770 m³
Liquid Mud Storage Capacity	576 to 2500 m³
Fuel Oil Storage Capacity	966 to 1400 m³
Drill Water Storage Capacity	3500 m³

3.5.2 Installation Vessels

The Petroleum Activities Program subsea and flowline installation scopes of work may require various installation vessels, with sufficient capacity to accommodate hardware and equipment such as flowlines, flexible jumpers, umbilicals and the pre-commissioning/dewatering spreads.

A typical installation vessel for subsea and flowline installation would be a DP vessel (usually DP2 Class) equipped with a primary differential global surface positioning system (DGPS) and an independent secondary DGPS backup. The specification of a typical subsea installation vessel is provided in **Table 3-5**.

Installation vessels are typically equipped with various material handling equipment, which includes cranes, winches, remotely operated vehicles (ROVs) and ROV launch and recovery systems, vertical lay system (VLS) with either vertical reel drive or horizontal reel drive (carousel) and pre-commissioning spread.

Lifting operations may involve loading and unloading equipment from support and supply vessels onto the installation vessel and subsequently onto the seabed. Cranes are typically equipped with active heave compensation and auto tension, modes and have lifting capacities in excess of lifting loads expected to be encountered during operations.

Table 3-5: Typical DP2 Class subsea installation vessel for *Deep Orient*

Component	Specification Range
Vessel Type	DP2 Class as a minimum
Crane Capacity	250 T active heave compensation crane as minimum
ROVs	Two Work Class ROVs
Deck Space	Approximately 1900 m²
Deck Strength	Approximately 15 T/m²
Accommodation	Approximately 120 people
Fuel Oil	Approximately 2200 m³
Potable Water	Approximately 800 m³

3.5.3 Subsea Support Vessel for LWI Activities

During the Petroleum Activities Program, a subsea support vessel for LWI operations may be used as an option for contingent well intervention, subsea installation and other activities. An example of this vessel type is the *Sapura Constructor*, which is a 117 m long subsea support vessel equipped with a saturation dive system, two Work Class ROVs, well intervention equipment, a helideck, moon pool and accommodation for 120 persons. The final vessel selection, if required, will be subject to commercial and/or operational considerations.

3.5.4 Support and Other Vessels

During the Petroleum Activities Program, the MODU and installation vessel will be supported by other vessels, such as general support vessel(s), cargo vessel(s), anchor handling vessel(s), barges, multiservice construction and heavy lift vessel(s). During the installation campaign, there may potentially be two HLVs and two platform supply vessels for field support and floating storage facilities.

Support vessels are used to transport equipment and materials between the MODU/installation vessel and port (e.g. Dampier, Onslow, Exmouth). If required, one of the vessels may be at the MODU to perform standby duties, and others will make regular trips between the Operational Area to port for routine, non-routine and emergency operations.

Support vessels do not anchor within the Operational Area during the activities due to water depth; therefore, vessels will use DP.

The support vessels are also available to assist in implementing the Oil Pollution First Strike Plan, should an environmental incident occur (e.g. spills).

3.5.5 Vessel Mobilisation

Vessels may mobilise from the nearest Australian port or directly from international waters to the Operational Area, in accordance with biosecurity and marine assurance requirements.

3.6 Other Support

3.6.1 Remotely Operated Vehicles

The MODU, installation vessel and support vessels may be equipped with an ROV system that is maintained and operated by a specialised contractor aboard the vessel. ROVs may be used during drilling operations and subsea installation, for activities such as:

- anchor holding testing
- pre-drill seabed and hazard survey
- blowout preventer (BOP) land-out and recovery
- BOP well control contingency
- visual observations at seabed during riserless drilling operation
- pre and post installation survey
- horizontal subsea xmas tree control systems hook-up and contingency control
- installation, testing and pre-commissioning of subsea infrastructure.

An ROV can be fitted with various tools and camera systems that can be used to capture permanent records (both still images and video) of the operations and immediate surrounding environment. Specifically, during installation, the ROV will be fitted with hydraulically driven tools to facilitate flowline tie-in.

An ROV may also be used in the event of an incident to deploy the Subsea First Response Toolkit. This is discussed further in **Appendix D**.

3.6.2 Helicopters

During the Petroleum Activities Program, crew changes will be performed using helicopters as required. Helicopter operations within the Operational Area are limited to helicopter take-off and landing on the helideck. Helicopters may be refuelled on the helideck. This activity will take place within the Operational Area and has been included in the risk assessment for this EP.

3.7 Project Vessel-based Activities

3.7.1 Holding Station: Mooring Installation and Anchor Hold Testing/Soil Analysis

Mooring uses a system of chains/wires and anchors, which may be pre-laid before the MODU arrives at the location, to maintain position when drilling. A mooring analysis will be performed to determine the appropriate mooring system for the Petroleum Activities Program. The mooring analysis will identify whether the mooring system will be pre-laid or set by the MODU, define proof tension values, and evaluate whether synthetic fibre mooring ropes are required. A pre-laid system can generally withstand higher sea states compared to a system that only uses the MODU's mooring chain/equipment and can also save the time in establishing anchors.

Installation and proof tensioning of anchors involves some disturbance to the seabed. Anchor handling vessels are used to deploy and recover the mooring system.

As part of mooring preparations, anchor hold testing may be conducted at the well locations. Anchor hold testing would be performed if Woodside determines that further assurance is required to ensure a robust mooring design.

Anchor hold testing may consist of an AHV or similar vessel dropping an anchor at a potential mooring location. The AHV would then tension the anchor to determine its ability to hold, embed and not drag at the location. This may have to be repeated several times at each location. An ROV may also be used to judge how deep the anchor has embedded and independently verify the seabed condition. Anchor hold testing activities would before the MODU arrives on location.

Soil analysis may also be necessary to provide data on composition and rock/substrate strength as input into the mooring design and verify seabed conditions for anchor holding. Soil analysis could include taking a physical sample of the seabed using ROV or other tools or using measuring devices such as a cone penetrometer. These tests would be performed up to several months before the MODU arrives on location and may occur from a support vessel or AHV.

Suction piling may be required as a contingent activity, and will be reviewed with the MODU contractor.

3.7.2 Holding Station: Dynamic Positioning (DP MODU only)

DP uses satellite navigation and radio transponders in conjunction with thrusters to maintain the position of the MODU at the required location. Information about the position of the MODU is provided via a number of seabed transponders, which emit signals that are detected by receivers on the MODU and used to calculate position. The transponders are typically deployed in an array on the seabed, using clump weights comprising concrete, for the duration of the drilling at each well, and are recovered at the end, generally by ROV. Clump weights are recovered if practicable to do so or may be left in-situ.

3.7.3 MODU and Support Vessel Activities

A variety of materials are routinely bulk transferred from support vessels to the MODU including drilling fluids (e.g. muds), base fluids, cements and drill water. A range of dedicated bulk transfer stations and equipment are in place to accommodate the bulk transfer of each type of material. There is also a capacity to bulk transfer waste oil from the MODU to the support vessel, for back-loading and disposal on shore.

The loading and back-loading of equipment, materials and wastes is one of the most common supporting activities conducted during drilling programs. Loading and back-loading is performed using cranes on the MODU to lift materials in appropriate offshore rated containers (e.g. ISO tanks, skip bins, containers) between the MODU and support vessel.

Seawater is pumped on board and used as a heat exchange medium for cooling machinery engines and high temperature drilling fluid on the MODU. It is subsequently discharged from the MODU at the sea surface at potentially a higher temperature. Alternately, MODUs may use closed loop cooling systems.

Potable water, primarily for accommodation and associated domestic areas, may be generated on vessels using a reverse osmosis plant. This process will produce brine, which is diluted and discharged at the sea surface.

The MODU and support vessels will also discharge deck drainage from open drainage areas, bilge water from closed drainage areas, putrescible waste and treated sewage and grey water. Solid hazardous and non-hazardous wastes generated during the Petroleum Activities Program are disposed of onshore by support vessels.

3.7.4 Subsea Installation and Support Vessel Activities

An installation vessel may be used for various activities such as pre and post installation survey, installation of subsea structures, installation of main and in-field flowline and electro-hydraulic umbilical (EHU), installation of interconnecting HFL, EFL and MEG jumper, tie-in to existing infrastructure, and pre-commissioning activities.

To support the installation vessel activities, HLVs may store equipment and hardware for direct loading/offloading to the installation vessel. Other support vessels may also be used to transport equipment, hardware and MEG from shore or HLV to the installation vessel.

3.7.5 Refuelling

The MODU will be refuelled via support vessels approximately once a month, or as required. Refuelling will occur within the Operational Area of the well being drilled at the time and has been included in the risk assessment for this EP. Other fuel transfers that may occur on board the MODU may include refuelling of cranes, helicopters or other equipment as required.

As the base case, refuelling of installation vessels is planned to occur outside of the Operational Area during interim mobilisation/demobilisation.

3.8 Drilling Activities

Well construction activities are conducted in a number of stages, as described below. Detailed well designs will be submitted to the Well Integrity department of NOPSEMA as part of the Approval to Drill and the accepted Well Operation Management Plan (WOMP), as required under the *Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011.*

3.8.1 Cement Unit Test

Upon arrival on location at the Operational Area, the MODU may need to perform a cement unit test, or ‘dummy cement job’, to test the functionality of the cement unit and the MODU’s bulk cement delivery system before performing an actual cement job. This operation is usually performed after a MODU has been out of operation for an amount of time (warm-stack), if maintenance on the cement unit has been performed, or if it is the first time a MODU is being used in-country and commissioning of the cement unit system is required.

A ‘dummy cement job’ involves mixing a sacrificial cement slurry at surface, and once functionality of the cement unit and delivery system has been confirmed, the slurry is discharged through the usual cement unit discharge line (which may be up to 10 m above the sea level) or through drill pipe below sea level, and occur as a cement slurry. The slurry is usually a mix of cement and water; however, may sometimes contain stabilisers or additives.

3.8.2 Top Hole Section Drilling

Petroleum Activities Program drilling commences with the top hole section as follows:

- The MODU arrives and establishes position over the well site.
- A pilot hole or holes may be drilled close to the intended well location. Pilot holes are used when geology and shallow hazards need to be confirmed or further understanding of the structural integrity of the rock is required. Pilot holes are drilled riserless, as described below, and result in additional cuttings, sweeps and potentially mud deposition to seabed.
- Top-hole sections are drilled riserless using seawater with pre-hydrated bentonite sweeps/XC Polymer sweeps or drilling fluids to circulate drilled cuttings from the wellbore.
- Once the top hole sections of the well have been drilled, steel tubulars (called conductor or casing) are inserted into the wellbore to form the surface/intermediate casing, and secured in place by pumping cement into the annular space back to about 300 m above the casing shoe or to surface (seabed), which will involve discharging excess cement at the seabed.
- At some well locations, top hole section drilling may be done using the batch drilling process. Batch drilling is where a number of wells are drilled together and the same section of each hole is drilled one after another, before going back and drilling the next section of each well until the target depth is reached for each well.

3.8.3 Blowout Preventer and Marine Riser Installation

After setting the surface or intermediate casing, a BOP is installed on the wellhead, and the marine riser above it, to provide a physical connection between the well and MODU. This enables a closed circulation system to be maintained, where weighted drilling fluids and cuttings can be circulated from the wellbore back to the MODU, via the riser.

In addition, the BOP provides a means for sealing, controlling and monitoring the well during drilling operations. The BOP components operate using open hydraulic systems, using water-based BOP control fluids. Each time the BOP is operated (including pressure testing approximately every 21 days and a function test about every seven days, excluding the week a pressure test is conducted), the maximum volume of BOP control fluid that will be released to the marine environment per well is up to about 90 L.

Hydraulic fluid used for operating the BOP rams is subject to the chemical assessment process outlined in **Section 3.10**.

3.8.4 Bottom Hole Section Drilling

A closed system (riser in place), is used for drilling bottom hole sections to the planned wellbore Total Depth (TD). The preference is for bottom hole sections to be drilled using water-based mud (WBM) drilling fluids, however non water-based mud (NWBM) may be used (**Section 3.10**).

Protective steel tubulars (casings and liners) are inserted as required. The size, grade, weight, length and inclination of the casing/liner sections within the wellbore are determined by factors such as the geology/subterranean pressures likely to be encountered in the area and any specific information or resource development requirements.

After a string of casing/liner has been installed into the wellbore, it is cemented into place. The casing/liner is then pressure tested. Once the pressure testing is passed, drilling of the next section can resume with the riser in place to circulate drill cuttings and drilling fluids back to the MODU.

Cementing operations are also performed to:

- provide annular isolation between hole sections and structural support of the casing/liner as required
- set a plug in an existing well to sidetrack
- plug a well so it can be suspended/abandoned.

Cement is transported as dry bulk to the MODU by the support vessels, mixed as required by the cementing unit on the MODU and pumped by high pressure pumps to the surface cementing head then directed down the well.

Excess cement (dry bulk) after well operations are completed, will either be held onboard and used for subsequent wells, provided to the next operator at the end of the program, or discharged to the marine environment. Excess cement that does not meet technical requirements during the Petroleum Activities Program may also be bulk discharged to the environment. Bulk discharges of cement may occur as a slurry through the usual cement discharge line or blown as dry bulk and discharged.

3.8.5 Formation Evaluation

Formation evaluation is the interpretation of a combination of measurements taken inside a wellbore to detect and quantify hydrocarbon presence in the rock adjacent to the well once TD is reached. Formation Evaluation While Drilling (FEWD) is the process by which the presence and quantity of hydrocarbon in a reservoir is measured according to its response to radioactive and electrical input. It may include extracting small cores, wireline logging, full diameter cores and other down-hole technologies, as required. FEWD tools will be incorporated into the drillstring during development drilling and may include Gamma Ray, Directional Deep resistivity, callipers, density-neutron, Sonic and tools which can measure formation pressures. Some FEWD tools contain radioactive sources; however, no radioactive material will be released to the environment and radiation fields are not generally detectable outside the tool when the tool is not energised. Therefore, they do not present an environmental risk.

3.8.6 Wellbore Clean Out

As required throughout activities with the riser connected, wells will be displaced from one drilling fluid system to another, or from the drilling fluid system to completion brine. A chemical clean-out pill or fluids train will be circulated between the two fluids. This will result in a discharge of operational fluids in accordance with Woodside's internal guidelines to ensure the potential impacts of the chemicals selected are acceptable, ALARP and meet Woodside's expectation for environmental performance.

Clean-out fluids and completion brine will be captured and stored on the MODU and discharged if oil concentration is <1% by volume, or returned to shore if discharge requirements cannot be met.

3.8.7 Xmas Tree Installation/Tubing Head Spool Installation

Before the upper completion is installed into the wells, the xmas trees and flow base/tubing head will be installed from an installation vessel in SIMOPS with the MODU, or directly from the MODU. Due to the subsea well layout, if installation was to occur from the installation vessel, the MODU will be required to kedge off or reposition away from the drill centre to allow the installation vessel to install the xmas trees and flow base/tubing head. Once the xmas trees and flow base/tubing head have been installed, they will be pressure-tested to confirm integrity before the MODU BOP is reconnected to continue with drilling and completions activities.

The xmas trees and flow base/tubing head will be installed with a preservation mixture in the production and annulus bores.

3.8.8 Completions Activities

Once a well has been drilled, well completion activities will be performed including installation of the lower completion, intermediate completion, production tubing and subsea tree and/or tubing head spool. The well is then pressure-tested for integrity before well unloading and suspension.

The wells will be completed with a conventional upper completion. After unloading, the well will be suspended with a gas column and two crown plugs installed in the tubing hanger. Crown plugs will be individually pressure-tested to verify suspension barriers before removing the BOP.

3.8.9 Well Unloading

3.8.9.1 General Description

During well unloading activities, all completion and reservoir fluids will be flared or discharged to the environment via the well test package. The base oil column, completion fluid, hydrocarbons and produced/condensed water will be measured, handled, separated, treated for overboard discharge (non-hydrocarbon) and flared/burned (hydrocarbon) through the temporary production system on the MODU.

3.8.9.2 Produced/Reservoir Water Disposal

The well test water treatment package will be used to treat produced/reservoir water before discharge. Prior to discharging, the fluids are cycled through an oilbond filtration system and gauge tank. Water filtration is standard practice for well unloading operations. Fluids that cannot be treated or flared will be sent onshore for disposal.

3.8.9.3 Emissions

During well unloading it is expected that condensate, diesel and methanol in the wellbore will be flared. The flare may be extinguished due to water ingress, lack of fuel (propane), weather impact or equipment failure resulting in cold venting of gas from the flare for several minutes.

3.9 Subsea Installation and Pre-commissioning Activities

3.9.1 Existing Subsea Infrastructure

The main components of the existing subsea infrastructure of the Pluto and Xena gas fields include:

- a 36” export trunkline
- two 20” interfield flowlines between manifold and facility
- a 6” chemical supply line from shore to the facility, and the 4” chemical supply lines from the facility to the wells
- xmas trees/well
- manifolds/drill centres
- spools
- electric and hydraulic jumpers
- flexible flowlines
- umbilicals
- risers
- flowline termination assembly

- mid-line connection structures
- pigging manifold
- non-return valve
- Xena tie-in.

3.9.2 Proposed Subsea Infrastructure

The subsea installation scope of work may include installing and pre-commissioning the infrastructure summarised in **Table 3-6**. The Petroleum Activities Program includes directly installing flowlines and infrastructure from the installation vessel in the relevant location. During hook-up and pre-commissioning of the new and existing facilities there will be potential for small discharges associated with the testing and connection activities of the subsea systems.

Wet storage of infrastructure items may be required during installation. During the wet storing period, the internal volumes of subsea equipment will be preserved and protected with inhibition fluids.

Table 3-6: Subsea installation component summary

Description	Detail	Dimensions (approx.) L × W × H
Pyxis Hub development		
Wells	Xmas tree	5 × 4 × 4 m
	Tree cap	3 × 3 × 3 m
Subsea manifolds	PYA production manifold	6 × 4 × 4 m
	XNA production manifold	6 × 4 × 4 m
Subsea flowlines	12” flexible flowline between PYA to XNA manifolds	Up to ~14 km in length
	10” flexible flowline between PYA manifold to PYA01 xmas tree	Up to ~10 km in length
	Flexible flowline/jumper(s)	Up to ~1000 m in length
	MEG jumper(s)	Up to ~500 m in length
Subsea control	Main umbilical	Up to ~14 km in length
	Infield umbilical	Up to ~10 km in length
	Various EFLs	Up to ~200 m in length
	Various HFLs	Up to ~150 m in length
Subsea structures	Manifold mudmats	12 × 11 × 2 m
	SDUs and UTAs mudmats	5 × 4 × 2 m
Xena Phase 2		
Well	Xmas tree	5 × 4 × 4 m
Subsea flowline	Flexible flowline between xmas tree and Pyxis-supplied manifold	Up to ~1000 m in length
Subsea control	Various EFLs and HFLs	Up to ~150 m in length
	Subsea service umbilical	Up to ~1 km in length
Subsea structures	Up to three crossings: umbilical crossing MEG line, flowline crossing umbilical line, flowline crossing MEG line	
	Potential SDUs and UTAs mudmats	5 × 4 × 2 m

Note: Xena Phase 3 infrastructure is expected to be of similar magnitude to that required for Xena Phase 2, subject to further engineering.

3.9.3 Pre-lay Survey

The flowline installation contractor may perform a pre-lay survey before starting the flowline installation. The pre-lay survey may be performed by a dedicated pre-lay survey vessel, which is typically similar in size to support vessels or potentially the installation vessel.

The pre-lay survey is a debris and hazard identification survey and not a full geophysical survey along the pre-determined route or proposed design route. A number of site surveys have already been performed and it is not anticipated that any debris will need to be removed before flowline installation. If required, these activities will fall under this EP and will be performed by an installation vessel, or alternatively, a support vessel or similar.

The pre-lay survey usually uses a side scan sonar fish towed behind the pre-lay survey vessel, designed to tow cleanly and with stability, and typically incorporates a safety line for emergency recovery. The towfish side scan sonar system is a compact high definition side scan sonar system designed for a wide range of seabed survey and inspection duties. The survey methods are non-intrusive and the equipment, under planned operation, will not disturb the seabed. Information is transferred to the vessel via an umbilical. The pre-lay survey may also be performed with an ROV or autonomous underwater vehicle using side scan sonar.

A multi-beam echo sounder (MBES) may also be used and is a common survey tool for offshore surveys. MBES uses a technique of sound pulses to establish the profile of the seabed. Most systems work by transmitting a broad acoustic pulse from a hull or pole-mounted transducer.

3.9.4 Underwater Acoustic Positioning

An array of long base line (LBL) transponders may be installed on the seabed as required to support drilling activities. The LBL array provides accurate positioning by measuring ranges to three or more transponders deployed at known locations on the seabed and structures.

An array of transponders is proposed within a radius of 300 m from the proposed location of infrastructure and will be in place for a period of approximately three months per well. Transmissions are not continuous but consist of short ‘chirps’ with a duration that ranges from 3 to 40 milliseconds. Transponders will not emit any sound when on standby and are planned to only be actively emitted sound for approximately 6 hours per well. When required for general positioning they will emit one chirp every five seconds (estimated to be required for four hours at a time). When required for precise positioning they will emit one chirp every second (estimated to be required for two hours at a time).

The LBL transponder may be moored to the seabed either by a clump weight or mounted on a seabed frame. The standard clump weights, made of bio-degradable cement, used will likely weigh about 80 kg. A typical seabed frame is 1.5m x 1.5m x 1.5m in dimension and weighs about 40kg. On completion of the positioning operation, the array transponders moored by clump weight are recovered by means of a hydrostatic release, which leaves the clump weight on the seabed. The transponders mounted on seabed frames will be removed by ROV.

3.9.5 Sediment, Mobilisation and Relocation

Sediment mobilisation and relocation techniques such as jetting, and mass flow excavation etc. may also be used to support subsea installation, such as to create a short corridor to submerge flowlines and umbilicals for crossings. Based on current engineering a flowline crossing is proposed between PYA01 and the PYA manifold at the base of the continental slope.

3.9.6 Installation of Supporting Structure

If required, supporting structures (e.g. mudmats, fixed datum points) will be installed by the installation vessel or pre-lay survey vessel before commencing or post flowline installation.

Manifold/UTA/SDU structures will be installed by the installation vessel. These structures will be loaded to the installation vessel during mobilisation or interim mobilisation. Each manifold will be installed with its associated mudmat, where SDU and UTA mudmat can potentially be installed separately.

Transponder(s) will be fitted on each structure before deployment. Structures will be deployed using the installation vessel's main crane to a pre-determined depth before engaging the ROV to guide it to the correct position. The structures will be positioned accurately on the seabed using the installed LBL array or USBL.

Additional pre-deployed clump weights can potentially be used to provide further assurance that the structure will be positioned in the correct location and orientation. These clump weights will be recovered post installation.

3.9.7 Flowline Initiation/Initiation Anchor Deployment

Commencement of the flowline installation generally requires using an initiation anchor to pull against in order to provide the required tension to the flowline as it transitions from the installation vessel to the seabed. The initiation anchor may consist of a suction pile, drag anchor or clump weight/dead-man anchor.

Anchoring, consisting of a concrete mattress or similar structure, may also be required during installation of the flowline along the continental slope.

3.9.8 General Flowline and EHU Installation

The installation contractor will mobilise an installation vessel to the field to install the flowlines, jumpers and EHU sections to the seabed. The installation vessel will operate in DP throughout the campaign.

Optimum flowline and umbilical routes will be selected by considering seabed bathymetry, pre-installation surveys and installation risk management, including dropped object risks and buckling/walking impacts. Due to the water depth, both flowline and EHU will be installed using a vertical lay system. This method will be used for the entire length of the flowline and EHU. Along the continental slope this method will be used to install both the flowline and EHU in a perpendicular direction.

The indicative installation methodology and principle applied when installing the flowline and EHU, is as follows:

1. Both flowline and EHU will be reeled onto either horizontal or vertical reels.
2. VLS will be installed on the vessel to lay both flowline and EHU.
3. During installation, a hydraulically driven centre reel drive will be engaged to the reel to rotate the reel in synchronised speed with the VLS.
4. Installation sequence for flowline is as follows, noting similar principle for the EHU, except that there is no midline connection:
    a. Prepare universal connection system and VLS onboard the vessel.
    b. Fit applicable subsea components (anodes, bend restrictors) to flowline, perform tests and pre-deployment checks.
    c. Deploy flowline, crane and connect ROV to tail end.
    d. Continue flexible flowline lay as per lay route while monitoring touchdown with ROV.
    e. Complete flowline reel change-over and midline connections when required until the total length of flowline has been laid to its connection point on the manifold.

f. Short flexible sections of flexible flowline and/or jumpers for Xena (in shallow water) may be installed using a lighter installation spread on the installation vessel, via a deck-mounted powered reel system in combination with a deployment chute mounted on the side of the installation vessel and temporary installation aids placed on the seabed.

3.9.9 General HFL, EFL and Jumper Installation

The Petroleum Activities Program includes installing new subsea components that will tie in the proposed production wells to the existing infrastructure of the Pluto and Xena gas fields as listed in **Table 3-6**. The HFLs and EFLs will be configured into deployment basket(s) and landed on the seabed using a crane. ROVs will complete the final subsea tie-in. Jumper(s) will be deployed and installed as per **Section 3.9.8**. Any existing jumpers that are replaced will be recovered using the same technique as installation but in reverse sequence.

3.9.10 Span/Scouring Rectification and Stabilisation

Spans are undulations in the seabed that do not provide sufficient support to the flowline. Spans are generally mitigated by installing structures, such as concrete mattresses, before installing the flowline. However, the flowline has been engineered, based on geophysical and geotechnical surveys, to avoid seabed features, where practicable. Initial outcomes identify that there are no requirements for pre-span rectification, including along the continental slope. Engineering validation will determine if span rectification is needed.

Scouring is the movement of seabed sediment (e.g. silt, sand and gravel) from around the base of the subsea structure to further afield due to prevailing hydrodynamic conditions, compromising the integrity of a structure. Scouring is generally mitigated by installing mattresses along the perimeter of the installed structure. Concrete mattresses are planned to be installed on one of the production manifolds; however, further engineering validation may dictate the same requirement for others.

The dimensions for each concrete mattress are typically 12 m by 3 m. The concrete mattresses will be transported either directly by installation vessel or by a support vessel to the installation vessel on site or during mobilisation for installation. The mattresses will be lifted off the installation vessel and lowered to the seabed by the vessel's main crane. The ROV from the installation vessel will be used to orientate the mattresses during installation.

Post-lay span rectification may also be required after flowline installation. This process typically involves placing grout bags under the span section. The empty bag is moved into position using ROV, then filled with grout supplied from a mixing and pumping spread on the vessel via a downline. Typical grout volumes depend on the size of the span and may vary from about 200 kg to 2000 kg per span. Concrete mattresses may also be used for post-lay span rectification, with the dimensions of mattresses and the process for installation likely to be similar to those described above for pre-lay span rectification.

If grout bags are used, the downline recovery time risks exceeding the grout curing time. If grout cures within the downline and pump, the equipment is likely to be rendered unserviceable, as well as the downline not being safely recoverable in the normal way. Therefore, after grouting activities at each span site, the downline and pump will need to be purged using seawater. This results in an amount of grout, approximately equivalent to the downline volume (5 m^3), being discharged to the ocean. This flushing is required once per grout site. The actual number is not known until the line is laid and need for span rectification determined, if any.

Stabilisation is a post lay activity to ensure light items, such as HFL, EFL and jumpers, remain at their installed positions; i.e. not being shifted due to strong sea bed current. Stabilisation is generally mitigated by installing sand bags on top of HFLs, EFLs and jumpers at a predetermined distance apart. Sand bags generally come in a standard size with 20 kg to 25 kg weight.

3.9.11 Flood, Clean, Gauge and Hydrotesting Pressure Testing

Pressure testing is performed to test the integrity of subsea infrastructure, test isolations and identify any leaks. Pressure is usually applied to the component from the Pluto facility but can also be applied via a downline from a support vessel. Failure of testing equipment or integrity of the tested infrastructure may lead to a loss of hydrotest fluids to the marine environment.

All chemicals used in flood, clean and gauge testing (FCGT) activities will be subject to the chemical selection assessment process described in **Section 3.10.1**.

3.9.11.1 Flooding

All production flexible flowlines will be installed filled with chemically treated 50 wt% MEG/water. All flexible jumpers will be installed filled with chemically treated 90 wt% MEG/water. The MEG concentration must be Fibre-grade (99.9 wt%) before mixing with water. All production flexible flowlines will not require further flooding post installation.

3.9.11.2 Hydrotesting

A leak test/system pressure test will be performed to confirm the integrity of subsea connections, flowlines, spools and jumpers as required by DNVGL-ST-F101 and API-RP-17B.

3.9.11.3 Cleaning, Gauging and Dewatering

Production flexible flowlines and jumpers will not be dewatered and inerted after installation, except for the main 12” production flexible flowline. As it is pre-flooded with chemically treated 50 wt% MEG pre-lay, a single bi-directional pig will be used, propelled by N2 gas to displace the fluid. The pig train may consist of bi-directional pigs if required.

The pig runs will discharge the MEG subsea. As treated seawater will separate each pig in the train, it is estimated an additional ~1% of the line volume will also be discharged. About 20% over-pumping is required to ensure the pig train has successfully arrived at the pig receiver; therefore, this amount will also require discharge. The estimated discharge volumes including chemical additives are shown in **Table 6-3**. There is also potential that some debris remaining from flowline installation activities within the line may be discharged with this water.

The direction of pig run and associated discharge locations will be determined through detailed engineering.

After the FCG/inline inspection pigging is completed, the flowline is left filled with nitrogen in preparation for hydrocarbon commissioning. The flowline end termination valves will be closed and the pig launchers/receivers will be removed.

3.9.12 Preservation Post Subsea Connection Break Out

During tie-in and pre-commissioning activities, any subsea connection break-outs will be preserved with chemical sticks.

3.9.13 EHU

The EHU cores will be pressurised at loadout and the pressure will be monitored throughout the lay. After laydown of each EHU section, the cores may be pressure-tested and the electrical and fibre optics subject to testing. Before connecting to the existing system, pressure will be checked to match existing system pressure.

The flying leads will be connected between the UTAs, manifold and to the xmas trees. This system will be subject to further pressure-testing and electrical and fibre optic continuity and signal tests.

3.9.14 Pre-commissioning of Subsea Infrastructure

The pre-commissioning associated with subsea infrastructure generally includes subsea control systems verification and function testing of valves to verify that the subsea umbilicals, electric and hydraulic flying leads are ready for entry into the commissioning phase.

3.10 Project Fluids

3.10.1 Assessment of Project Fluids

All chemicals that may be operationally released or discharged to the marine environment by the Petroleum Activities Program are evaluated using a defined framework and set of tools to ensure the potential impacts are acceptable, ALARP and meet Woodside's expectation for environmental performance.

All approved drilling and completion chemicals are included on the Drilling and Completions – Master Chemical List which is reviewed during a six-month chemical review to drive continuous environmental improvement.

The chemical assessment process follows the principles outlined in the Offshore Chemical Notification Scheme (OCNS) which manages chemical use and discharge in the United Kingdom (UK) and the Netherlands. It applies the requirements of the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention). The OSPAR Convention is widely accepted as best practice for chemical management.

All chemical substances on the OCNS ranked list of registered products have an assigned ranking based on toxicity and other relevant parameters, such as biodegradation and bioaccumulation, in accordance with one of two schemes (as shown in **Figure 3-3**):

1. Hazard Quotient (HQ) Colour Band: Gold, Silver, White, Blue, Orange or Purple (listed in order of increasing environmental hazard), or
2. OCNS Grouping: E, D, C, B or A (listed in order of increasing environmental hazard). Used for inorganic substances, hydraulic fluids and pipeline chemicals only.

Hazard Quotient Colour Band	Gold	Silver	White	Blue	Orange	Purple
OCNS Grouping	E	D	C	B	A	
	Lowest Hazard →				Highest Hazard	

Figure 3-3: OCNS ranking scheme

Chemicals fall into the following assessment types:

- No further assessment: Chemicals with an HQ band of Gold or Silver or an OCNS ranking of E or D with no substitution or product warnings do not require further assessment. Such chemicals do not represent a significant impact on the environment under standard use scenarios and are therefore considered ALARP and acceptable.
- Further assessment/ALARP justification required: The following types of chemicals require further assessment to understand the environmental impacts of discharge into the marine environment:
  - chemicals with no OCNS ranking
  - chemicals with an HQ band of White, Blue, Orange or Purple or an OCNS ranking of A, B or C

- chemicals with an OCNS product or substitution warning.

3.10.1.1 Further Assessment/ALARP Justification

This includes assessing the ecotoxicity, biodegradation and bioaccumulation of the chemicals in the marine environment in accordance with the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) Hazard assessment and the Department of Mines and Petroleum (DMP) Chemical Assessment Guide: *Environmental Risk Assessment of Chemicals used in WA Petroleum Activities Guideline.*

Ecotoxicity

Chemical ecotoxicity is assessed using the criteria used by CEFAS to group chemicals based on ecotoxicity results (**Table 3-7**). If a chemical has an aquatic or sediment toxicity within the criteria for the OCNS grouping of D or E, this is considered acceptable in terms of ecotoxicity.

Table 3-7: CEFAS OCNS grouping based on ecotoxicity results

Initial grouping	A	B	C	D	E
Results for aquatic-toxicity data (ppm)	<1	>1-10	>10-100	>100-1000	>1000
Result for sediment toxicity data (ppm)	<10	>10-100	>100-1000	>1000-10,000	>10,000

Note: Aquatic toxicity refers to the Skeletonema constatum *EC_{50},* Acartia tonsa *LC_{50} and* Scophthalmus maximus *(juvenile turbot) LC_{50} toxicity tests; sediment toxicity refers to* Corophium volutator *LC_{50} test.*

Biodegradation

The biodegradation of chemicals is assessed using the CEFAS biodegradation criteria, which aligns with the categorisation outlined in the DMP Chemical Assessment Guide: *Environmental Risk Assessment of Chemicals used in WA Petroleum Activities Guideline.*

CEFAS categories biodegradation into the following groups:

- Readily biodegradable: results of >60% biodegradation in 28 days to an OSPAR harmonised offshore chemical notification format (HOCNF) accepted ready biodegradation protocol.
- Inherently biodegradable: results >20% and <60% to an OSPAR HOCNF accepted ready biodegradation protocol or result of >20% by OSPAR accepted inherent biodegradation study.
- Not biodegradable: results from OSPAR HOCNF accepted biodegradation protocol or inherent biodegradation protocol are <20%, or half-life values derived from aquatic simulation test indicate persistence.

Chemicals with >60% biodegradation in 28 days to an OSPAR HOCNF accepted ready biodegradation protocol are considered acceptable in terms of biodegradation.

Bioaccumulation

The bioaccumulation of chemicals is assessed using the CEFAS bioaccumulation criteria, which aligns with the categorisation outlined in the DMP Chemical Assessment Guide*: Environmental Risk Assessment of Chemicals used in WA Petroleum Activities Guideline.*

The following guidance is used by CEFAS:

- Non-bioaccumulative: LogPow <3, or BCF ≤100 and molecular weight is ≥700.
- Bioaccumulative: LogPow ≥3 or BC >100 and molecular weight is <700.

Chemicals that meet the non-bioaccumulative criteria are considered acceptable.

If a product has no specific ecotoxicity, biodegradation or bioaccumulation data available, the following options are considered:

- Environmental data for analogous products can be referred to where chemical ingredients and composition are largely identical.
- Environmental data may be referenced for each separate chemical ingredient (if known) within the product.

Alternatives

If no environmental data is available for a chemical or if the environmental data does not meet the acceptability criteria outlined above, potential alternatives for the chemical will be investigated, with preference for options with an HQ band of Gold or Silver, or OCNS Group E or D with no substitution or product warnings.

If no more environmentally suitable alternatives are available, further risk reduction measures (e.g. controls related to use and discharge) will be considered for the specific context and implemented where relevant to ensure the risk is ALARP and acceptable.

Decision

Once the further assessment/ALARP justification has been completed, the relevant environment adviser must concur that the environmental risk as a result of chemical use is ALARP and acceptable.

3.10.2 Drilling Fluid System

3.10.2.1 Water Based Mud System

The Petroleum Activities Program will use a water drilling fluid system as the preferred option.

In addition to the base fluid, drilling muds contain a variety of chemicals, incorporated into the selected drilling fluid system to meet specific technical requirements (e.g. mud weight required to manage pressure, or for borehole stability). All chemicals selected for use have been assessed under Woodside's internal guidelines to ensure potential impacts are acceptable, ALARP and meet Woodside's expectation for environmental performance.

The WBM drilling fluid will either be mixed on the MODU or received pre-mixed, then stored and maintained in a series of pits aboard the MODU. The top hole sections will be drilled riserless with seawater containing pre-hydrated gel sweeps, and cuttings and drilling fluids returned to the seabed. The bottom hole sections may be drilled using WBM in a closed circulation system which enables reuse of the WBM drilling fluids.

WBM drilling fluids that cannot be reused (e.g. due to bacterial deterioration or do not meet required drilling fluid properties) or are mixed in excess of required volumes, may be operationally discharged to the ocean under the MODU's Permit to Work (PTW) system. Opportunities to reuse the WBM drilling fluids at the end of the Petroleum Activities Program are reviewed across current Woodside drilling activities.

WBM may not be able to be reused between drilling sections due to the drilling sequence, technical requirements of the mud (i.e. no tolerance for deterioration of mud during storage) and maintenance of productivity/injectivity.

A number of factors unique to each drilling program will determine the quantities of WBM drilling fluids required and subsequent discharge volumes if no suitable reuse option is available.

3.10.2.2 Non-water Based Mud System

The decision to use NWBM drilling fluids for the bottom hole sections of a particular well is based on a variety of technical factors relevant to wellbore conditions, such as well temperature, well shape and depth, reactivity of the formation to water and well friction. The technical justification to use NWBM includes environment, health, safety and waste management considerations.

The use of NWBM drilling fluids is subject to a formal written commercial and/or technical justification approved in accordance with the Best Practice – Overburden Drilling Fluids Environmental Requirements. The main ingredient of NWBM is base oil, and similar to a WBM system, a range of standard solid and liquid additives may be added in the pits to alter specific mud properties for each section of the well, dependent on the conditions encountered while drilling. Where NWBM is used, the base oil will be a Group III oil (Saraline 185V), for all development wells.

The NWBM drilling fluid will be primarily mixed onshore (new or reuse of existing stock) and transferred to the MODU by a support vessel, where it is stored and maintained in the mud pits. During drilling operations, the NWBM drilling fluid, like the WBM, is pumped by high pressure pumps down the drill string and out through the drill bit, returning via the annulus between the drill string and the casing back to the MODU via the riser.

The used NWBM pumped back to the MODU contains drill cuttings and is pumped to the solid control equipment (SCE), where the drill cuttings are removed before being pumped back to the pits ready for reuse. The technical properties of the NWBM drilling fluids are maintained/altered (e.g. to increase weight) using additives as required when in the mud pits.

The NWBM drilling fluids that cannot be re-used (i.e. do not meet required drilling fluid properties or are mixed in excess of required volumes) are recovered from the mud pits and returned to the shore base for onshore processing, recycling and/or disposal. The mud pits and associated equipment/infrastructure are cleaned when NWBM is no longer required, with wash water treated onboard through SCE before discharge with mud pit washings, or returned to shore for disposal if discharge criteria cannot be achieved (refer to **Section 3.10.2.3**).

3.10.2.3 Mud Pits

There are typically a number of mud pits (tanks) on the MODU that provide a capacity to mix, maintain and store fluids required for drilling activities. The mud pits form part of the drilling fluid circulating system. The mud pits and associated equipment/infrastructure are cleaned out at the end of drilling and completions operations. Mud pit wash residue is operationally discharged with less than 1% oil contamination by volume. Mud pit residue over 1% oil volume is sent to shore for disposal.

3.10.3 Drill Cuttings

Drill cuttings generated from the well are expected to range from very fine to very coarse (<1 cm) particle/sediment sizes. Cuttings generated during drilling of the top hole sections are discharged at the seabed. Estimated volumes of drill cuttings that may be discharged during the Petroleum Activities Program are presented in **Table 6-2**.

The bottom hole sections will be drilled with a marine riser that enables cuttings and drilling fluid to be circulated back to the MODU, where the cuttings are separated from the drilling fluids by the SCE. The SCE comprises but is not limited to shale shakers, cuttings dryer(s) and centrifuges. The SCE uses shale shakers to remove coarse cuttings from the drilling mud. After being processed by the shale shakers, the recovered mud from the cuttings may be directed to centrifuges, which are used to remove fine solids (4.5 to 6 µm). The cuttings are usually discharged below the water line and the mud is recirculated into the fluid system.

If NWBM is needed to drill a well section, the cuttings which are separated from the NWBM via the shakers will also pass through a cuttings dryer and associated SCE, to reduce the average oil on cuttings for the entire well (only section using NWBM) to 6.9% wt/wt or less on wet cuttings, prior to discharge.

3.11 Contingent Activities

The following sections present contingencies that may be required, if operational or technical issues occur during the Petroleum Activities Program. These contingencies have been considered within the relevant impact assessment sections and do not represent significant additional risks or impacts, but may generate additional volumes of drilling fluids and cuttings being discharged operationally.

3.11.1 Respud

A respud may be required for a number of reasons, such as if the conductor or well head slumps or fails installation criteria (typically during top hole drilling). Re-spudding involves moving the MODU to a suitably close location (e.g. ~50 m from the original location) to recommence drilling. A respud activity would result in repeating top hole drilling (**Section 3.8.2**).

The environmental aspects of re-spudding are the same as those for drilling and are considered to be adequately addressed by this EP (**Section 6.6.5**), with no significant changes to existing environmental risks or any additional environmental risks likely. The net environmental effect will be limited to an increase in the volume of cuttings generated (**Table 6-2**) and discharged at the seabed, from the repeat drilling of the top hole section, plus an increase in the quantity of cement discharged at seabed from cementing the conductor and surface casing strings.

3.11.2 Sidetrack

The option of a sidetrack instead of a respud may be required if operational issues are encountered. The environmental aspects of a sidetrack well are the same as those for routine drilling activities, which are considered to be adequately addressed by this EP (**Section 6.6**), with no significant changes to existing environmental risks or any additional environmental risks likely. The net environmental effect will be limited to an increase in the volume of cuttings generated **(Table 6-2**), potential increase in the use of drilling fluids and the additional emissions (atmospheric and waste) associated with an extended drilling program.

3.11.3 Workover

The existing production wells (PLA01 to PLA07 and XNA01) and proposed development wells (PYA01, PL-PYA02, XNA02 and XNA03) may be worked over. A workover or intervention may be required to restore production or integrity due to a failed completion or component in the well. The environmental aspects of a workover operation are the same as those for well completion activities and are considered to be adequately addressed by this EP (**Sections 6.6** and **6.7**), with no significant changes to existing environmental risks or any additional environmental risks likely.

3.11.4 Well Suspension

During drilling activities, a well may need to be temporarily suspended. Suspension involves establishing suitable barriers, removing the riser and disconnecting the MODU from the well. The BOP may sometimes be left in place to act as a barrier. Suspension may be short term (e.g. in the case of a cyclone) or longer term (more than one year). On return to a well after suspension, the MODU reconnects to the well via the riser, and with BOP in place, barriers are removed and drilling and completions activity resumes.

3.11.5 Wireline Logging

Wireline contingencies that may be in place for development drilling include gamma ray and casing collar locator for depth correlation, ultrasonic imaging tool and cement bond log to measure cement integrity, formation pressures (XPT), density, neutron and resistivity and punch perforators/tubing cutters suitable for all tubing sizes. Wireline contingency work will be performed with appropriate isolation barriers in place, i.e. an overbalanced fluid column. If wireline work is required to occur in a live well, or where there is a risk of barrier failure, the operation will be performed with full pressure control equipment at the surface.

Some logging tools may contain low activity radiation sources. Radiation fields are not generally detectable outside the tool when the tool is not energised; therefore, they do not present an environmental risk.

3.11.6 Well Intervention

An intervention may be performed on any of the Petroleum Activities Program wells. Interventions may be performed due to down-hole equipment failure or to address underperformance of a well. Key well intervention methods include wire-line and coiled tubing. Potential environmental impacts from intervention activities have been included in this EP, including discharge of suspension fluids and brines and small volume gas releases subsea due to removal of a tree cap which may be in place if the well was previously suspended.

3.11.7 Well Abandonment

The Petroleum Activities Program covers the drilling of production wells, which are not envisaged to be abandoned until the end of the production field life. For technical reasons, the lower section of a well may need to be abandoned, before sidetracking, or if a respud is required.

Well abandonment activities are conducted in accordance with Woodside’s internal standards. Base oil may be used for inflow testing before abandonment, to verify barrier integrity. Base oil would be pumped down the drill string and reverse-circulated back to the rig, with fluids collected for disposal onshore. If stored in a mud pit, the base oil and other fluids associated with the test may result in pit wash water contaminated with hydrocarbons. If this is the case, mud pit wash water would be discharged in accordance with requirements in this EP; with a hydrocarbon content <1% by volume.

If required, wells will be abandoned with abandonment cement plugs, including verification of the uppermost cement plug by tagging and/or pressure testing through a prescribed program. A lower section of a well may also be abandoned before sidetracking.

After abandonment activity, the marine riser and BOP will be removed and every reasonable attempt made to retrieve the wellhead. Conventional wellheads are removed by deploying a cutting device on drill pipe which then cuts through the conductor, allowing the wellhead to be retrieved to the surface. Backup cutting equipment is sent offshore as a contingency should the primary set of equipment fail. The conductor cutting equipment is very reliable with a high success rate of cutting wellheads.

If these recognised removal techniques are ineffective, the wellhead may be left in-situ. The integrity of the wellbore is not affected by the wellhead assembly remaining in-situ.

3.11.8 Wellhead Assembly Left In-situ

If a well is abandoned due to the requirement to respud, the wellhead assembly may be left in-situ until final field decommissioning. Well abandonment activities would be performed as outlined in **Section 3.11.7** but the well assembly would remain. The integrity of the wellbore is not affected by the wellhead assembly remaining in-situ. The environmental aspects of the wellhead assembly remaining in-situ as a contingent activity are considered to be adequately addressed by this EP (**Section 6.6.1**), with no significant changes to existing environmental risks or any additional environmental risks likely.

Final decommissioning of the development wellhead assembly and other subsea infrastructure at the end of field life will be subject to a separate EP.

3.11.9 Sediment Mobilisation and Relocation

If required, an ROV-mounted suction pump/dredging unit may be used to relocate sediment/cuttings around the wellhead or other infrastructure, to keep the area clear and safe for operations and equipment. This activity has the potential to generate plumes of suspended sediment during pumping and disturb benthic fauna in the immediate area.

3.11.10 Venting

During drilling of the well, a kick may occur. A kick is an undesirable influx of formation fluid into the wellbore. To maintain well integrity in this situation, a small volume of greenhouse gas is released to the atmosphere via the degasser, in a well control operation known as ‘venting’.

3.11.11 Emergency Disconnect Sequence

An emergency disconnect sequence (EDS) may be implemented if the MODU is required to rapidly disengage from the well. The EDS closes the BOP (i.e. shutting in the well) and disconnects the riser to break the conduit between the wellhead/BOP and MODU. Common examples of when this system may be initiated include the movement of the MODU outside of its operating circle (e.g. due to a failure of one or more of the moorings or DP system) or the movement of the MODU to avoid a vessel collision (e.g. third-party vessel on collision course with the MODU). EDS aims to leave the wellhead and BOP in a secure condition but will result in loss of the drilling fluids/cuttings in the riser after disconnection.

4 DESCRIPTION OF THE EXISTING ENVIRONMENT

4.1 Overview

In accordance with Regulation 13(2) and 13(3) of the Environment Regulations, a description of the existing environment that may be affected by the activity (planned and unplanned activities, as defined in **Section 2.4.1** and described in **Section 3**), including details of the particular relevant values and sensitivities of the environment, are provided in this section and have been used for the risk assessment.

For the purposes of this EP, Woodside has identified the EMBA by combining the potential spatial extent of surface and in-water (dissolved and entrained) hydrocarbons, resulting from a worst-case credible spill, loss of well integrity. The EMBA also includes areas that are predicted to experience shore-line contact with hydrocarbons above threshold concentrations. Hydrocarbon exposure thresholds used to define the EMBA are outlined in (**Table 4-1**) and shown in **Figure 4-1.**

It should be noted that the maps presented do not represent the predicted coverage of any one hydrocarbon spill or a depiction of a slick or plume at any particular instant in time. Rather, the contours are a composite of a large number of theoretical slick paths, integrated over the full duration of the simulations under variations metocean conditions.

Hydrocarbons may be visible at low concentrations of approximately 1 g/m^2. Any ecological impacts at the thresholds for the EMBA may also result in socio cultural impacts from dissolved and entrained hydrocarbons. Therefore these have been used to define an additional boundary within which socio-cultural impacts to the visual amenity of the marine environment may occur. This additional area is referred to as the socio-cultural EMBA in this EP. Socio-cultural values described within this wider EMBA include the following:

- protected areas
- National and Commonwealth Heritage Listed places
- tourism and recreation and
- fisheries.

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

Table 4-1: Hydrocarbon Spill Thresholds used to Define EMBA for Surface and In-water Hydrocarbons

Hydrocarbon Type	EMBA[1]	Socio-cultural EMBA[1]
Surface	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.	1 g/m^2 This represents a wider area where a visible sheen may be present on the surface but is below concentrations at which ecological impacts are expected to occur.
Dissolved	50 ppb This represents potential toxic effects, particularly sublethal effects to highly sensitive species. It is a highly conservative threshold given that the lowest ‘no effect concentration’ (NOEC) observed in Woodside’s ecotoxicity testing for a suitable surrogate is 123 ppb (refer to **Section 6.7.1**).	

Hydrocarbon Type	EMBA[1]	Socio-cultural EMBA[1]
Entrained	100 ppb This represents potential toxic effects, particularly sublethal effects to sensitive species. It is a conservative threshold in relation to the lowest 'no effect concentration' (NOEC) observed in Woodside's ecotoxicity testing (refer to **Section 6.7.1**).	

[1] Further details including the source of the thresholds used to define the EMBA in this table are provided in **Section 6.7.1**.

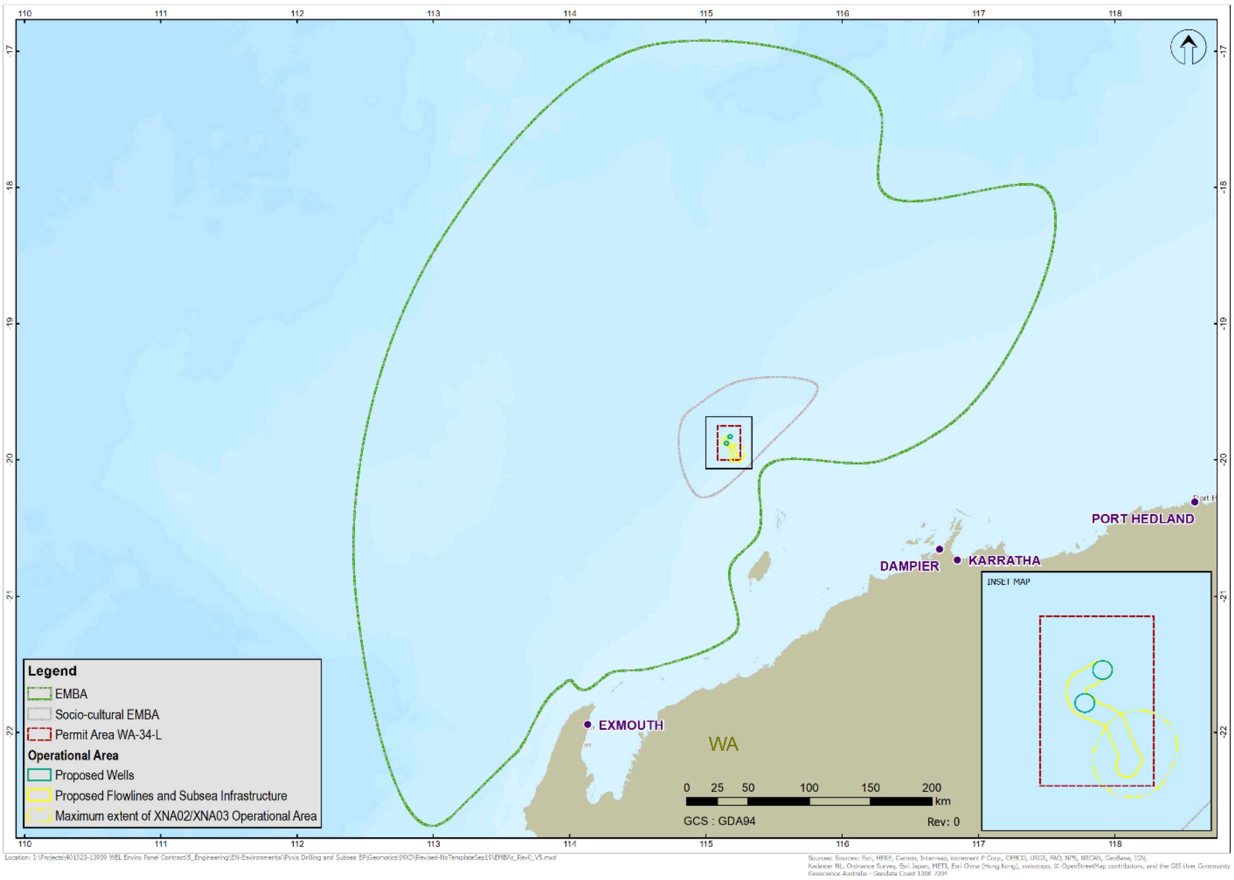


Figure 4-1: EMBA for the Petroleum Activities Program

4.2 Summary of Key Existing Environment Characteristics

A summary of the key existing environment characteristics, in line with the process of identifying and describing the existing environment in relation to the 'nature and scale' of the activity (refer Section 2.4.2), is provided in **Table 4-2**. The key existing environment characteristics, in **Table 4-2**, are described in terms of the Permit Area and EMBA (as described in **Section 4**).

Table 4-2: Summary of key existing environment characteristics for the Permit Area and wider EMBA

	Sensitive Receptor	EP Section	Description
Physical Environment	***Climate and Meteorology***	**4.4.1**	***Permit Area and EMBA*** • Dry tropical climate with hot summers and mild winters. • Most rainfall occurs during October to April. • Seasonal wind patterns with south-westerly winds characterising summer months and south-easterly winds characterising winter months. Winds during transition period between seasons typically more variable. • Tropical cyclones have occurred in the region during summer period.
	Oceanography	**4.4.2**	***Permit Area*** • Locally generated wind surface currents are superimposed on geostrophic and tidal currents. • Geostrophic flow characterised by the southward flowing Leeuwin Current, which strengthens in winter and weakens in summer. • Water quality is expected to reflect the offshore oceanic conditions of the North West Shelf Province and wider North West Marine Region (NWMR). • Surface water temperatures are relatively warm, ranging seasonally from about 24.3 to 28.5 °C. • Offshore waters are expected to be of high quality given the distance from shore and lack of terrigenous inputs. ***EMBA*** • Water quality is regulated by the Indonesian Throughflow (ITF), which plays a key role in initiating the Leeuwin Current and brings warm, low-nutrient, low-salinity water to the NWMR. It is the primary driver of the oceanographic and ecological processes in the NWMR. • Variation in surface salinity throughout the year is minimal (35.2 and 35.7 practical salinity units). • During summer, the Leeuwin Current typically weakens and the Ningaloo Current develops, facilitating upwelling of cold, nutrient-rich waters up onto the continental shelf. • Other areas of localised upwelling in the NWMR include the Exmouth Plateau, where these seabed topographical features force the surrounding deeper, cooler, nutrient-rich waters up into the photic zone. • Turbidity is primarily influenced by sediment transport by oceanic swells and primary productivity.
	Bathymetry	**4.4.2.4**	***Permit Area*** • Permit Area is located in deep waters of about 170–990 m. ***EMBA*** • Relatively complex bathymetric features close to the Permit Area include plateaus, deeps/holes/valleys, terraces, trenches/troughs and canyons within the continental slope. • A number of bathymetric features occur in the EMBA.
	Marine Sediment	**4.4.3**	***Permit Area*** • Seabed comprises soft sediments, with surface layer of sand between 1–4 m thick overlying cemented sands, typical of the region. • Sediments along the export pipeline route are predominantly fine sand with variable proportions of coarser sand fractions, silt, shells and shell fragments, coral cemented materials. • Hard substrate previously described for two areas of seabed including sea cliffs in about 1000 m depth where the continental slope meets the abyssal plain, and a series of rock pinnacles present in a confined area (<3 km²) located in about 300 m water depth. ***EMBA*** • Sediment character changes with depth and distance from shore, with sediments becoming progressively finer with increasing depth and distance, particularly beyond the continental shelf break.
	Air Quality	**4.4.4**	There is limited air quality data for the NWMR. However, ambient air quality in the Permit Area and EMBA is expected to be of high quality.
Habitats	***Critical Habitat – EPBC Listed***	**4.5.1.1**	No Critical Habitats or Threatened Ecological Communities, as listed under the EPBC Act, are known to occur within the Permit Area. Refer to the relevant section for each protected species for a description of the critical habitats that may occur within the EMBA.
	Marine Primary Producers	**4.5.1.2**	***Permit Area*** • Given the water depth, benthic primary producers will not occur within the Permit Area. ***EMBA*** <u>Coral Reefs</u> • Nearest coral habitat to the Permit Area is Rankin Bank (25 km from Permit Area). • Coral reef habitats include the Montebello/Barrow islands (50 km and 80 km respectively). <u>Seagrass Beds/Macroalgae</u> • Seagrass/macroalgae habitat is widely distributed in coastal waters that receive sufficient light to support seagrass and macroalgae. The closest to the Permit Area are located at the Montebello/Barrow islands (50 km and 80 km respectively). <u>Mangroves</u> • None present within the EMBA.
	Lifecycle Stages 'Critical' Habitats	**4.5.1.3**	Refer to Biologically Important Areas (BIAs) and species descriptions.

	Sensitive Receptor	EP Section	Description
	Other Communities/ Habitats	**4.5.1.4**	***Permit Area*** *Plankton* • Plankton communities in the Permit Area are likely to reflect the broader NWMR. *Pelagic and Demersal Fish Populations* • Fish communities in the Permit Area are likely to comprise small and large species pelagic fish, as well as demersal species associated with subsea infrastructure. • The Continental Slope Demersal Fish Communities Key Ecological Feature (KEF) overlaps the Permit Area and may support demersal fish assemblages. • Existing subsea infrastructure is likely to support fish assemblages. *Filter Feeders and Other Benthic Communities* • The continental slope region of the Permit Area comprises a sparse abundance, high variability and high diversity of infauna dominated by polychaetes with other fauna including nemerteans and sipunculids and crustaceans. • Over the continental shelf region of the Permit Area discrete areas of hard substrate hosting sessile filter feeding communities may be present. ***EMBA*** *Plankton* • Offshore phytoplankton communities in the NWMR are characterised by smaller taxa (e.g. bacteria), while shelf waters are dominated by larger taxa (e.g. diatoms). *Pelagic and Demersal Fish Populations* • Key demersal fish biodiversity areas are likely to occur in other complex habitats (e.g. coral reefs). • Relatively complex habitats (e.g. reefs, Rankin Bank) support high demersal fish richness and abundance. *Filter Feeders and Other Benthic Communities* • The NWMR has been identified as a sponge diversity hotspot with a high variety of biodiverse areas.
Protected Species	***Biologically Important Areas***	**4.5.2.1** and **Table 4-5**	***Permit Area*** • Flatback turtle internesting buffer BIA. • Foraging area for the wedge-tailed shearwater. • Whale shark foraging area. • Pygmy blue whale migration corridor. ***EMBA*** • Flatback turtle internesting buffer BIA. • Green turtle internesting buffer BIA. • Hawksbill turtle internesting buffer BIA. • Loggerhead internesting buffer BIA. • Lesser crested tern breeding BIA. • Fairy tern breeding BIA. • Roseate tern breeding BIA. • Humpback whale migration BIA. • Pygmy blue whale foraging BIA.
	Marine Mammals	**4.5.2.2**	***Permit Area and EMBA*** • Sei, fin and sperm whales – likely to infrequently occur within proximity to the continental slope section of the Permit Area during winter months. • Blue whale – migration corridor BIA overlaps the facility section of the Permit Area; occurrence is expected between about April and January. • Humpback whale – migration corridor BIA overlaps the EMBA; occurrence is expected between May and November. • Southern right whale – unlikely to occur within Permit area but may occur in EMBA. • Bryde’s whale – presence in the Permit Area is likely to be a remote occurrence and limited to a few individuals; may be seasonally present between December and June. • Antarctic minke whale – unlikely to occur within Permit Area but may occur in EMBA. • Killer whale, orca – no recognised key localities, expected to rarely occur within the Permit Area. • Spotted bottlenose dolphin – unlikely to occur within Permit Area but may occur in EMBA. • Indo-pacific humpback dolphin – unlikely to occur within Permit Area but may occur in EMBA. • Dugongs – unlikely to occur within Permit Area but may occur in EMBA.

	Sensitive Receptor	EP Section	Description
	Marine Turtles	**4.5.2.3**	***Permit Area*** • Due to water depth within the Permit Area, greater than 170 m, there is no foraging habitat for the flatback, green, hawksbill and loggerhead turtles within the Permit Area. Leatherback turtles have the potential to forage within the Permit Area. • The Permit Area contains an internesting BIA for flatback turtles. Presence of the species within the Permit Area is likely to be limited to the internesting periods. ***EMBA*** • The EMBA contains a number of internesting BIAs for flatback, green, hawksbill and loggerhead turtles. Leatherback turtles may occur within the EMBA but there are no known nesting beaches in Western Australia. • Marine turtles may forage in shallow waters on the continental shelf, including Rankin Bank (25 km from the Permit Area).
	Seasnakes	**4.5.2.3**	***Permit Area*** • Given the offshore location and deeper water depths of the Permit Area, seasnake sightings will likely be infrequent and comprise a few individuals. ***EMBA*** • Seasnakes frequent the waters of the continental shelf and around offshore islands.
	Fishes and Elasmobranchs	**4.5.2.3**	***Permit Area and EMBA*** • Great white sharks – unlikely to occur within the Permit Area given absence of preferred prey; known to occur within the EMBA. • Shortfin and longfin mako sharks – potential for infrequent transit of the Permit Area, known to occur within the EMBA. • Whale sharks – foraging BIA overlaps the Permit Area (although this may constitute migration corridor for animals moving to and from annual aggregation off Ningaloo Coast); occurrence is expected between March and July. • Grey nurse sharks – may infrequently transit continental shelf waters overlapping the Permit Area; are likely to be found in shallow waters of the EMBA. • Giant and reef manta rays – occurrence within the Permit Area is expected to be infrequent. • Narrow, dwarf and green sawfish – may infrequently transit continental shelf waters of the Permit Area; will occur in shallow coastal habitats in the EMBA (near Montebello and Barrow islands).
	Oceanic Seabirds and/or Migratory Shorebirds	**4.5.2.4**	***Permit Area*** • Eleven species of Threatened and/or Migratory bird species were identified as potentially occurring within the Permit Area; no EPBC listed critical habitat associated with these species has been identified within the Permit Area. • A foraging BIA for wedge-tailed shearwater, during their breeding season (August–April), overlaps the Permit Area. ***EMBA*** • Nine species of Threatened and/or Migratory bird species were identified as potentially occurring within the EMBA but outside the Permit Area. Additionally, three BIAs for birds overlap the EMBA: • Breeding BIA for lesser crested terns (45 km from the Permit Area) • Breeding BIA for Fairy tern (40 km from the Permit Area). • Breeding BIA for Roseate tern (45 km from the Permit Area).
Socio-economic	***Cultural Heritage***	**4.6.1**	***Permit Area*** • There are no known sites of Aboriginal or European cultural or heritage significance within or in the vicinity of the Permit Area. ***EMBA*** • There are no known sites of Aboriginal or European cultural or heritage significance within the EMBA. The closest areas are Barrow Island and Montebello Islands and the adjacent foreshore containing numerous registered Indigenous heritage sites. • The closest listed shipwrecks to the Permit Area include *Curlew, Marietta, Vianen* and *Wild Wave* (China), within 1 km south of the Permit Area. • The closest National Heritage listed and proposed places include Barrow Island, Montebello Islands, Dampier Archipelago and the Ningaloo Coast. • The Commonwealth Heritage listed place Ningaloo Marine Area – Commonwealth waters occurs within the EMBA (205 km southwest of the Permit Area). • The World Heritage place the Ningaloo Coast occurs within the EMBA (189 km southwest of the Permit Area).
	Ramsar Wetlands	**4.6.2**	No Ramsar wetlands in the Permit Area or EMBA.
	Fisheries – Commercial	**4.6.3.1**	***Permit Area*** There are a number of Commonwealth and State fisheries designated management areas that overlap the Permit Area; however, only the State Pilbara Demersal Scalefish Fishery (mainly trap fishing), is expected to be active within the Permit Area: *Commonwealth Fisheries* • Southern Bluefin Tuna Fishery • Western Skipjack Fishery • Western Tuna and Billfish Fishery • North-West Slope Trawl Fishery. *State Fisheries*

	Sensitive Receptor	EP Section	Description
			• Pilbara Demersal Scalefish Fishery • West Coast Deep Sea Crustacean Managed Fishery • Specimen Shell Managed Fishery • Onslow Prawn Managed Fishery • Pearl Oyster Managed Fishery • Marine Aquarium Managed Fishery • West Australian Abalone Fishery • Mackerel Managed Fishery • South West Coast Salmon Managed Fishery. There are no aquaculture activities within or adjacent to the Permit Area. ***EMBA and Socio-cultural EMBA*** • No additional fisheries overlap the EMBA and/or Socio-cultural EMBA.
	Fisheries – Traditional	**4.6.4**	There are no traditional, or customary fisheries within or adjacent to the offshore Permit Area. Traditional fisheries are typically restricted to shallow coastal waters and/or areas with structure such as reef. Barrow Island and Montebello Islands and the adjacent foreshores have a known history of fishing, when areas were occupied (as identified from historical records).
	Tourism and Recreation	**4.6.5**	***Permit Area*** • Given the distance to the nearest access node from the Permit Area (>160 km to the Dampier boat ramp on the Burrup Peninsula), recreational fishing effort is not expected. ***EMBA*** • Recreational fishing is expected to occur throughout the EMBA, primarily in continental shelf waters including Rankin Bank (25 km from the Permit Area). • The Montebello Islands are popular for marine nature-based tourist activities (50 km from the Permit Area).
	Shipping	**4.6.6**	***Permit Area*** • No Australian Maritime Safety Authority (AMSA) shipping fairways pass through the Permit Area. ***EMBA*** • The coastal and offshore waters of the region support significant commercial shipping activity, mostly associated with the mining and oil & gas industries. • Major shipping routes are associated with entry to the ports of Barrow Island, Dampier, Port Walcott, Onslow and Port Hedland.
	Oil and Gas Infrastructure	**3.9.1** and **4.6.7**	***Permit Area*** • Existing Pluto subsea infrastructure including wells and manifolds. ***EMBA*** • Numerous Petroleum Titles surround the Permit Area. • The Wheatstone Platform and Pluto Platform lie within 15 km of the Permit Area. Additional platforms are located more than 50 km from the Permit Area.
	Defence	**4.6.8**	There are designated Defence practice areas in the offshore marine waters off Ningaloo and the North West Cape, which partially overlap the Permit Area.
Values and Sensitivities	***Protected Areas***	**4.7**	***Permit Area*** None ***EMBA*** Ningaloo Coast and Gascoyne: • The Ningaloo Coast World Heritage Area overlaps the EMBA (189 km from the Permit Area) • The Gascoyne Australian Marine Park Habitat Protection Zone and Multiple Use Zone overlap the EMBA (306 km and 159 km from the Permit Area respectively) • Ningaloo Australian Marine Park overlaps the EMBA (205 km from the Permit Area). Montebello/Barrow/Lowendal islands: • Montebello Australian Marine Park (<1 km from the Permit Area at its closest point) • Montebello Islands Marine Park/Barrow Island Marine Park/Barrow Island Marine Management Area (40 km, 80 km and 55 km respectively from the Permit Area at their closest point) • Barrow Island Nature Reserve and Lowendal Island Nature Reserve (75 km and 80 km from the Permit Area respectively at their closest point).
	Key Ecological Features	**4.7.3**	***Permit Area*** • Continental Slope Demersal Fish Communities KEF. ***EMBA*** • Ancient Coastline at 125 m Depth Contour KEF (within 1 km of the Permit Area). • Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula KEF (160 km from the Permit Area)

	Sensitive Receptor	EP Section	Description
			• Commonwealth waters adjacent to Ningaloo Reef (205 km from the Permit Area) • Exmouth Plateau (72 km from the Permit Area) • Glomar Shoals North-west (138 km from the Permit Area).
	Other Sensitive Areas	**4.7.4.1**	Rankin Bank lies about 25 km west of the Permit Area, within the EMBA.

4.3 Regional Setting

The Permit Area is located in Commonwealth waters within the NWMR, as defined under the Integrated Marine and Coastal Regionalisation of Australia (National Oceans Office and Geoscience Australia, 2005). Within the NWMR, the Permit Area lies across the boundary of the North West Shelf Province and the Northwest Province (**Figure 4-2**). The subsea hydrocarbon gathering system (wells, xmas trees, flowlines, spools, jumpers, umbilicals, etc.) extends from about 170 m on the continental shelf down the continental slope, reaching depths of about 990 m.

The North West Shelf Province and Northwest Province are both characterised by the following biophysical features (Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC), 2012a):

- There are transitional climatic conditions between dry tropics to the south and humid tropics to the north.
- There are strong seasonal winds and moderate offshore tropical cyclone activity.
- Deeper surface waters are tropical year-round and highly stratified during summer months (thermocline occurring at water depths between 30 and 60 m). In winter, surface waters are well mixed with thermoclines occurring deeper around 120 m depth.
- Surface ocean circulation is strongly influenced by the ITF via the Eastern Gyre. During summer when the ITF is weaker, south-west winds cause intermittent reversals in currents. These events may be associated with occasional weak shelf upwellings.
- Internationally significant migratory routes, resident populations, and breeding and/or feeding grounds for a number of *EPBC Act* listed threatened and migratory marine species, including humpback whales, marine turtles, whale sharks, seabirds and migratory shorebirds, are all present.
- The seabed in the region consists of sediments that generally become finer with increasing water depth, ranging from sand and gravels on the continental shelf to mud on the slope and abyssal plain. About 60–90% of the sediments in the region are carbonate derived (Brewer et al., 2007). The distribution and re-suspension of sediments on the inner shelf is strongly influenced by the strength of tides across the continental shelf as well as episodic cyclones. Further offshore, on the mid to outer shelf and on the slope, sediment movement is primarily influenced by ocean currents and internal tides, the latter causing re-suspension and net downslope deposition of sediments (Baker et al., 2008).

As the North West Shelf Province is located mainly over the continental shelf, and the Northwest Province entirely over the continental slope, notable differences exist between the two provinces. The North West Shelf Province encompasses the continental shelf between North West Cape and Cape Bougainville and includes water depths of 0–200 m, with half the region in depths between 50–100 m (DSEWPaC, 2012). The Northwest Province occurs in mainly offshore waters, between Exmouth and Port Hedland, with waters depths generally between 1000 and 3000 m (DSEWPaC, 2012). The Northwest Province acts as a transitional boundary between tropical and temperate marine biological communities and supports relatively high levels of endemism of demersal fish species, while the North West Shelf Province has high species richness but a relatively low level of endemism (DSEWPaC, 2012). Furthermore, the majority of species in the North West Shelf Province are tropical and are recorded in other areas of the Indian Ocean and Western Pacific Ocean.

Benthic communities within the North West Shelf Province range from nearshore benthic primary producer habitats such as seagrass beds, coral communities and mangrove forests to offshore soft sediment seabed habitats associated with low density sessile and mobile benthos such as sponges, molluscs and echinoids (with noted areas of sponge hotspot diversity). Within the Northwest Province benthic habitats comprise mainly soft sediment communities with sparse epifauna communities; however, several topographic features such as the Exmouth Plateau, terraces and canyons (several of which are associated with KEFs) do exist in the region (refer to **Section 4.7**) (DSEWPaC, 2012; Department of the Environment, Water, Heritage and the Arts (DEWHA), 2008).

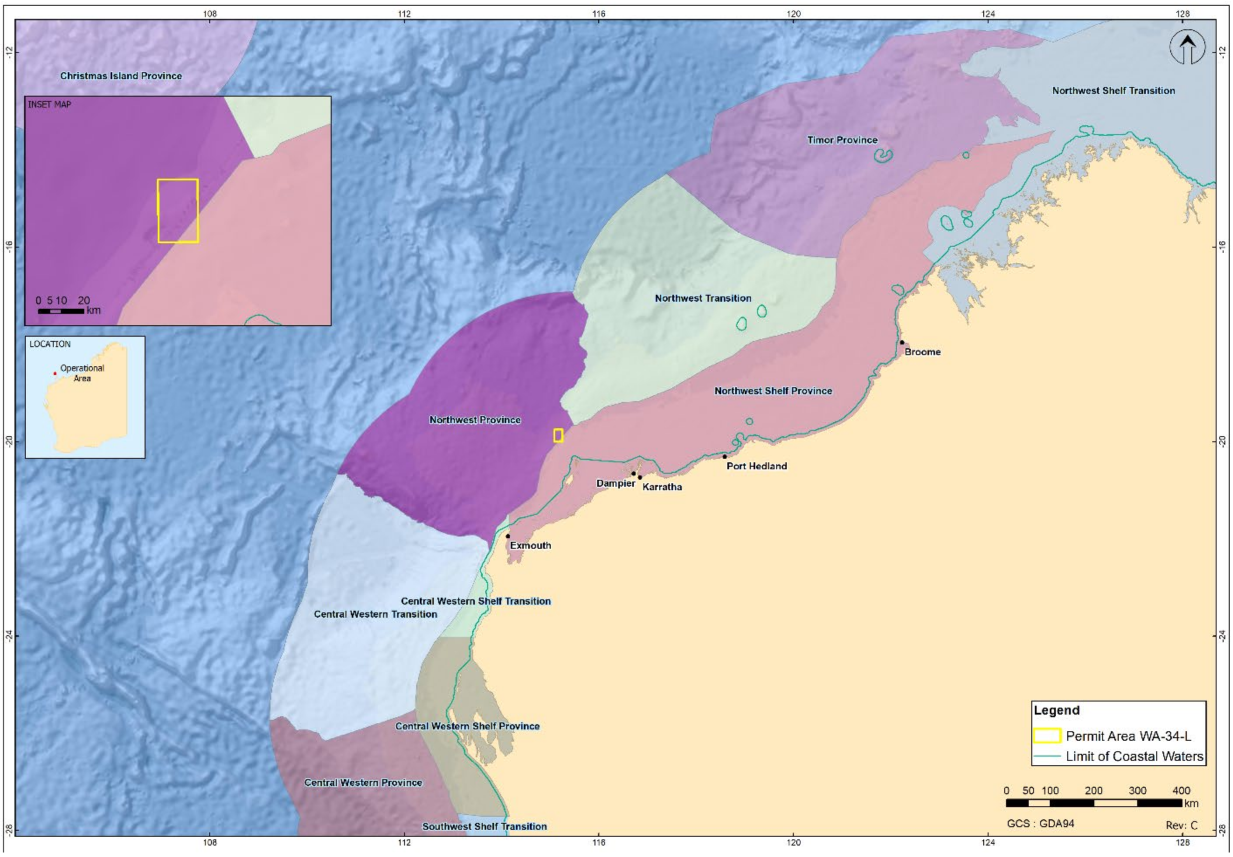


Figure 4-2: North West Marine Region and the location of the Permit Area

4.4 Physical Environment

4.4.1 Climate and Meteorology

4.4.1.1 Seasonal Patterns

The Permit Area experiences a tropical monsoon climate, with distinct wet (October to April) and dry (May to September) seasons (Pearce et al., 2003). Rainfall in the region typically occurs during the wet season, with highest falls observed during late summer (Bureau of Meteorology (BoM), n.d.) and is often associated with the passage of tropical low pressure systems and cyclones (Pearce et al., 2003). Rainfall outside this period is typically low (**Figure 4-3**).

Air temperatures in the region, as measured at Karratha aerodrome, follow seasonal trends (**Figure 4-3**). Maximum temperatures during summer reach an average of 36 °C in January, falling to an average maximum of 26 °C in July. Average minimum temperatures range from 26 °C in December to 14 °C in May.

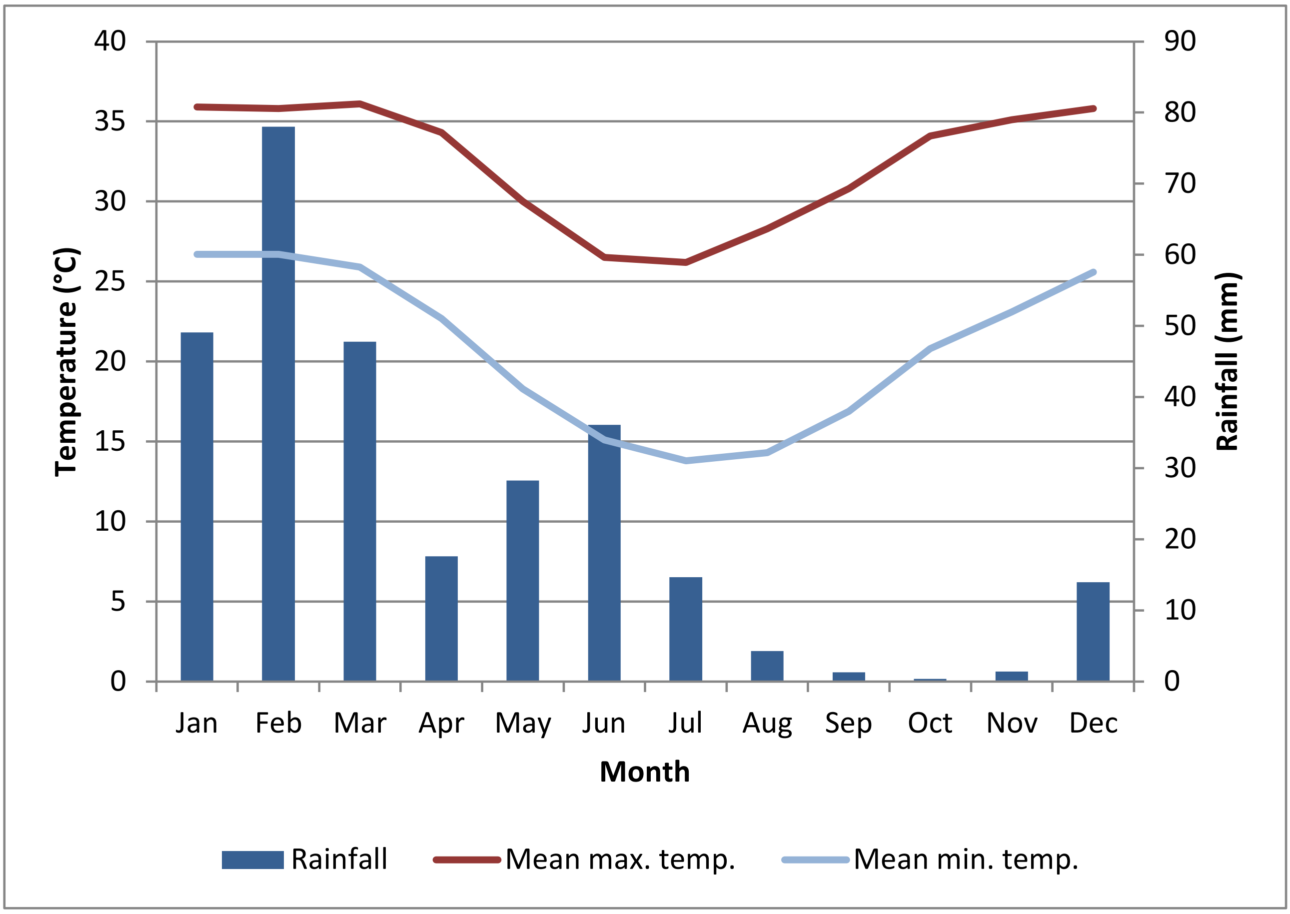
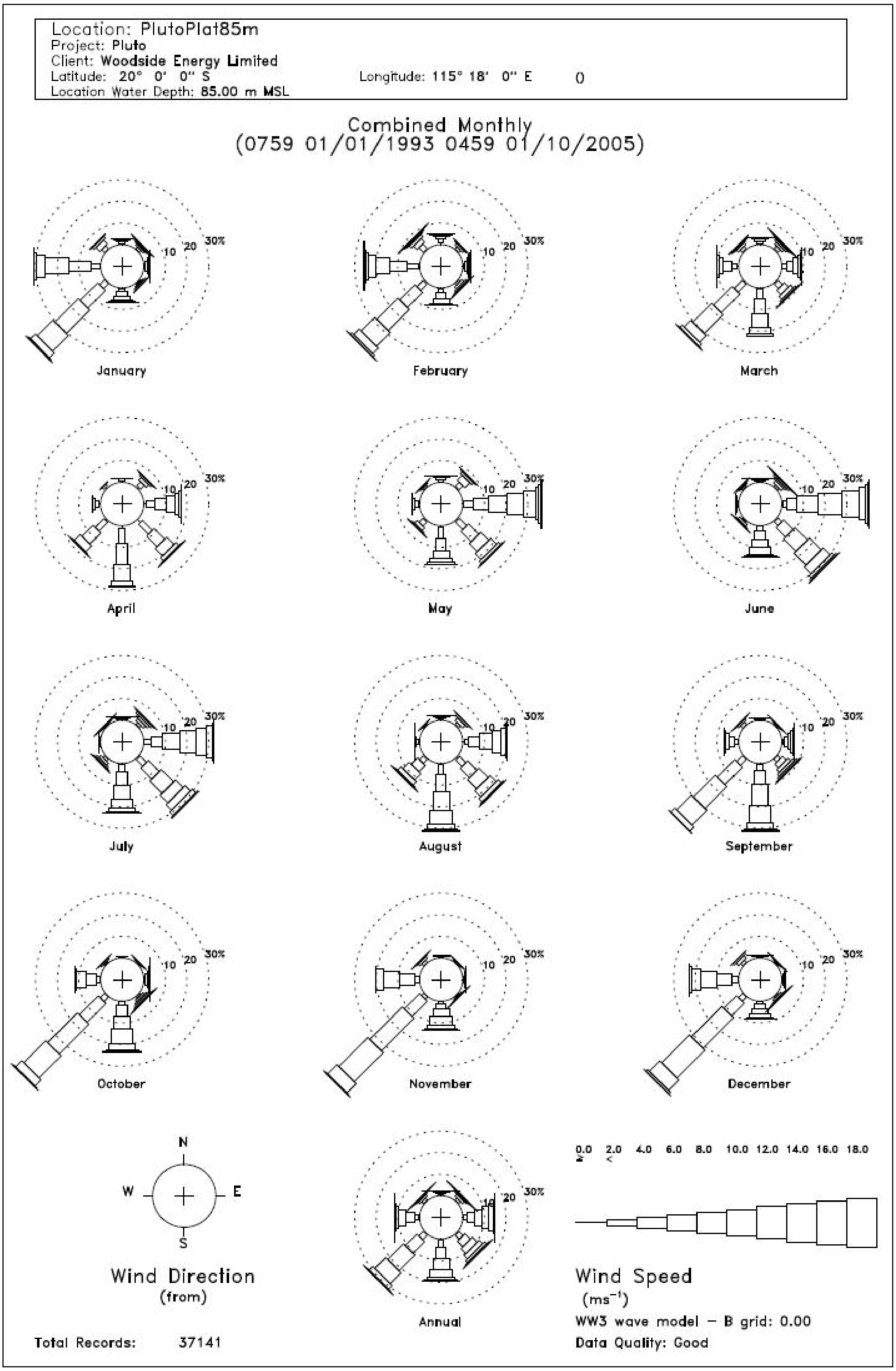


Figure 4-3: Mean monthly maximum temperature, minimum temperature and rainfall from Karratha Aerodrome meteorological station from January 1993 to June 2017 (BoM, n.d.)

4.4.1.2 Wind

Winds typically vary seasonally, with a tendency for winds from the south-westerly quadrant during summer months (September to March) and the south-easterly quadrant in winter (April to August) (**Figure 4-4**). The summer south-westerly winds are driven by high pressure cells that pass from west to east over the Australian continent. During winter months the relative position of the high pressure cells moves further north, leading to prevailing easterly winds blowing from the mainland (Pearce et al., 2003). Winds typically weaken and are more variable during the transitional period between the summer and winter regimes, typically April and August (**Figure 4-4**).



Source: Woodside (2007)

Figure 4-4: Non-cyclonic monthly wind-roses measured at the Pluto facility from 1993 to 2005

4.4.1.3 Tropical Cyclones

Cyclones are a relatively frequent event in the region (**Figure 4-5**), with the Pilbara coast experiencing more cyclonic activity than any other region of the Australian mainland coast (BoM, n.d.). The cyclone season officially runs from November to April each year although cyclones also occur outside this period (BoM, n.d.). Significant storm surge is associated with the passage of a cyclone, which can result in very high tides and coastal flooding (BoM, n.d.; Pearce et al., 2003).

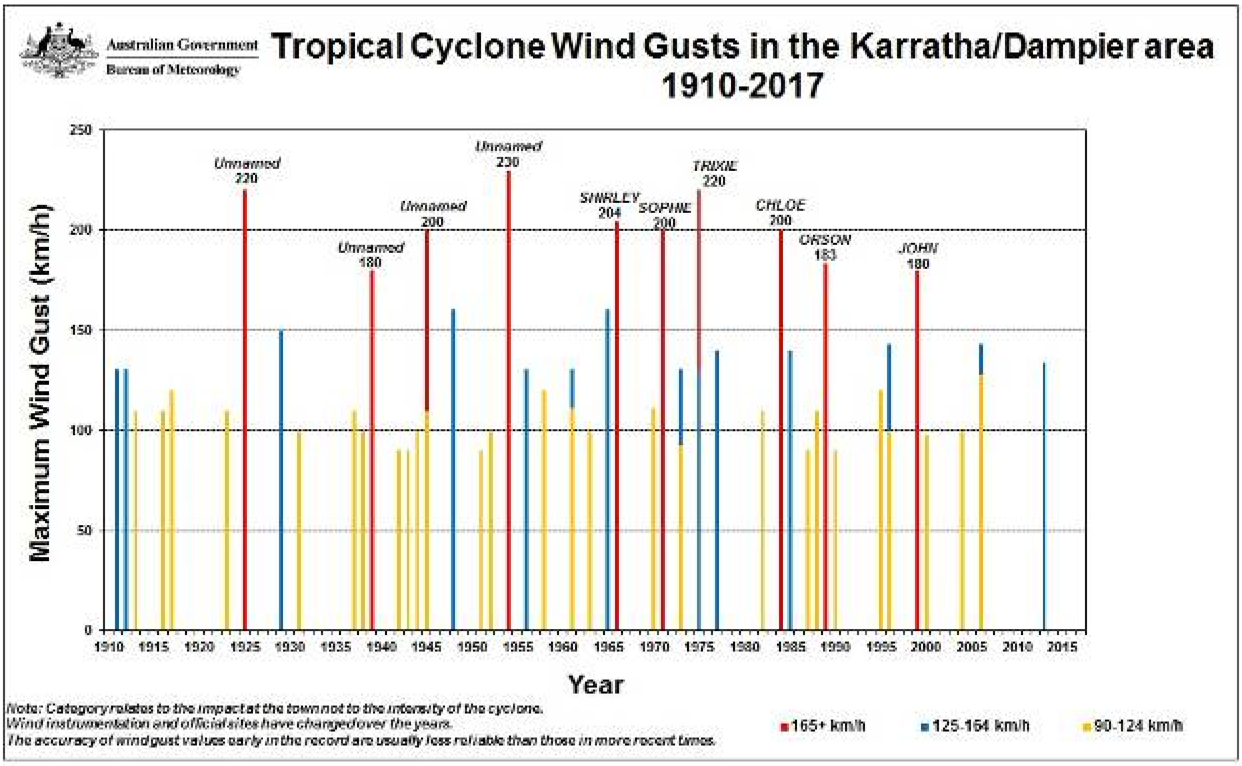


Figure 4-5: Tropical cyclone activity in the Dampier/Karratha region 1910–2017 (source: BoM, n.d.)

4.4.2 Oceanography

4.4.2.1 Currents and Tides

Currents in the region consist of local currents driven by winds and tides, superimposed on synoptic scale geostrophic currents. Local winds generate stress on the water surface, forcing the surface layer in the general direction of wind movement, but with an offset (15–45%) in an anti-clockwise direction (Coriolis Effect). In the open ocean, sustained winds result in wind-forced currents of about 3% of the wind speed (Holloway and Nye, 1985). Thus, a sustained wind of 20 knots may force surface currents of up to 0.6 knots. Wind patterns in the region are described in **Section 4.4.1.2** and shown in **Figure 4-4**.

The large-scale ocean circulation of the NWMR is primarily influenced by the ITF (Meyers et al., 1995; Potemra et al., 2003), and the Leeuwin Current (Batteen et al., 1992; Godfrey and Ridgway, 1985; Holloway and Nye, 1985; James et al., 2004; Potemra et al., 2003). Both currents are significant drivers of NWMR ecosystems. The currents are driven by pressure differences between the equator and the higher density cooler and more saline waters of the Southern Ocean, strongly influenced by seasonal change and El Niño and La Niña episodes (DSEWPaC, 2012a). The ITF and Leeuwin Current are strongest during late summer and winter (Holloway and Nye, 1985; James et al., 2004). Flow reversals to the north-east associated with strong south-westerly winds are typically weak and short lived but can generate upwelling of cold deep water onto the shelf (Condie et al., 2006; Holloway and Nye, 1985; James et al., 2004).

The Leeuwin Current flows southward along the edge of the continental shelf and is primarily a surface flow (up to 150 m deep). It is strongest during winter. The Ningaloo Current flows in the opposite direction, running northward along the outside of Ningaloo Reef and across the inner shelf from September to mid-April (**Figure 4-6**). In March, on the termination of the Northwest Monsoon, an ‘extended Leeuwin Current’ currently known as the Holloway Current develops, flowing to the south-east along the North West Shelf Province (DSEWPaC, 2012a).

In addition to the synoptic-scale current dynamics, tidally driven currents are a significant component of water movement in the NWMR. Wind driven currents become dominant during the neap tide (Pearce et al., 2003). In summer, the stratified water column and large tides can generate internal waves over the upper slope of the NWMR (Craig, 1988). As these waves pass the shelf break at about 125 m depth, the thermocline may rise and fall by up to 100 m in the water column (Holloway, 1983; Holloway and Nye, 1985). Internal waves of the NWMR are confined to water depths between 70 and 1000 m and the dissipation energy from such waves can enhance mixing in the water column (Holloway et al., 2001).

Tides in the NWMR are semi-diurnal and have a pronounced spring-neap cycle, with tidal currents flooding towards the south-east and ebbing towards the north-west (Pearce et al., 2003). The NWMR exhibits a considerable range in tidal height, from microtidal ranges (<2 m) south-west of Barrow Island to macrotidal ranges (>6 m) north of Broome (Brewer et al., 2007; Holloway, 1983). Storm surges and cyclonic events can also significantly raise sea levels above predicted tidal heights (Pearce et al., 2003).

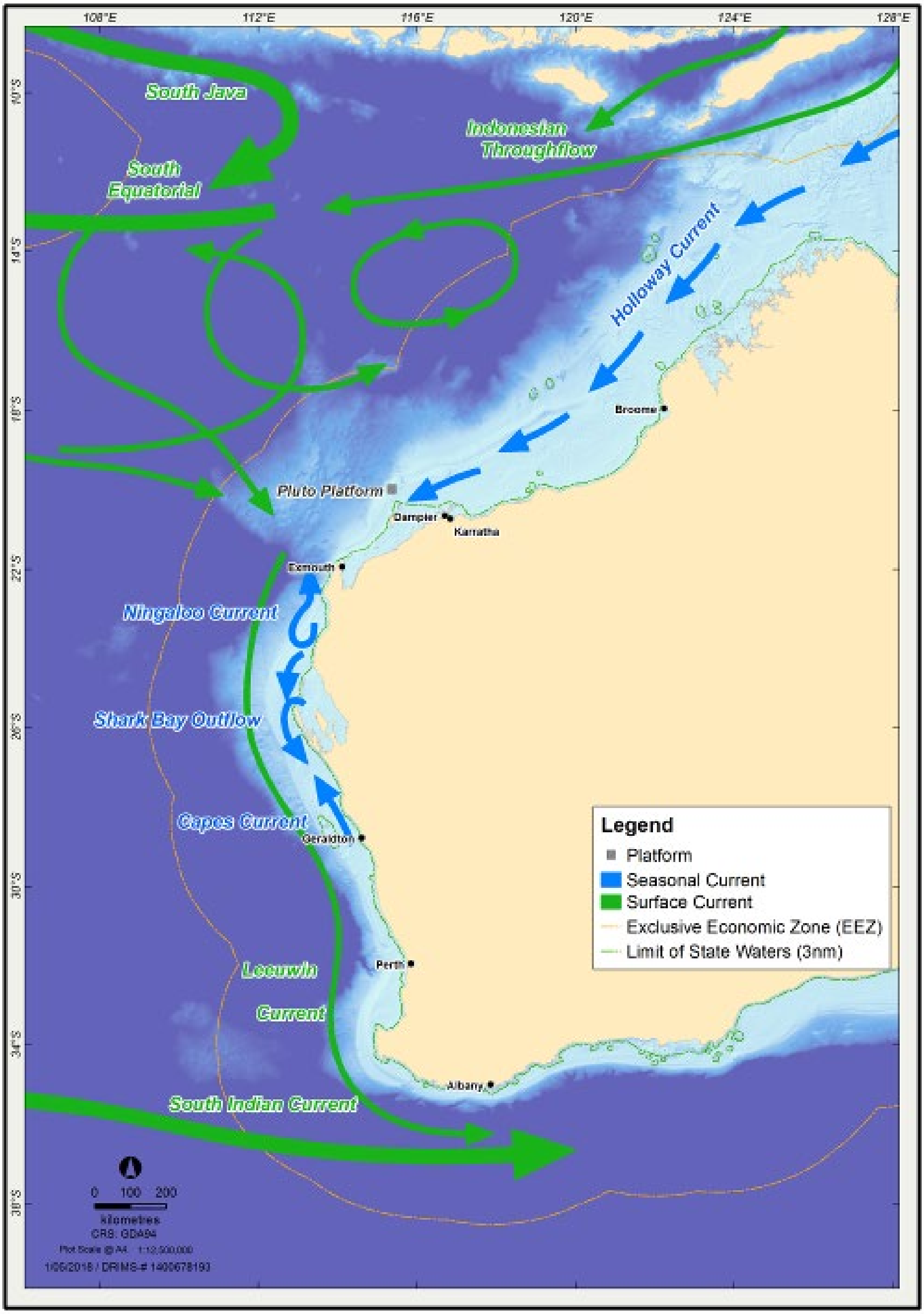


Figure 4-6: Large-scale ocean circulation of the North West Marine Region including the location of the Indonesian Throughflow and other significant currents (DEWHA, 2008)

4.4.2.2 Wave Height

Datawell waverider buoys measured wave height from 1993 to 2005 near the Pluto facility, recording a maximum measured non-cyclonic significant wave height of 6.2 m and a combined non-cyclonic and cyclonic maximum wave height of 11.4 m.

Waves within the NWMR reflect the direction of the synoptic winds. They flow predominantly from the south-west in the summer and from the east in winter (Pearce et al., 2003). Only 10% of significant wave heights off Dampier exceed 1.2 m, with the average wave height being 0.7 m (Pearce et al., 2003). Storms and cyclones may generate swells up to 8.0 m high (Pearce et al., 2003).

4.4.2.3 Seawater Characteristics

The offshore, oceanic seawater characteristics of the NWMR exhibit seasonal and water depth variation in temperature and salinity being greatly influenced by major currents in the region (see **Section 4.4.2**). Surface waters are relatively warm year round due to the tropical water supplied by the ITF and the Leeuwin Current, with temperatures reaching 30 °C in summer and dropping to 22 °C in winter (Pearce et al., 2003). Near seabed temperatures in deeper waters (greater than 120 m water depth) are less variable, with temperatures averaging 22–24 °C year round.

During summer the water column is thermally stratified due to surface heating, with the thermocline occurring between 30 and 60 m water depth, indicating surface waters are well mixed within the Permit Area (BMT Oceanica, 2015; James et al., 2004). Surface waters are also relatively well mixed in winter due to a weaker thermal gradient and persistent south-easterly winds promoting mixing, with the thermocline occurring at around 120 m depth (DSEWPaC, 2012; James et al., 2004).

Seawater temperature records around the Pluto platform (located about 15 km to the east of the Permit Area) over a period of 13 months from December 2005 to January 2007 show surface waters reach their maximum average temperatures in March and April (average about 28.5 °C) and are coolest in August, September and October (average about 24.3 °C) (BMT Oceanica, 2015; Woodside, 2006).

Variation in surface salinity across the NWMR throughout the year is minimal (between 35.2 and 35.7 practical salinity units), with slight increases occurring during the summer months due to intense coastal evaporation (James et al., 2004; Pearce et al., 2003). This small increase in salinity during summer is then countered by the arrival of the lower salinity waters of the Leeuwin Current and ITF in autumn and winter (James et al., 2004).

Turbidity is primarily influenced by sediment transported by oceanic swells and primary productivity (Pearce et al., 2003). Upwelling of nutrient-rich waters may increase phytoplankton productivity in the photic zone, which may increase local turbidity (Wilson et al., 2003). In nearshore areas, turbidity is highly variable due to storm runoff, wind generated waves and large tidal ranges (Pearce et al., 2003). Periodic events such as major sediment transport associated with tropical cyclones may influence turbidity on a regional scale (Brewer et al., 2007).

Water quality in the NWMR, within the EMBA is regulated by the ITF, a low-salinity water mass that plays a key role in initiating the Leeuwin Current (DSEWPaC, 2012). It brings warm, low nutrient, low salinity water from the western Pacific Ocean through the Indonesian archipelago to the Indian Ocean. It is the primary driver of the oceanographic and ecological processes in the region (DEWHA, 2008). South of the NWMR, the Leeuwin Current continues to bring warm, low nutrient, low salinity water further south. Eddies formed by the Leeuwin Current transport nutrients and plankton communities offshore (DEWHA, 2008). During summer the Leeuwin Current typically weakens and the Ningaloo Current develops, facilitating upwellings of cold, nutrient-rich waters up onto the continental shelf (DSEWPaC, 2012). Other areas of localised upwelling in the NWMR include the Wallaby Saddle and Exmouth Plateau (within the Northwest Province), where these seabed topographical features force the surrounding deeper, cooler, nutrient-rich waters up into the photic zone (DSEWPaC, 2012).

4.4.2.4 Bathymetry

The Permit Area is characterised by both the continental shelf and the continental slope of the NWMR. The existing and proposed subsea hydrocarbon gathering system within the Permit Area (wells, xmas trees, flowlines, spools, jumpers, umbilical, etc.) extends from between 170 m on the continental shelf and 990 m on the continental slope (**Figure 4-7**).

The bathymetry within the continental shelf section of the Permit Area is generally flat, which is consistent with the broader North West Shelf Province (Baker et al., 2008). Bathymetry around the Pluto Platform, located on the continental shelf about 15 km to the east of the Permit Area, is considered to be relatively flat and featureless (Woodside, 2006). Across the shelf, the seabed has a gentle (about 0.05°) seaward gradient to where it transitions to a steep distal slope about 200 to 300 km offshore, in water depths of around 200 m (Dix et al., 2005). The continental slope descends relatively rapidly from the shelf edge to greater depths up to 5000 m within the Northwest Province (James et al., 2004; Woodside, 2006).

Within the broader Northwest Province, the continental slope comprises seven major geomorphic features, including plateaus, deeps/holes/valleys, terraces, trenches/troughs and canyons (Baker et al., 2008). Key features overlapping the Permit Area include:

- A number of canyon systems trend east-west across the continental slope and have an increased seafloor gradient of up to 80°.
- About 20 m high cliff-like structures occur at about 1000 m depth where the continental slope meets the abyssal plain.
- Mudstone outcrops occur at 900 to 1000 m depth.
- A field of rock pinnacles (up to 2.5 m tall and 6 m wide in an area covering about 3 km²) occurs at a depth of about 300 m on the continental slope.

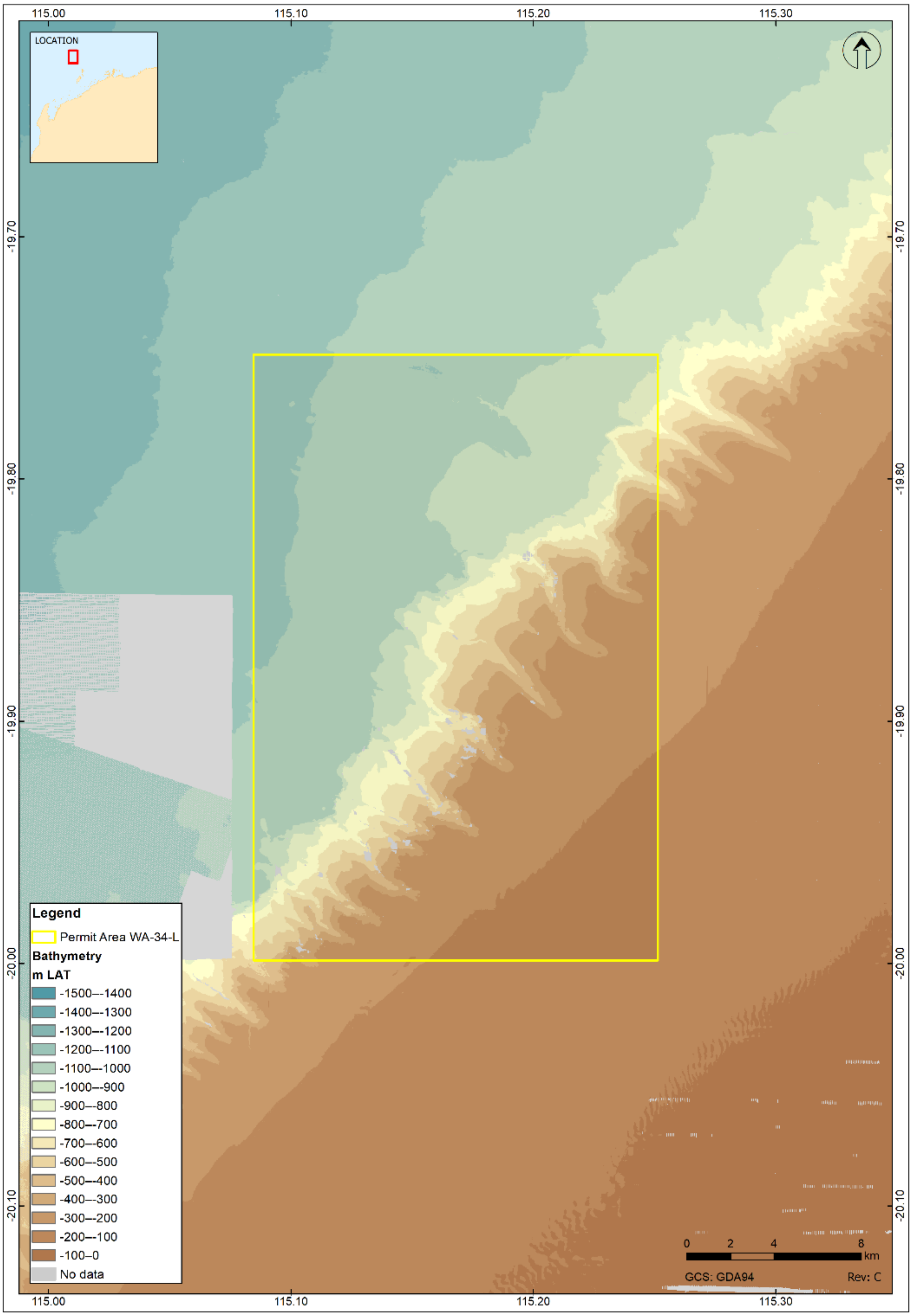


Figure 4-7: Bathymetry of the Permit Area

4.4.3 Marine Sediment

Sediments in the outer NWMR are relatively homogenous and are typically dominated by sands and a small portion of gravel (Baker et al., 2008). Fine sediment size classes (e.g. muds) increase with proximity to the shoreline and the shelf break, but are less prominent in the intervening continental shelf (Baker et al., 2008). Carbonate sediments typically account for the bulk of sediment composition, with both biogenic and precipitated sediments present on the outer shelf (Dix et al., 2005). Beyond the shelf break within the NWMR (200 m depth contour), the proportion of fine sediments increases along the continental slope towards the abyssal plain (Baker et al., 2008).

Previous benthic surveys revealed that the seabed around the Pluto platform (located 15 km to the east of the Permit Area) comprised soft sediments, with a surface layer of sand between 1–4 m thick overlying cemented sands, typical of the region (SKM, 2007; Woodside, 2006). On the continental slope, sediments ranged from fine sands to silts, with sediments generally becoming finer with increasing water depth down to 600 m for both slope and canyon transects. Below 600 m sediment became slightly coarser, but still relatively fine compared to continental shelf sediments (between 150–200 m) (SKM, 2007).

While the Permit Area comprises mainly soft sediments, one KEF, the Continental Slope Demersal Fish Communities KEF, overlaps the area. Another, the Ancient Coastline at 125 m Depth Contour KEF, is located within 200 metres south-east of the Permit Area. Areas of hard substrate may be associated with these KEFs, which are considered to support more diverse benthic communities that are characteristic of the wider region. Refer to **Section 4.7.3** for information about the environmental values of KEFs overlapping the Permit Area and EMBA. Results from the geotechnical and geophysical survey of the Pluto field indicated hard substrate for two areas of seabed (M. Bowler [Woodside] 2006 *personal communications*, January). The main area of exposed hard substrate, sea cliffs, occurs in about 1000 m depth where the continental slope meets the abyssal plain. The bottom of the rocky cliffs is situated in about 1050 m water depths with an almost vertical wall extending 20 m up to about 1030 m at the surveyed location. The rock appears to be sedimentary with clear bands or layers occurring in the rock profile. Where the seabed gradients are less steep, sediments have accumulated. The size of the areas is unknown but were limited in size. From about 1030 m to 880 m, rock and mud stone outcrops occur, interspersed with large areas of soft sediment. Observations of the ROV's manipulator arm indicated that the mudstone was very soft, disintegrating very easily. The mudstone was quite flat in areas with limited vertical relief and the sediment build-up on the exposed rock and mudstone minimal, which suggests that sediment movement down the slope is very limited and/or strong currents sweep away exposed sediments (Advisian, 2019). The only other exposed hard substrate known to occur in the Pluto field is a series of rock pinnacles present in a confined area (<3 km^2) located in about 300 m water depth. They are up to 2.5 m in height and 6 m in diameter and often occur in 10 m deep scour depressions (Advisian, 2019). Additional information about these is provided in **Section 4.5.1.4**.

4.4.4 Air Quality

There is a lack of air quality data for the offshore NWMR air shed. Studies have been performed for the nearshore Pilbara environment to monitor known sources of potential air pollution for locations such as the Burrup Peninsula and Port Hedland, but no monitoring is performed offshore.

Due to the extent of the open ocean area and the activities that are currently performed, it is considered the ambient air quality across the Permit Area and wider offshore NWMR will be of high quality.

4.5 Biological Environment

4.5.1 Habitats

4.5.1.1 Critical Habitat – EPBC Listed

No Critical Habitats or Threatened Ecological Communities as listed under the EPBC Act are known to occur within the Permit Area or EMBA, as indicated by the EPBC Act Protected Matters Report produced on 15 February 2019 and 9 September 2019, respectively (**Appendix C**).

4.5.1.2 Marine Primary Producers

Sea floor communities in deeper shelf waters receive insufficient light to sustain ecologically sensitive primary producers such as seagrasses, macroalgae or zooxanthellate corals. Given the depth of water for the Permit Area (between about 170–990 m), these benthic primary producer groups will not occur in the Permit Area, but may occur within the EMBA in shallower waters (typically <30 m water depth) near offshore islands, reefs and sedimentary banks.

Coral Reef

Coral reefs habitats have a high diversity of corals, associated fish and other species of both commercial and conservation importance. No coral reefs have been identified within the Permit Area or the EMBA except at Rankin Bank (about 24 km east from the Permit Area at the closest point).

Hard corals in the region typically have a distinct spawning season, with most species spawning during autumn (March/April) (Rosser and Gilmour, 2008; Simpson et al., 1993). Further information about environmentally sensitive locations with coral reef habitats is provided in **Section 4.7**.

Seagrass Beds/Macroalgae

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 due to large tidal movement, high turbidity, large seasonal freshwater run-off and cyclones. No seagrass beds or macroalgae occur in the Permit Area as the seabed depth receives insufficient photosynthetically active radiation to support such communities. However, seagrass beds and macroalgae habitats are widespread in shallow waters in the region. The nearest such areas are the offshore islands of the Montebello/Barrow/Lowendal islands (41–76 km south) which are outside the EMBA. Further information about locations with seagrass and macroalgae habitats is provided in **Section 4.7**.

4.5.1.3 Lifecycle Stages 'Critical' Habitats

Spawning, Nursery, Resting and Feeding Areas

Critical habitats for species conservation include spawning, nursery, resting and feeding areas. These critical habitats will vary for each species. No critical habitat for protected species were identified as overlapping the Permit Area or EMBA from the EPBC Protected Matters Search reports (**Appendix C**); however, areas that may be considered habitat critical to the survival of a protected species (e.g. turtles) do overlap the EMBA and are presented in more detail in **Section 4.5.2** within BIAs and the relevant species sub-sections.

Migration Corridors

Many marine species, including cetaceans, whale sharks and migratory seabirds and shorebirds migrate seasonally between feeding, breeding and nursery habitats using migration corridors. Any migration corridor for a protected species that passes through the Permit Area, or within the EMBA, is outlined in **Section 4.5.2** within BIAs and the relevant species sub-sections.

4.5.1.4 Other Communities/Habitats

Plankton

Phytoplankton within the Permit Area and EMBA is expected to reflect the conditions of the NWMR. Primary productivity of the NWMR appears to be largely driven by offshore influences (as reported by Brewer et al., 2007), with periodic upwelling events and cyclonic influences driving coastal productivity with nutrient recycling and advection. 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 Permit Area and EMBA 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 & Gilmour, 2008; Simpson et al., 1993) and fish larvae abundance (Department of Conservation and Land Management (CALM), 2005) can occur throughout the year.

Within the wider region, peak primary productivity occurs in late summer/early autumn, along the shelf edge of the Ningaloo Reef. It also links to a larger biologically productive period in the area that includes mass coral spawning events, peaks in zooplankton and fish larvae abundance (CALM, 2005), with periodic upwelling throughout the year.

Pelagic and Demersal Fish Populations

Fish species in the NWMR (including the Permit Area and the EMBA) comprise small and large pelagic and demersal species. Small pelagic fish inhabit a range of marine habitats, including inshore and continental shelf waters. They feed on pelagic phytoplankton and zooplankton and represent a food source for a wide variety of predators including large pelagic fish, sharks, seabirds and marine mammals (Mackie et al., 2007). Large pelagic fish in the NWMR include commercially targeted species such as mackerel, wahoo, tuna, swordfish and marlin. Large pelagic fish are typically widespread, found mainly in offshore waters (occasionally on the shelf), and often travel extensively.

Similar to survey findings at the Goodwyn facility (McLean et al., 2017), the presence of subsea infrastructure within the Permit Area and associated with the nearby Pluto facility has likely resulted in the development of demersal fish communities that would otherwise not occur in the Permit Area. The type and number of fish present is also highly variable and also depends on the relative position of the pipeline above the seabed. Partially buried pipelines do not appear to provide the same habitat complexity and opportunity that suspended or resting pipelines provide (McLean et al., 2017). Fish assemblages and colonising invertebrate habitats on these artificial hard substrates also vary with depth and age. Generally speaking, the structures that are located in shallower water (<135 m) had a greater diversity of fish compared to habitats at 350 m depth, where the number of fish species and abundance declined markedly (McLean et al., 2018). The study by Bond et al. (2018) also confirmed that compared to adjacent natural seabed habitats, pipeline fish fauna were characterised by higher relative abundance and biomass of commercially important species.

Given continental shelf waters overlap the Permit Area, pelagic species will also be present. The Continental Slope Demersal Fish Communities KEF overlaps the Permit Area and the Ancient Coastline at 125 m Depth Contour KEF is in close proximity (less than 200 m at its closest point). These KEFs include areas of hard substrate that are known or are likely to support a higher diversity of demersal fish assemblages. Rankin Bank (24 km east of the Permit Area) has also been identified as supporting high demersal fish richness and abundance (Australian Institute of Marine Science (AIMS), 2014). Further information about the KEFs and Rankin Bank is provided in **Section 4.7**.

Filter Feeders and Other Benthic Communities

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 and are closely associated with substrate type, with areas of hard substrate typically supporting more diverse epibenthic communities (Heyward et al., 2001a). Conversely, higher diversity infauna is 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 (Brewer et al., 2007; Rainer, 1991; SKM, 2007; Woodside, 2006).

A number of targeted surveys investigating epibenthos and infauna within offshore North West Shelf Province shelf and slope environments have been performed by Woodside. Woodside has collected survey data from numerous sampling locations within and surrounding the Permit Area, using ROV/video investigations of benthic habitats and infauna and epifauna sampling using sediment grabs and epibenthic sled (SKM, 2007; Ocean Affinity, 2018).

Benthic grab sampling in the vicinity of the continental slope region of the Permit Area revealed a sparse abundance, high variability and high diversity of infauna dominated by polychaetes, with other fauna including nemerteans and sipunculids and crustaceans (mainly amphipods) (SKM, 2007). Higher, albeit low, infauna density was reported at the shelf break (200 m) compared to deeper areas on the continental slope. Epifaunal sled samples to 800 m depth including from inside and outside the canyon systems on the continental slope found deepwater solitary cnidarians were the most common fauna in samples, followed by crustaceans (mostly decapods), bony fish and sponges, with urchins, sea stars and brittle stars also recorded (SKM, 2007). Epifauna, cnidarians and demersal fish were also more common in samples taken at 200 m compared to deeper depths and it was noted other epifauna groups showed some variation in abundance with depth (SKM, 2007). These survey findings were typical of other surveys in the region which revealed deep water habitats consist primarily of bare unconsolidated carbonate sediments supporting a sparse assemblage of deposit and filter feeding organisms, including glass sponges, urchins, sea cucumbers, sea stars and crustaceans (Mobil, 2011; Heyward et al., 2001b; URS, 2010).

Only limited areas of deepwater hard substrate have been observed over the continental slope, namely rock pinnacles on the upper continental slope and exposed cliff-like features and relatively soft expanses of mudstone outcrops on the mid continental slope (**Section 4.4.3**). Benthic fauna is closely associated with substrate type, with areas of hard substrate typically supporting more diverse epibenthic communities (Heyward et al., 2001a). The original SKM (2006) survey incorrectly identified the rock pinnacle structures as biogenic in origin, having been created by the deepwater coral *Lophelia* (SKM, 2005). A subsequent ROV survey, completed by Ocean Affinity (July 2018), collected much higher resolution imagery of the rock pinnacle field which was sent to Professor Murray Roberts (University of Edinburgh) for expert assessment. It was confirmed that the yellow corals which were originally identified as *Lophelia* were “at first glance *Dendrophyllia cornigera* (well known in the Mediterranean Sea), but perhaps more likely a *Leptosammia* species (same family: *Dendrophylliidae*)”. It was also confirmed that there was no evidence of *Lophelia* sp. in the imagery that was reviewed (M. Roberts, personal communication). The pinnacles also provided structure for a diversity of fauna including fish and invertebrates. Many tens of fish were observed gathered around these pinnacles, most probably belonging to either the *Glaucosomidae* or *Pricanthidae* families. Crinoids, hydroids and ophiuroids were also common. The approximate location of the area where rock pinnacles are located is illustrated in **Figure 4-8**. The distance of the rock pinnacles from proposed subsea infrastructure and potential impacts to these are further discussed in **Section 6.6.2**. Other species visible on the mounds include anemones, soft corals, small crustaceans like shrimp and some larger brachyurans, possibly *Cyrtomaia suhmii.* No epifauna was observed on the exposed rock cliffs. Where the seabed gradients were less steep, sediments accumulated and large anemones and batfish were observed. However, both the abundance and diversity of epifauna was limited in these rock areas, compared to the sedimentary seabed located above and below this area of rock cliffs. At about 900–1000 m, mudstone outcrops were also observed dominated by glass sponges (Advisian, 2019).

Over the continental shelf section of the Permit Area, discrete areas of hard substrate hosting sessile filter feeding communities may be associated with the Continental Slope Demersal Fish Communities KEF and the nearby Ancient Coastline at the 125 m Depth Contour KEF. However, Falkner et al. (2009) concluded the Ancient Coastline may not represent different habitat type compared to the surrounding areas and suggested that associated faunal communities may be similar. Refer to **Section 4.7.3** for more information about KEFs overlapping the Permit Area and EMBA. ROV footage on the continental shelf (<300 m water depth), collected as part of subsea facility inspections around the Pluto field within Permit Area WA-34-L and WA-48-L, have been performed. While the Pluto platform itself is located within WA-48-L, in 83 m water depth, much of the subsea infrastructure including flowlines, pipelines and wellheads are in WA-34-L in ~190 m water depth. The footage from the Xeres-1A Well Head survey confirmed that the seabed comprises soft unconsolidated sediments, possibly fine sand silts. The well head structure provides hard substrate for colonisation by a range of invertebrates such as barnacles, hydroids and anemones. The structure in turn provides habitat for a range of fish species. The footage from the annual surveys of the Pluto frond mats also confirmed that the seabed surrounding the pipeline comprises soft unconsolidated sediments that are mainly fine sand. Pipelines and wellheads offer significant areas of hard bottom habitat in a region that is characterised by soft unconsolidated sediments. The most common forms present include barnacles, sea whips (Octocorals), anemones, hydroids and to a lesser extent sponges and crinoids (Advisian, 2019).

Within the EMBA, the NWMR has been identified as a sponge diversity hotspot with a variety of areas of potentially high and unique sponge biodiversity, particularly in the Commonwealth waters of Ningaloo Marine Park (CALM, 2005; Rees et al., 2004).

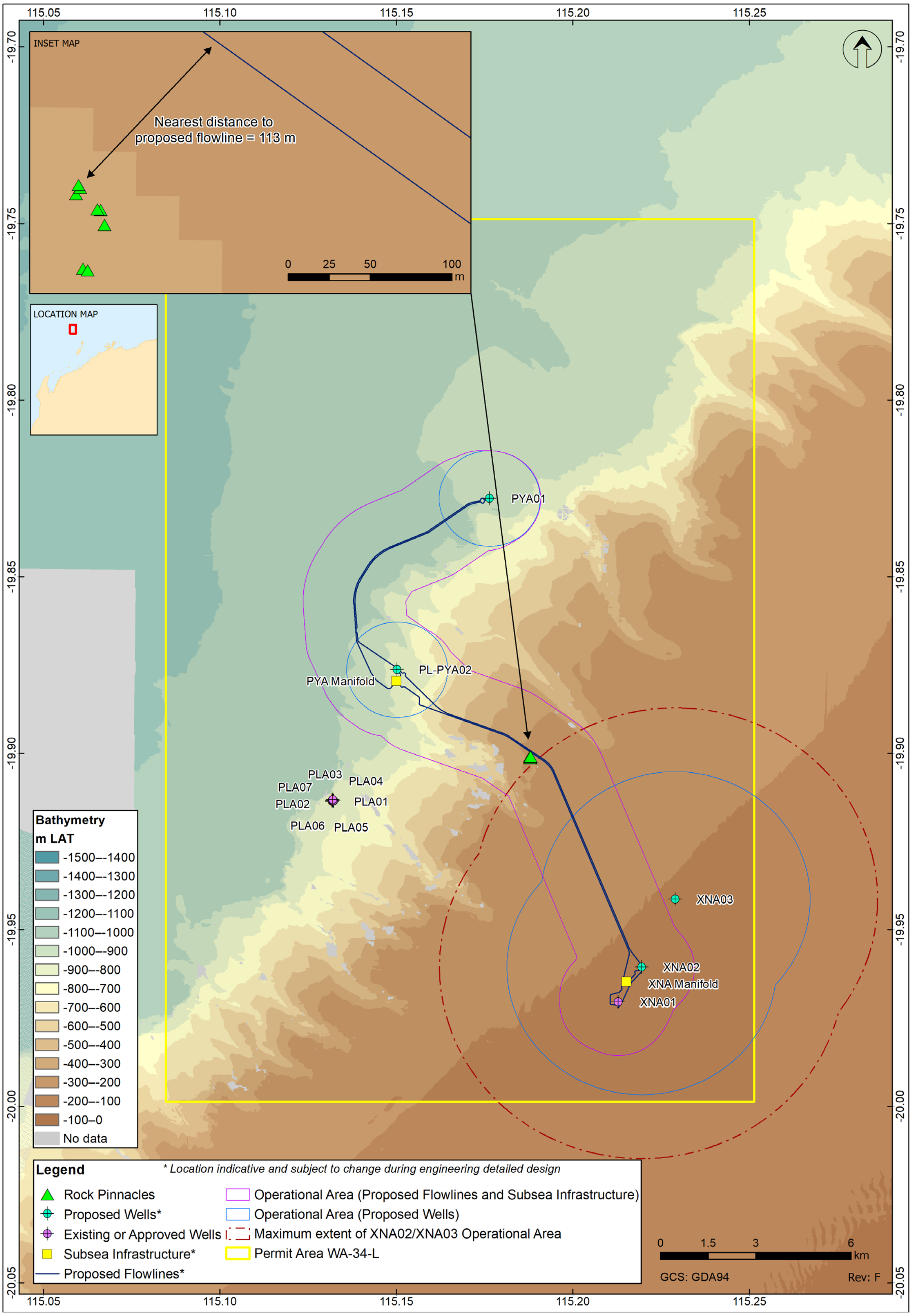


Figure 4-8: Location of rock pinnacles within Permit Area

4.5.2 Species

4.5.2.1 Protected Species

The EPBC Act Protected Matters Search Tool (PMST) has been used to identify listed species that may occur within the Permit Area and the EMBA; this informs the assessment of planned events as well as unplanned events in **Section 6**. Two EPBC Act PMST reports were generated: one based on the Permit Area, and one based on the EMBA. The EMBA is the combined entrained, dissolved and surface EMBAs for all credible hydrocarbon spill scenarios. 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.

A total of 40 EPBC Act listed species considered to be MNES were identified as potentially occurring within the Permit Area and EMBA. Of the 48 EPBC Act listed species, a subset of 33 species were identified as potentially occurring within the Permit Area. They include 25 and 42 species listed as threatened and/or migratory respectively. Two conservation dependent species have also been identified with a potential to occur within the Permit Area and EMBA. The full list of all marine species identified is provided in the EPBC Act PMST reports in **Appendix C** and summarised in **Table 4-3**.

Table 4-3: Threatened and migratory marine species under the EPBC Act potentially occurring with the Permit Area or within the EMBA

Species Name	Common Name	Threatened Status	Migratory Status	Permit Area/EMBA	
				Permit Area	*EMBA*
Mammals					
Balaenoptera borealis	Sei Whale	Vulnerable	Migratory	✓	✓
Balaenoptera musculus	Blue Whale	Endangered	Migratory	✓	✓
Balaenoptera physalus	Fin Whale	Vulnerable	Migratory	✓	✓
Megaptera novaeangliae	Humpback Whale	Vulnerable	Migratory	✓	✓
Eubalaena australis	Southern Right Whale	Endangered	Migratory	X	✓
Balaenoptera edeni	Bryde’s Whale	N/A	Migratory	✓	✓
Physeter macrocephalus	Sperm Whale	N/A	Migratory	✓	✓
Balaenoptera bonaerensis	Antarctic Minke Whale, Dark-shoulder Minke Whale	N/A	Migratory	X	✓
Orcinus orca	Killer Whale, Orca	N/A	Migratory	✓	✓
Tursiops aduncus (Arafura/Timor Sea populations)	Spotted Bottlenose Dolphin (Arafura/Timor Sea populations)	N/A	Migratory	✓	✓
Sousa chinensis	Indo-Pacific Humpback Dolphin	N/A	Migratory	X	✓
Dugong dugon	Dugong	N/A	Migratory	X	✓
Reptiles					
Caretta caretta	Loggerhead Turtle	Endangered	Migratory	✓	✓
Chelonia mydas	Green Turtle	Vulnerable	Migratory	✓	✓
Dermochelys coriacea	Leatherback Turtle, Leathery Turtle, Luth	Endangered	Migratory	✓	✓
Eretmochelys imbricata	Hawksbill Turtle	Vulnerable	Migratory	✓	✓
Natator depressus	Flatback Turtle	Vulnerable	Migratory	✓	✓
Aipysurus apraefrontalis	Short-nosed Seasnake	Critically endangered	N/A	X	✓

Species Name	Common Name	Threatened Status	Migratory Status	Permit Area/EMBA	
				Permit Area	*EMBA*
Sharks and Rays					
Carcharodon carcharias	White Shark, Great White Shark	Vulnerable	Migratory	✓	✓
Isurus oxyrinchus	Shortfin Mako, Mako Shark	N/A	Migratory	✓	✓
Isurus paucus	Longfin Mako	N/A	Migratory	✓	✓
Rhincodon typus	Whale Shark	Vulnerable	Migratory	✓	✓
Carcharias taurus	Grey Nurse Shark (west coast population)	Vulnerable	N/A	✓	✓
Manta birostris (recently revised taxonomy Mobula birostris (White et al., 2017)	Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray	N/A	Migratory	✓	✓
Manta alfredi (recently revised taxonomy Mobula alfredi (White et al., 2017)	Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray	N/A	Migratory	✓	✓
Anoxypristis cuspidata	Narrow Sawfish, Knifetooth Sawfish	N/A	Migratory	✓	✓
Pristis clavata	Dwarf Sawfish, Queensland Sawfish	Vulnerable	Migratory	X	✓
Pristis zijsron	Green Sawfish, Dindagubba, Narrowsnout Sawfish	Vulnerable	Migratory	✓	✓
Fish					
Sphyrna lewini	Scalloped Hammerhead	Conservation dependent	N/A	✓	✓
Thunnus maccoyii	Southern Bluefin Tuna	Conservation dependent	N/A	✓	✓
Birds					
Calidris canutus	Red Knot, Knot	Endangered	Migratory	✓	✓
Calidris ferruginea	Curlew Sandpiper	Critically endangered	Migratory	✓	✓
Macronectes giganteus	Southern Giant-Petrel, Southern Giant Petrel	Endangered	Migratory	✓	✓
Numenius madagascariensis	Eastern Curlew, Far Eastern Curlew	Critically endangered	Migratory	✓	✓

Species Name	Common Name	Threatened Status	Migratory Status	Permit Area/EMBA	
				Permit Area	EMBA
Actitis hypoleucos	Common Sandpiper	N/A	Migratory	✓	✓
Anous stolidus	Common Noddy	N/A	Migratory	✓	✓
Calidris acuminata	Sharp-tailed Sandpiper	N/A	Migratory	✓	✓
Calidris melanotos	Pectoral Sandpiper	N/A	Migratory	✓	✓
Fregata ariel	Lesser Frigatebird, Least Frigatebird	N/A	Migratory	✓	✓
Calonectris leucomelas	Streaked Shearwater	N/A	Migratory	✓	✓
Pandion haliaetus	Osprey	N/A	Migratory	✓	✓
Sternula nereis	Australian Fairy Tern	Vulnerable	Migratory	X	✓
Fregata minor	Great Frigatebird, Greater Frigatebird	N/A	Migratory	X	✓
Papasula abbotti	Abbott's Booby	Endangered	N/A	X	✓
Pterodroma mollis	Soft-plumaged Petrel	Vulnerable	N/A	X	✓
Rostratula australis	Australian Painted-snipe	Endangered	N/A	X	✓
Thalassarche impavida	Campbell Albatross	Vulnerable	Migratory	X	✓
Apus pacificus	Fork-tailed Swift	N/A	Migratory	X	✓
Ardenna carneipes	Flesh-footed Shearwater	N/A	Migratory	X	✓
Sterna dougallii	Roseate Tern	N/A	Migratory	X	✓

Listed Threatened Species Recovery Plans

The requirements of the species recovery plans and conservation advices (**Table 4-4**) will be considered to identify any requirements that may apply to the risk assessment (**Section 6**). Recovery plans are enacted under the EPBC Act and remain in force until the species is removed from the Threatened list. Conservation advice provides guidance on immediate recovery and threat abatement activities that can be performed to facilitate the conservation of a listed species or ecological community.

Table 4-4 outlines the recovery plans and conservation advices relevant to those species identified as potentially occurring within or using habitat in the Permit Area and EMBA areas by the EPBC Protected Matters search (**Table 4-4**) and summarises the key threats to those species, as described in relevant recovery plans and conservation advices.

Table 4-4: Conservation advice for EPBC Act listed species considered during environmental risk assessment

Species	Recovery plan/conservation advice (date issued)	Key threats identified in the recovery plan/ conservation advice	Relevant conservation actions/advice	Relevant EP section
All vertebrate fauna				
All vertebrate fauna	Threat abatement plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans (Department of the Environment and Energy (DoEE), 2018)	Marine debris	Identify offshore installations such as oil rigs as a potential source of marine debris.	**6.7.7**
Marine Mammals				
Sei whale	Conservation advice *Balaenoptera borealis* (sei whale) (Threatened Species Scientific Committee, 2015a)	Noise interference	Assess and manage acoustic disturbance.	**0**
		Vessel disturbance	Assess and manage physical disturbance and development activities.	**6.7.3**
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)	Noise interference	Assessing and addressing anthropogenic noise.	**0**
		Vessel disturbance	Minimising vessel collisions.	**6.7.3**
Fin whale	Approved conservation advice for *Balaenoptera physalus* (fin whale) (Threatened Species Scientific Committee, 2015b)	Noise interference	Assessing and addressing anthropogenic noise.	**0**
		Vessel disturbance	Minimising vessel collisions.	**6.7.3**
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, 2012b)	Noise interference	Assessing and addressing anthropogenic noise.	**6.6.3**
		Vessel disturbance	Minimising vessel collisions.	**6.7.3**
Humpback whale	Approved conservation advice for *Megaptera novaeangliae* (humpback whale) (Threatened Species Scientific Committee, 2015c)	Noise interference	Assessing and addressing anthropogenic noise.	**6.6.3**
		Vessel disturbance	Minimising vessel collisions.	**6.7.3**

Species	Recovery plan/conservation advice (date issued)	Key threats identified in the recovery plan/ conservation advice	Relevant conservation actions/advice	Relevant EP section
Reptiles				
All marine turtle species (loggerhead turtle, green turtle, leatherback turtle, hawksbill turtle, flatback turtle)	Recovery plan for marine turtles in Australia (DoEE, 2017)	Marine debris	Reduce the impacts from marine debris.	**6.7.7**
		Chemical discharge	Minimise chemical discharge.	**6.6.5**, **6.6.6**, **6.7.5**, **6.7.6**
		Light pollution	Minimise light pollution.	**6.6.9**
		Vessel disturbance	No explicit relevant management actions; vessel strikes identified as a threat.	**6.7.3**
		Noise interference	No explicit relevant management actions; vessel strikes identified as a threat.	**6.7.3**
Leatherback turtle	Approved conservation advice on *Dermochelys coriacea* (Threatened Species Scientific Committee, 2008a)	Vessel disturbance	No explicit relevant management actions; vessel strikes identified as a threat.	**6.7.3**
Short-nosed seasnake	Approved conservation advice for *Aipysurus apraefrontalis* (short-nosed sea snake) (DSEWPaC, 2011)	Habitat degradation/ modification	None applicable.	N/A
Sharks and Rays				
Grey nurse shark (west coast population)	Recovery plan for the grey nurse shark (*Carcharias taurus*) (Department of the Environment, 2014)	No additional threats identified (ex. marine debris)	None applicable.	N/A
White shark, great white shark	Recovery plan for the white shark (*Carcharodon carcharias*) (DSEWPaC, 2013)	No additional threats identified (ex. marine debris)	None applicable.	N/A
All sawfish (green sawfish, dwarf sawfish)	Sawfish and river shark multispecies recovery plan (Commonwealth of Australia, 2015b)	Habitat degradation/ modification	No explicit relevant management actions; habitat loss, disturbance and modification identified as a threat.	**6.6.2**, **6.7.9**, **6.7.10**
Green sawfish, dindagubba, narrow snout sawfish	Approved conservation advice for green sawfish (Threatened Species Scientific Committee, 2008b)	Habitat degradation/ modification	No explicit relevant management actions; habitat loss, disturbance and modification identified as a threat.	**6.6.2**, **6.7.9**, **6.7.10**
Dwarf sawfish	Approved conservation advice for *Pristis clavata* (dwarf sawfish) (DEWHA, 2009a)	Habitat degradation/ modification	No explicit relevant management actions; habitat loss, disturbance and modification identified as a threat.	**6.6.2**, **6.7.9**, **6.7.10**

Species	Recovery plan/conservation advice (date issued)	Key threats identified in the recovery plan/ conservation advice	Relevant conservation actions/advice	Relevant EP section
Whale shark	Approved Conservation Advice for *Rhincodon typus* (whale shark) (Threatened Species Scientific Committee, 2015d)	Vessel disturbance	Minimise offshore developments and transit time of large vessels in areas close to marine features likely to correlate with whale shark aggregations and along the northward migration route that follows the northern Western Australian coastline along the 200 m isobath.	**6.7.8**
		Habitat degradation/ modification	No explicit relevant management actions; habitat loss, disturbance and modification identified as a threat.	**6.6.2**, **6.7.9**, **6.7.10**
Seabirds				
Migratory shorebird species (red knot, bar-tailed godwit, pectoral sandpiper, oriental plover, oriental pratincole, osprey, common greenshank)	Wildlife conservation plan for migratory shorebirds (Commonwealth of Australia, 2015c)	Habitat degradation/ modification	Ensure all areas important to migratory shorebirds in Australia continue to be considered in development assessment processes.	**6.7.7**, **6.6.5**, **6.6.6**, **6.7.5**, **6.7.6**
Red knot, knot	Approved Conservation Advice for *Calidris canutus* (red knot) (Threatened Species Scientific Committee, 2016a)	Pollution/contamination	No explicit relevant management actions; pollution identified as a threat.	**6.7.7**, **6.6.5**, **6.6.6**, **6.7.5**, **6.7.6**
Eastern curlew, far eastern curlew	Approved Conservation Advice for *Numenius madagascariensis* (eastern curlew) (Threatened Species Scientific Committee, 2015e)	Pollution/contamination	No explicit relevant management actions; pollution identified as a threat.	**6.7.7**, **6.6.5**, **6.6.6**, **6.7.5**, **6.7.6**
Southern giant-petrel, *Campbell albatross*	National recovery plan for threatened albatrosses and giant petrels (DSEWPaC, 2011)	Marine pollution	No explicit relevant management actions; pollution identified as a threat.	**6.7.7**, **6.6.5**, **6.6.6**, **6.7.5**, **6.7.6**
Curlew sandpiper	Conservation advice *Calidris ferruginea* curlew sandpiper (Threatened Species Scientific Committee, 2015f)	Marine pollution	No explicit relevant management actions; pollution identified as a threat.	**6.7.7**, **6.6.5**, **6.6.6**, **6.7.5**, **6.7.6**

Species	Recovery plan/conservation advice (date issued)	Key threats identified in the recovery plan/ conservation advice	Relevant conservation actions/advice	Relevant EP section
Soft-plumaged petrel	Conservation advice *Pterodroma mollis* soft plumaged petrel (Threatened Species Scientific Committee, 2015g)	Habitat degradation/modification	No explicit relevant management actions.	**6.7.7**, **6.6.5**, **6.6.6**, **6.7.5**, **6.7.6**
Abbott's booby	Conservation Advice *Papasula abbotti* Abbott's booby (Threatened Species Scientific Committee, 2015h)	Habitat degradation/modification	No explicit relevant management actions.	**6.7.7**, **6.6.5**, **6.6.6**, **6.7.5**, **6.7.6**

Habitat Critical to the Survival of a Species

The Recovery Plan for Marine Turtles in Australia (DoEE, 2017) has established a 'Habitat Critical to the Survival of a Species' that identifies critical habitats for the survival for marine turtle stocks under the EPBC Act. Habitat critical to the survival of a species 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
- for reintroducing populations or recovery of the species.

Nesting and internesting habitats have been identified, described and mapped for the green turtle, loggerhead turtle, flatback turtle, hawksbill turtle, olive ridley turtle and the leatherback turtle (DoEE, 2017). The Permit Area does not include any 'habitat critical to the survival of a species' though some are located in the EMBA (Figure 4-9).

It is noted that 'habitat critical to the survival of a species' differs from 'Critical Habitat' as defined under Section 207A of the EPBC Act (Register of Critical Habitat). No 'Critical Habitat' has been identified and listed for marine turtles.

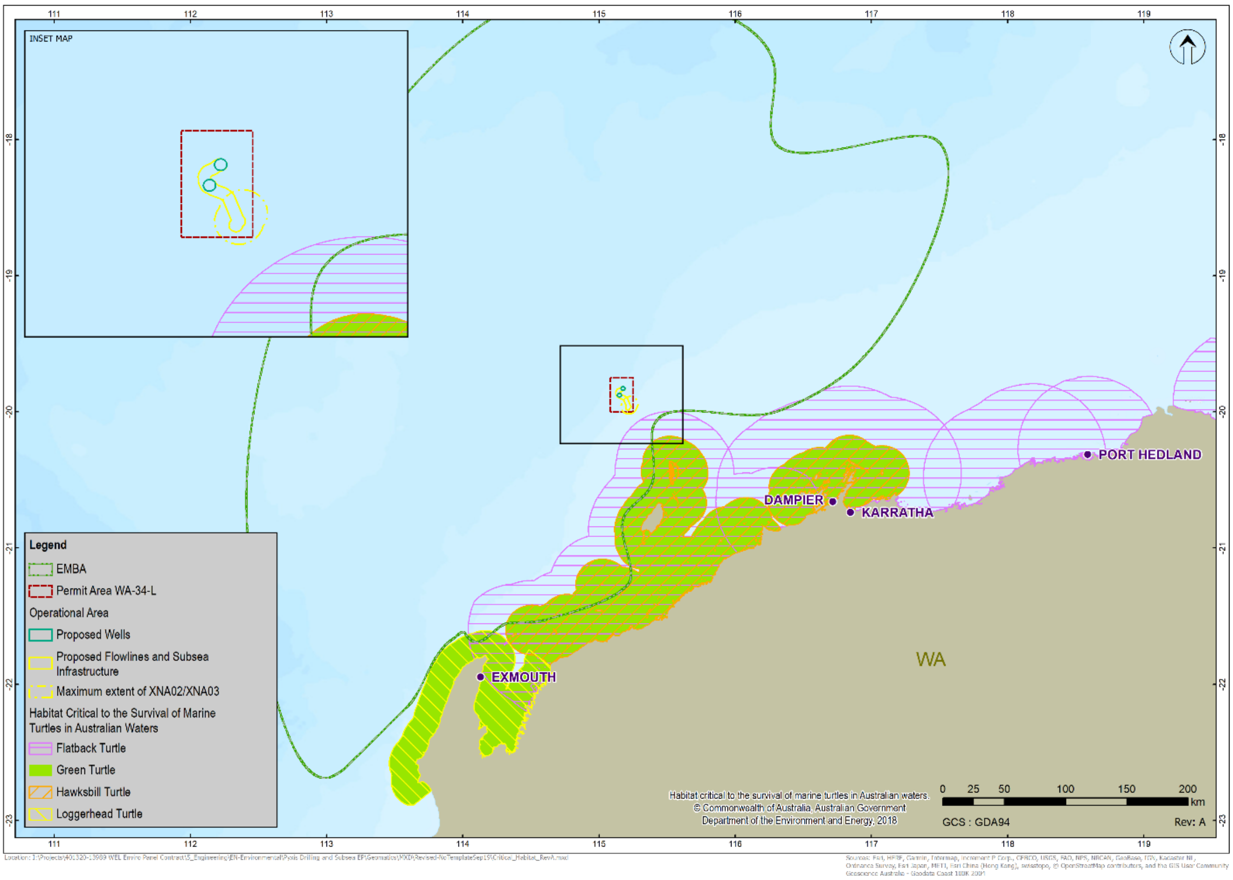


Figure 4-9: Habitat critical to the survival of marine turtle species in the EMBA

Biologically Important Areas

A review of the DoEE Conservation Values Atlas identified that the following BIAs overlap spatially with the Permit Area:

- pygmy blue whale migration corridor (northern migration April to August; southern migration October to January) from Indonesian Waters to south-west Australia.
- flatback turtle internesting buffer around the Montebello Islands and Dampier Archipelago during their summer nesting period
- whale shark foraging area off Ningaloo Coast along the 200 m isobath, with seasonally high use (April–June)
- foraging area for the wedge-tailed shearwater across the Kimberley, Pilbara and Gascoyne coasts during its breeding season (August–April). This species was not identified through the PMST search as having the potential to occur within the Permit Area or EMBA.

A number of additional BIAs occur within the EMBA. These BIAs are summarised in **Table 4-5**. Refer to specific fauna sections in **Section 4.5.2** for further discussion of BIAs within the EMBA.

Table 4-5: BIAs beyond the Permit Area but within the EMBA

Species	BIA type	Approximate distance from closest point of Permit Area (km)
Mammals		
Humpback whale	Migration (North and South)	30
Pygmy blue whale	Foraging (Ningaloo)	220
Marine Reptiles		
Flatback turtle	Internesting buffer (Thevenard Island)	65
Green turtle	Internesting buffer (Montebello Islands)	25
	Internesting buffer (Middle Island West Coast and Barrow Island West Coast and North Coast)	55
Hawksbill turtle	Internesting buffer (Montebello Islands)	30
	Internesting buffer (Barrow Island)	60
Loggerhead turtle	Internesting buffer (Montebello Islands)	40
Birds		
Lesser crested tern*	Breeding (Kimberley, Pilbara and Gascoyne coasts and islands)	45
Fairy tern	Breeding (Pilbara and Gascoyne coasts and islands)	40
Roseate tern	Breeding (Kimberley, Pilbara and Gascoyne coasts and islands)	45

** The lesser crested tern is not listed as migratory or threatened under the EPBC Act.*

Seasonal Sensitivities of Protected Species

Periods of the year coinciding with key environmental sensitivities for the Permit Area and the wider regional context, including EPBC Act listed threatened and/or migratory species potentially occurring within the Permit Area are presented in **Table 4-6**. These relate to breeding, foraging or migration of the indicated fauna.

Table 4-6: Key environmental sensitivities and timings for fauna (indicative)

Species	January	February	March	April	May	June	July	August	September	October	November	December
Species identified as occurring across the Permit Area												
Blue whale – northern migration (Exmouth, Montebello, Scott Reef)[1]												
Blue whale – southern migration (Exmouth, Montebello, Scott Reef)[2]												
Humpback whale – northern migration (Jurien Bay to Montebello)[3]												
Humpback whale – southern migration (Montebello to Jurien Bay)[4]												
Bryde's whale – foraging (Shark Bay)[6]												
Killer whale – foraging (Shark Bay)[6]												
Whale shark* – foraging/aggregation near Ningaloo[10]												
Green turtle – various nesting/feeding/hatchlings/ mating areas within wider region[8]												
Flatback turtle – various nesting/feeding/ hatchlings/mating areas within wider region[8]												
Loggerhead turtle – various nesting areas within wider region[8]												
Hawksbill turtles – various nesting/hatchlings/ mating areas within wider region [9]												
Manta rays – presence/aggregation/breeding (Ningaloo)[11]												
Migratory shorebirds – aggregation/breeding[7]												
Osprey – breeding (Ningaloo)[13]												
Species identified as occurring in the EMBA												
Antarctic minke whale – presence (Scott Reef)[5]												
Fairy tern – breeding (Ningaloo)[12]												
Roseate tern – breeding (Ningaloo) [12]												

	Species likely to be present in the region
	Peak period. Presence of animals reliable and predictable each year

References for species seasonal sensitivities:

1. (DSEWPaC, 2012a,b; McCauley and Jenner, 2010; McCauley, 2011)
2. (DSEWPaC, 2012a, b; McCauley and Jenner, 2010)
3. (CALM, 2005; Environment Australia, 2002; Jenner et al., 2001a; McCauley and Jenner, 2001)
4. (McCauley and Jenner, 2001)
5. (McCauley, 2011)
6. (Department of Environmental Protection, 2001)
7. (CALM, 2005; Department of Environmental Protection, 2001; DSEWPaC, 2012b; Environment Australia, 2002)
8. (Chevron Australia Pty Ltd, 2015; CALM, 2005; DSEWPaC, 2012a)
9. (Chevron Australia Pty Ltd, 2015; DSEWPaC, 2012a)

10. (CALM, 2005; DSEWPaC, 2012a; Environment Australia, 2002; Sleeman et al., 2010)
11. (Environment Australia, 2002)
12. (CALM, 2005; Environment Australia, 2002)

**Periods of sensitivity include whale shark foraging off Ningaloo Coast and foraging northward from the Ningaloo Marine Park along the 200 m isobath.*

4.5.2.2 Marine Mammals

Cetaceans – Whales

Sei Whale

The Sei whale is a baleen whale which, like many species of baleen whales, was significantly reduced in numbers by commercial whaling. The species has 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). Sei whales have been infrequently recorded in Australian waters (Bannister et al., 1996) which could be due to the similarity in appearance of sei whales and Bryde's whales leading to incorrect recordings. There are no known mating or calving areas in Australian waters. The species has a preference for deep waters, and typically occurs in oceanic basins and continental slopes (Prieto et al., 2012); records of the species occurring on the continental shelf (<200 m water depth) are uncommon in Australian waters (Bannister et al., 1996).

Occurrence within the Permit Area is likely to be restricted to one or a few individuals infrequently transiting the area, with a higher likelihood of occurrence during winter months. Sei whales may also occur in the EMBA, in oceanic waters beyond the continental shelf during winter months when the species moves away from Antarctic feeding areas.

Blue Whale

There are two recognised subspecies 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) (Department of Environment and Heritage, 2005a). On this basis, nearly all blue whales sighted in the NWMR are likely to be pygmy blue whales.

The 2015 Conservation Management Plan for the Blue Whale (Commonwealth of Australia, 2015a) delineated the known distribution of blue whales in Australian waters and identified a number of BIAs for blue whales within WA waters (migratory corridor and foraging BIAs). The migration corridor BIA established in the plan is based on passive acoustic monitoring conducted by McCauley and Jenner (2010) and overlaps the Permit Area.

Data from the study was used to estimate migration timing and numbers of whales passing by the survey area. From this, the study reported that between 662 and 1559 whales passed the Exmouth noise logger during the 2004 southerly migration (McCauley and Jenner, 2010). The pygmy blue whale northern migration was more protracted (83 days, versus 51 days during the southern migration, for 90% of the whales to pass); therefore, conversion to population estimates was not considered reliable. More recent acoustic and satellite tracking surveys at various locations along the WA coast have further delineated pygmy blue whale migration from McCauley and Jenner (2010) as an annual north-bound migration past Exmouth and the Montebello Islands between April and August (peak period between May and June), and southbound migration from October to the end of January, peaking in late November to early December (Double et al., 2014; McCauley and Duncan, 2011).

The pygmy blue whale migration is thought to follow deep oceanic routes (DEWHA, 2008). In the NWMR, pygmy blue whales migrate along the 500 m to 1000 m depth contour on the continental slope where they are likely to feed opportunistically on ephemeral krill aggregations (DEWHA, 2008). Satellite tagging (2009–2012) established the general distribution for pygmy blue whales to be in water depths over 200 m and commonly over 1000 m (Double et al., 2012b) (**Figure 4-10**). This data was revisited in 2014 and showed that whales travelled relatively near to the Australian coastline (100.0 ± 1.7 km) until reaching North West Cape, after which they travelled offshore (238.0 ± 13.9 km). Once away from the Australian coast, the water depths of recorded pygmy blue whale presence exceeded 4000 m (Double et al., 2014).

Occurrence within the Permit Area and the EMBA is likely to be mostly restricted to one or a few individuals occasionally transiting the area, with a higher likelihood of occurrence during April–August and October–January, during their seasonal migrations.

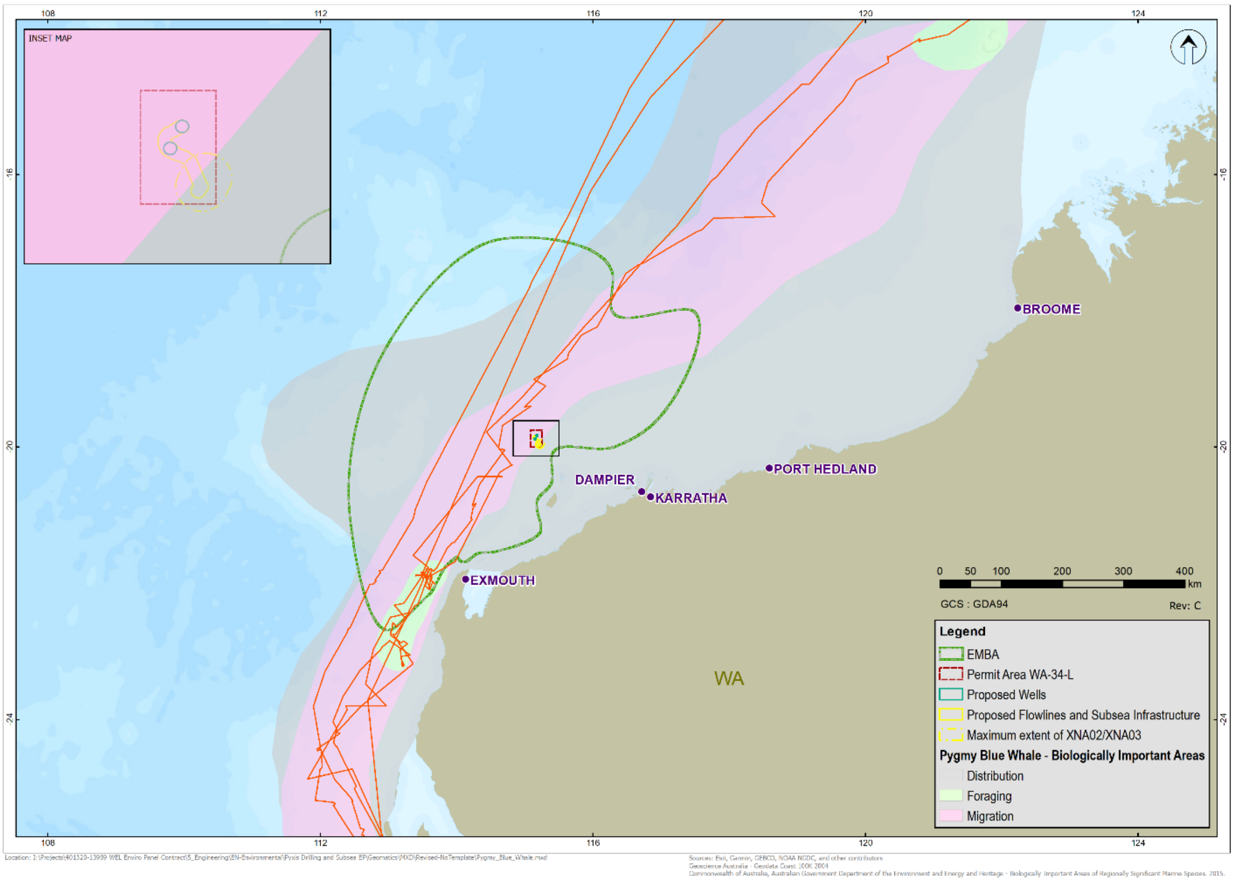


Figure 4-10: Permit Area and pygmy blue whale satellite tracks and BIAs (after Double et al., 2012b, 2014)

Fin Whale

The fin whale is a large baleen whale with a cosmopolitan distribution in all ocean basins between 20 and 75 °S (Department of Environment and Heritage, 2005a). The global population of fin whales was reduced significantly by commercial whaling, with the species being targeted due to its large size and broad distribution. Like other baleen whales, fin whales migrate annually between high latitude summer feeding grounds and lower latitude over-wintering areas (Bannister et al., 1996).

Fin whales are thought to follow oceanic migration paths, and are uncommonly encountered in coastal or continental shelf waters. The 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). There are also no known BIAs for fin whales in the NWMR. Fin whales are likely to infrequently occur within the Permit Area. Occurrence within the Permit Area and offshore areas of the EMBA is likely to be mostly restricted to one or a few individuals occasionally transiting the area, mainly during winter months when the species may move away from Antarctic feeding areas.

Humpback Whale

Humpback whales occur throughout Australian waters as two genetically distinct, east and west populations; both populations' distributions are influenced by migratory pathways and aggregation areas for resting, breeding and calving. In the west, humpback whales migrate north to breeding grounds in Camden Sound of the west Kimberley, between May and November, after feeding in Antarctic waters during the summer months (Jenner et al., 2001). Calving typically occurs between mid-August and early September, within nearer shelf waters of the Camden Sound (outside the EMBA; about 1100 km away from the Permit Area). The whales' southern migration runs between August and November, with females and calves the last to leave the breeding grounds. The humpback whale population that migrates along the Western Australian coast has been estimated to be as large as 33,300 in 2008 (Salgado-Kent et al., 2012).

From the North West Cape, north-bound humpback whales travel along the edge of the continental shelf passing mainly to the west of the Muiron, Barrow and Montebello islands (**Figure 4-11**). The southern migratory route follows a relatively narrow track between the Dampier Archipelago and Montebello Islands. The humpback migration BIA is about 30 km from the Permit Area within the EMBA. Exmouth Gulf and Shark Bay are known resting/aggregation areas for southbound humpback whales. In particular, cow/calf pairs may stay in Exmouth Gulf for up to two weeks. The Exmouth Gulf and Shark Bay humpback whale BIAs are located outside the EMBA, located about 210 km and 530 km away respectively from the Permit Area. Noise loggers deployed near the Goodwyn facility (located about 55 km from the Permit Area) detected humpback whales at the end of September, likely migrating south, and from June to mid-August in deeper water, nearer to the continental shelf, likely migrating north (RPS Environment and Planning, 2011). The southward migration of cow/calf pairs is slightly later during October (extending into November and December). During the southbound migration it is likely that most individuals, particularly cow/calf pairs, stay closer to the coast than the northern migratory path. During these migration periods, humpback whales may occur within the Permit Area.

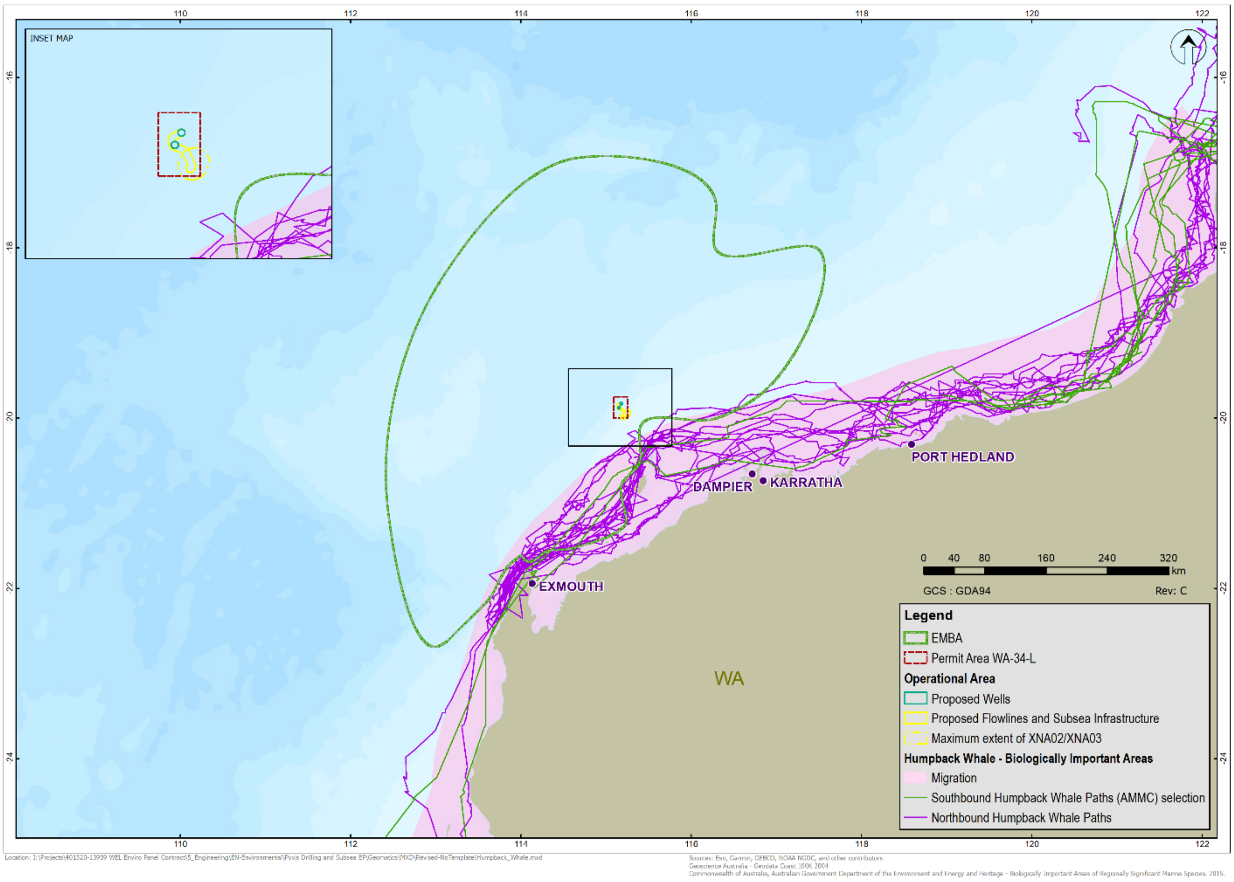


Figure 4-11: Permit Area and humpback whale satellite tracks and BIA (Double et al., 2010, after 2012a)

Southern Right Whale

Southern right whales were identified as occurring within the EMBA, not within the Permit Area. 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, such as Doubtful Island Bay, east of Israelite Bay and to a lesser extent Twilight Cove (DoE, 2016c). During the calving season, between May and November, female southern right whales that are either pregnant or with calf can be in shallow protected waters along the entire southern Western Australian coast and west up to about Two Rocks, north of Perth. Sightings in more northern waters are relatively rare; however, they have been recorded as far north as Exmouth (Bannister et al., 1996).

Antarctic Minke Whale

The Antarctic minke whale is distributed worldwide and has been recorded off all Australian states, 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 is not well known. In the EMBA, the Antarctic minke whale may be seasonally present during winter months in low numbers; however, the species is not expected to occur within the Permit Area.

Bryde's Whale

Bryde's whales are distributed widely throughout tropical and sub-tropical waters (DoEE, 2015). 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 Abrolhos Islands and north of Shark Bay (Bannister et al., 1996). Two movement behaviours are recognised for Bryde's whales: inshore (largely sedentary) and offshore (may migrate). Data suggests offshore whales may migrate seasonally, heading towards warmer tropical waters during the winter; however, information about migration is not well known (McCauley and Duncan, 2011). There is some taxonomic confusion, with Bryde's whales bearing similarity to, and historically confused with, the sei whale (Bannister et al., 1996), particularly in whaling catch statistics (Slijper et al., 1964).

Bryde's whales may occur through a broad area of the continental shelf in the NWMR region, including the Permit Area and EMBA (McCauley and Duncan, 2011; RPS Environment and Planning, 2011). This species has been detected within the NWMR from mid-December to mid-June, peaking in late February to mid-April (RPS Environment and Planning, 2011). The presence of Bryde's whales in the Permit Area is likely to be a remote occurrence and limited to a few individuals. In the EMBA, occurrence is also likely to be limited. There are no known BIAs for Bryde's whales in the NWMR.

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). Sperm whales have been recorded in all Australian state waters and are known to migrate northward in winter and southwards in summer (Bannister et al., 1996). In Western Australia, sperm whales have two BIAs recognised for foraging activities. These two areas are located west of Rottnest Island and along the southern coastline between Cape Leeuwin and Esperance (outside the EMBA). In deep water off the North West Cape, sperm whales have been sighted in pod sizes up to six animals between February and April from two separate surveys, in 2010 and 2017 (EPI Group, 2017; RPS Environment and Planning, 2010).

The species is known to migrate northwards in winter and southwards in summer but detailed information about the distribution and migration patterns of sperm whales off the WA coast is not available. Sperm whales are likely to only infrequently occur within proximity to the Permit Area and in far offshore waters of the EMBA. Their presence is likely to be a rare occurrence and limited to a few individuals infrequently transiting the area, particularly during winter months.

Cetaceans – Tooth Whales, Dolphins and Porpoises

Killer Whale

Killer whales are found in all of the world's oceans, from the Arctic and Antarctic regions to tropical seas (Department of Environment, 2013a; Ford et al., 2005), and have been recorded off all states of Australia (Bannister et al., 1996). 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 & Gill, 1999).

Anecdotal evidence suggests killer whales may feed on dugongs in Shark Bay (outside the EMBA), between June and August (Department of Environmental Protection, 2001), but there are no recognised key localities or important habitats for killer whales within the Permit Area or EMBA. The presence of killer whales is likely to be a rare occurrence and limited to a few individuals infrequently transiting the EMBA, with a very low likelihood of them transiting the Permit Area.

Indo-Pacific Humpback Dolphin

The Indo-Pacific humpback dolphin's taxonomy was recently revised with evidence that there are multiple species under the *Sousa* genus which are distinguished by their morphology, genetics and biogeography (Jefferson and Rosenbaum, 2014). The species present in Australian waters is considered a newly described species: the Australian humpback dolphin. This species is defined mainly by a large distributional gap which corresponds with a long-standing boundary between faunal regions in Australia and much of Asia, also known as the Wallace Line (Jefferson and Rosenbaum, 2014).

The Australian humpback dolphin is distributed across the Sahul Shelf, from northern Australia to southern New Guinea (Jefferson and Rosenbaum, 2014). Distribution of the humpback dolphin in Australia is linked to the warm eastern boundary current, with resident groups within Ningaloo Reef (Bannister et al., 1996). Humpback dolphins inhabit shallow coastal, estuarine habitats in tropical and subtropical regions generally in depths of less than 20 m (Corkeron et al., 1997; Jefferson, 2000; Jefferson and Rosenbaum, 2014).

There are a number of BIAs listed for Australian humpback dolphins in the NWMR; however, none overlap the EMBA or Permit Area. Given their preference for shallow coastal habitats, the Australian humpback dolphin is unlikely to occur within the Permit Area but may be infrequently present in shallower waters of the EMBA.

Spotted Bottlenose Dolphin (Arafura/Timor Sea populations)

There are four known subpopulations of spotted bottlenose dolphins, of which the Arafura/Timor Sea populations were identified as potentially occurring within the Permit Area and the EMBA. The species occurs in open coastal waters, primarily within the continental shelf, and within the coastal waters of oceanic islands from Shark Bay to the western edge of the Gulf of Carpentaria. The species forages in a range of habitats and within deeper waters than most dolphin species, but is generally restricted to water depths of less than 200 m (DSEWPaC, 2012a).

The Arafura/Timor Sea spotted bottlenose dolphin population is considered migratory; however, its movement patterns are considered highly variable, with some individuals displaying year-round residency to a small area and others undertaking long-range movements and migrations (DoEE, 2017). The species is likely to occur only infrequently in the Permit Area. Within the EMBA, the species is likely to transit across the continental shelf waters of the NWMR.

Dugongs

Dugongs are large herbivorous marine mammals that generally inhabit coastal areas. The species is distributed along the Western Australian coast throughout the Gascoyne, Pilbara and Kimberley, with notable populations in the following areas (DSEWPaC, 2012a; Marsh et al., 2002; Preen et al., 1997):

- Ningaloo Marine Park (State waters) (about 210 km south-west of the Permit Area, outside the EMBA)
- Exmouth Gulf (about 210 km south-west of the Permit Area, outside the EMBA).

Dugong distribution is correlated with seagrass habitat in which dugong feed, 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). However, given that the Permit Area is located offshore in deep water which does not support seagrass habitat and does not contain any critical dugong habitat, the occurrence of dugongs in the area is considered unlikely. There are no dugong BIAs within the EMBA, about 205 km south-west of the Permit Area.

4.5.2.3 Marine Reptiles

Marine Turtles

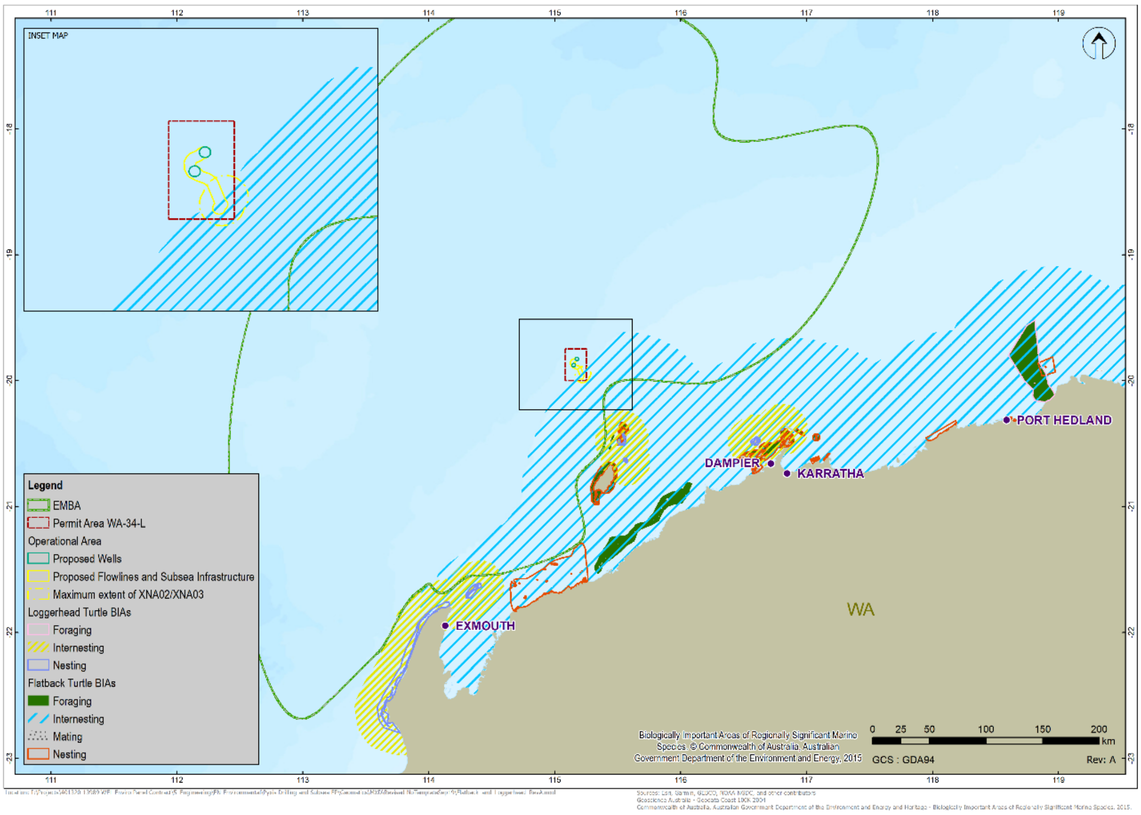
Five of the six marine turtle species recorded for the NWMR have the potential to occur within the Permit Area (**Appendix C**): the loggerhead, green, leatherback, hawksbill and flatback turtles.

There is no emergent habitat within the Permit Area; therefore, nesting aggregations of marine turtles are unlikely to occur in the vicinity of the Permit Area. Given the water depth (greater than 130 m) foraging adult turtles are not expected to occur within the Permit Area, except for the leatherback turtle which feeds predominantly on gelatinous pelagic fauna such as jellyfish. Turtles may forage at Rankin Bank, which lies about 25 km east of the Permit Area.

One BIA for the flatback turtle overlaps the Permit Area.

- flatback turtle internesting buffer around the Montebello Islands and Dampier Archipelago during their summer nesting period.

Table 4-5, and **Figure 4-12** details additional BIAs which overlap the EMBA. There are no additional areas considered habitat critical to the survival of marine turtle species, as identified in the Recovery Plan for Marine Turtles in Australia 2017–2027 (Commonwealth of Australia, 2017) which overlap the Permit Area or EMBA.



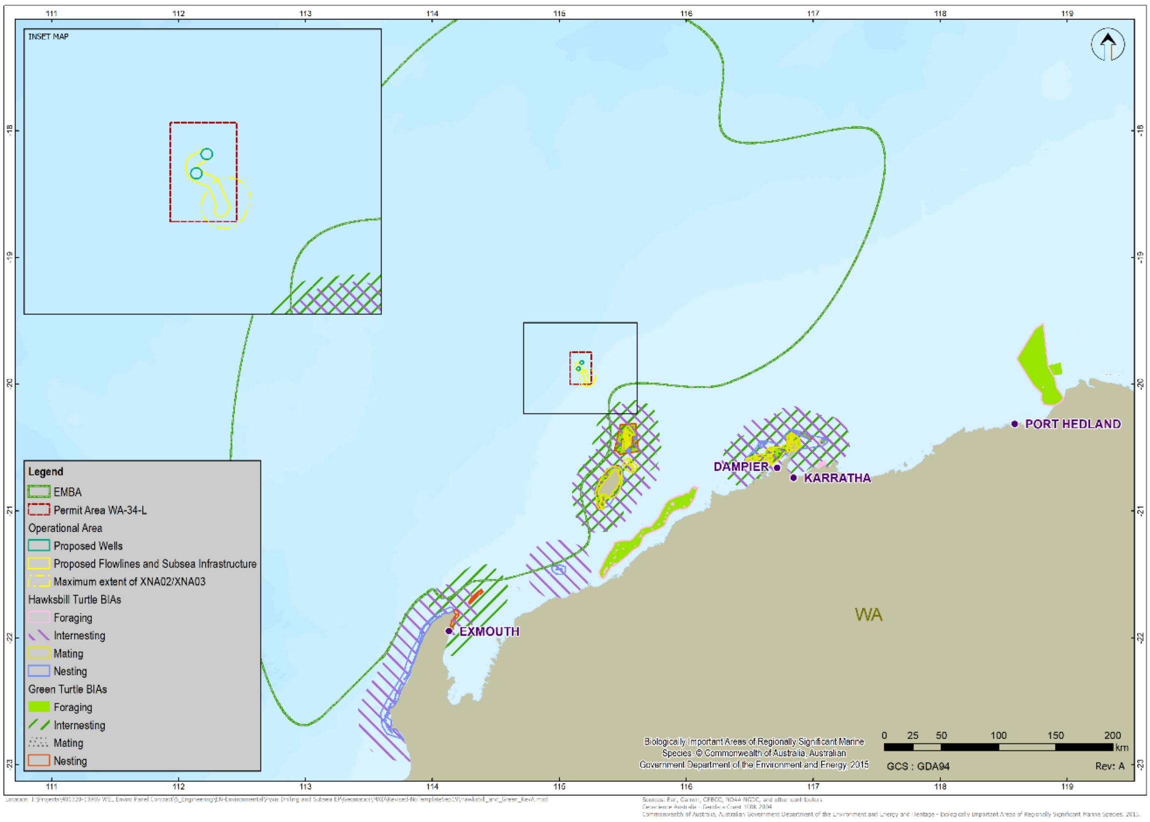


Figure 4-12: BIAs for marine turtles in region of the EMBA

The internesting and nesting BIAs are based on known nesting beaches, which are widely distributed throughout the mainland coast and islands of the Pilbara. Many turtles are likely to remain near their nesting beaches, and as they leave beaches they typically spread out and consequently, density decreases rapidly with increasing distance from a nesting beach (Waayers et al., 2011; Whittock et al., 2014). It is also possible that marine turtles forage in shallow waters along the mainland coastline, as well as around offshore islands and shoals.

Four of the turtle species (green, loggerhead, flatback and hawksbill) have significant nesting rookeries on beaches along the mainland coast and islands off the coast including the Montebello/Barrow islands, all of which are outside the EMBA (50 km and 80 km from the Permit Area respectively) (Commonwealth of Australia, 2017; Limpus, 2007, 2008a,b, 2009a,b). **Table 4-7** provides additional details of the marine turtle species identified, including breeding and nesting seasons, diet and key habitats (including BIAs) within the NWMR (including areas outside of the EMBA region).

Table 4-7: Key information about marine turtles in the North West Marine Region

Turtle species	Key seasons within the NWMR	Diet	Key habitats
Green turtle	**Breeding**: Approximately September to March. **Nesting**: November to April. Peak period from January to February.	Seagrasses and algae	**Preferred habitat**: Nearshore reef habitats in the photic zone. **Distribution**: Ningaloo Coast to Lacepede Islands. **Major nesting sites**: Montebello Islands, Barrow Island, Muiron Islands, some islands of the Dampier Archipelago, and North West Cape. **Internesting habitat**: Generally within 10 km of nesting beaches (Waayers et al., 2011). **Nearest BIA**: Internesting on the Montebello Islands during summer, with a 20 km internesting buffer. This BIA overlaps the EMBA.
Loggerhead turtle	**Breeding**: Approximately September to March. **Nesting**: Late October to late March. Peak period from late December to early January.	Carnivorous – feeding mainly on molluscs and crustaceans	**Preferred habitat**: Nearshore and island coral reefs, bays and estuaries in tropical and warm temperate latitudes. **Distribution**: Shark Bay to North West Cape and as far north as Muiron Islands and Dampier Archipelago. **Major nesting sites**: Principally from Dirk Hartog Island, along the Gnarloo and Ningaloo Coast to North West Cape and the Muiron Islands. There have been occasional records from Varanus and Rosemary Islands in the Pilbara. Late summer nesting recorded for Barrow Island, Lowendal Islands and Dampier Archipelago. **Internesting habitat**: Limited data on Australian loggerhead turtles; however, literature indicates internesting habitat for this species is generally within 20 km of nesting beaches (Commonwealth of Australia, 2017). **Nearest BIA**: Internesting buffer around the Montebello Islands (peak late December–early January) with a 20 km internesting buffer. This BIA overlaps the EMBA.

Turtle species	Key seasons within the NWMR	Diet	Key habitats
Hawksbill turtle	**Breeding**: Approximately October to January. **Nesting**: All year round with peak in September to January.	Mainly sponges – also seagrasses, algae, soft corals and shellfish	**Preferred Habitat**: Nearshore and offshore reef habitats. **Distribution**: Shark Bay north to Dampier Archipelago. **Major nesting sites**: The most significant rookery in WA is at Rosemary Island. Other rookeries include Varanus Island in the Lowendal group, some islands in the Montebello group and along the Ningaloo Coast (Limpus, 2009). **Internesting habitat**: Limited data on Australian hawksbill turtles; however, literature indicates internesting habitat for this species is generally within 20 km of nesting beaches Commonwealth of Australia, 2017. **Nearest BIA**: Internesting buffer around the Montebello Islands in spring and early summer (peak October) with a 20 km internesting buffer. This BIA overlaps the EMBA.
Flatback turtle	**Breeding**: Peak between December and February. **Nesting**: November to March with peak period in December and January.	Carnivorous – feeding mainly on soft bodied prey such as sea cucumbers, soft corals and jellyfish	**Preferred Habitat**: Nearshore and offshore sub-tidal and soft bottomed habitats of offshore islands. **Distribution:** Shark Bay north to Dampier Archipelago. **Major nesting sites**: The largest nesting sites of the Pilbara region are Barrow Island and the mainland coast (Mundabullangana Station near Cape Thouin and smaller nesting sites at Cemetery Beach in Port Hedland and Bell's Beach near Wickham). Other significant rookeries include Thevenard Island, the Montebello Islands, Varanus Island, the Lowendal Islands, and islands of the Dampier Archipelago. **Internesting habitat**: Up to 70 km from nesting beaches (Waayers et al., 2011; Whittock et al., 2014). Satellite tracking of flatback turtle nesting populations at Barrow Island indicates this species travels to the east of Barrow Island, towards WA mainland coastal waters, between nesting events. **Nearest BIA**: Internesting buffer around Montebello Islands in summer with an 80 km internesting buffer. This BIA overlaps the Permit Area.
Leatherback turtle	No confirmed nesting activity in Western Australia.	Carnivorous – feeding mainly in the open ocean on jellyfish and other soft-bodied invertebrates	**Preferred Habitat**: Nearshore, coastal tropical and temperate waters, may be encountered within the NWMR but noted that there are no known nesting sites within the NWMR.

Post-nesting migratory routes for green, hawksbill and flatback turtles recorded for the NWMR (Barrow Island and mainland sites) (Chevron Australia Pty Ltd, 2015) and green turtle tracking for post-nesting individuals from Scott Reef (Guinea, 2009), outside of the EMBA, indicated no overlap with the Permit Area. Green, flatback and hawksbill turtles travelling from nesting sites to foraging grounds generally travelled east or south of Barrow Island and around or through the Dampier Archipelago and along the coast towards foraging grounds to the north (north of Broome). The hawksbill turtle is an exception as it tends to travel south to the coastal island chain south of Barrow Island (Chevron Australia Pty Ltd, 2015). Tracking data indicates the three marine turtle species recorded for the NWMR travel and forage in coastal waters that are relatively shallow (Chevron Australia Pty Ltd, 2015), as follows:

- hawksbill turtles – less than 10 m deep
- green turtles – less than 25 m deep
- flatback turtles – less than 70 m deep.

Flatback turtle nesting off north-western Australia extends approximately from Exmouth to the Lacepede Islands (Limpus, 2007); hence the Permit Area is close to the southernmost limit of flatback turtle nesting (and consequently internesting) habitat. Tagging studies of nesting flatback at Ashburton Island (near Onslow), one of the southernmost nesting sites, indicated internesting turtles may travel up to 35 km from the nesting beach (RPS, 2010). Whittock et al. (2014) tracked flatback turtles from beaches on the east coast of Barrow Island, finding the mean displacement of internesting females was 25.7 and 27.2 km from Thevenard Island and Barrow Island respectively. These results indicate that internesting turtles remain in continental shelf waters, which is consistent with the distribution of preferred foraging habitat of soft-bottomed shallow continental shelf waters (Limpus, 2007). Based on the results of tagging studies and the absence of suitable foraging habitat in the Permit Area, flatback turtles are likely to be uncommon within the offshore section of the Permit Area, despite the overlapping internesting buffer BIA. However, the species is expected to occur within the EMBA, particularly in the vicinity of known nesting beaches between November and March.

Seasnakes

Seasnakes occur across the NWMR and are reported to occur in offshore and nearshore waters. They occupy diverse habitats including coral reefs, turbid water habitats and deeper water (Guinea et al., 2004). Species exhibit habitat preferences depending on water depth, benthic habitat, turbidity and season (Heatwole and Cogger, 1993). The majority of information about the occurrence of seasnakes has been sourced from bycatch logs maintained by the Northern Prawn Fishery (DEWHA, 2008) (this fishery does not overlap the Permit Area or EMBA).

The short-nosed seasnake, listed as Critically Endangered under the EPBC Act, was identified as potentially occurring within the EMBA (although not within the Permit Area). There are a small number of records of individuals collected along the Western Australian coast from the Exmouth Gulf to Broome (Storr et al., 2002; Kangas et al., 2017). The origin of these specimens has not been determined; they may have been vagrants or they may represent a population which has not yet been identified. This species may have a wider distribution; however, there are no conclusive records relating to the species distribution outside Australian waters (DSEWPaC, 2011a).

Seasnakes of the families *Hydrophidae* and *Laticaudidae* are widespread in the EMBA and are protected under the EPBC Act. The Protected Matters Search identified 16 species of seasnake listed as marine under the EPBC Act within the EMBA (**Appendix C**). The most commonly sighted seasnake in the region is the olive seasnake (*Aipysurus laevis*), which is generally found along lower reef edges and upper lagoon slopes of leeward reefs. The olive seasnake is associated with shallow water, as large, deep water expanses create a significant barrier to movement. Given the water depth of the Permit Area, seasnake sightings will be infrequent and likely comprise a few individuals. Seasnakes have a higher likelihood of occurrence in shallower (<100 m deep) waters of the Montebello AMP within the EMBA.

Sharks, Fish and Rays

Great White Shark

The white shark was identified as potentially occurring within the Permit Area. 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). They are also known to make open ocean excursions of several hundred kilometres and can cross ocean basins (Weng et al., 2007a,b). Although white sharks are not known to form and defend territories, they are known to return seasonally/regularly to regions with high prey density, such as pinniped colonies (Bruce, 2008).

Given the migratory nature of the species, its low abundance, broad distribution in temperate waters across southern Australia and absence of preferred prey (pinnipeds), white sharks are unlikely to occur within the Permit Area or EMBA.

Shortfin Mako

The shortfin mako shark is a pelagic species with a circumglobal, wide-ranging oceanic distribution in tropical and temperate seas (Mollet et al., 2000), and was identified as potentially occurring within the Permit Area. The shortfin mako is commonly found in water with temperatures greater than 16 °C and can grow to almost 4 m. Females mature later (19 to 21 years) than males (seven to nine years) and adults have moderate longevity estimates of 28 to 29 years (Bishop et al., 2006). The shortfin mako shark is an apex and generalist predator that feeds on a variety of prey, such as teleost fish, other sharks, marine mammals and marine turtles (Campana et al., 2005). 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). Little is known about the population size and distribution of shortfin mako sharks in Western Australia; however, it is possible they may transit the Permit Area and EMBA.

Longfin Mako

The longfin mako is a widely distributed, but rarely encountered, oceanic shark species. The longfin mako was identified as potentially occurring within the Permit Area. The species can grow to just over 4 m long and is found in northern Australian waters, from Geraldton in Western Australia to at least Port Stephens in New South Wales, and is uncommon in Australian waters relative to the shortfin mako (Bruce, 2013; DEWHA, 2010). There is very little information about these sharks in Australia, with no available population estimates or distribution trends. A study from southern California documented juvenile longfin mako sharks remaining near surface waters, while larger adults were frequently observed at greater maximum depths of about 200 m (Sepulveda et al., 2004). Longfin mako sharks may occur in the Permit Area and broader EMBA, but given their widespread distribution and apparent low density they are likely to be uncommon.

Whale Shark

The whale shark was identified as potentially occurring within the Permit Area. Whale sharks aggregate annually to feed in the waters of the Ningaloo Coast (this feeding BIA lies about 230 km south-west of the Permit Area, outside the EMBA) from March to July, with the largest numbers recorded in April and May (Sleeman et al., 2010). However, seasonal aggregation can be variable, with individual whale sharks recorded at other times of the year. The population (comprising individuals that visit the reef at some point during their lifetime) has been estimated to range between 300 and 500 individuals and it is expected that the number visiting Ningaloo Reef in any given year will be somewhat smaller (Meekan et al., 2006). Timing of the whale shark migration to and from Ningaloo coincides with the coral mass spawning period when there is an abundance of food (krill, planktonic larvae and schools of small fish) in the waters adjacent to Ningaloo Reef. At Ningaloo

Reef, whale sharks stay within a few kilometres of the shore and in waters about 30–50 m deep (Wilson et al., 2006).

After the aggregation period, the distribution of the whale sharks is largely unknown. Tagging, aerial and vessel surveys suggest the group disperses widely, up to 1800 km away. Satellite tracking has shown the sharks may follow three migration routes from Ningaloo (Meekan and Radford, 2010; Wilson et al., 2006) (**Figure 4-13**):

- north-west, into the Indian Ocean
- directly north, towards Sumatra and Java
- north-east, passing through the North West Shelf Province travelling along the shelf break and continental slope.

These tagging studies provided the justification for a foraging BIA for whale sharks, which overlaps the Permit Area, as shown in **Figure 4-13**. Though the BIA has been defined as a foraging area for whale sharks, it is more likely to be a migration pathway with whale sharks undertaking opportunistic foraging. It is expected that whale sharks may traverse the Permit Area during their migrations to and from Ningaloo Reef. However, it is expected that whale shark presence within the area would be of a relatively short duration and not in significant numbers, given the main aggregations are recorded in coastal waters, particularly the Ningaloo Reef edge (CALM, 2005).

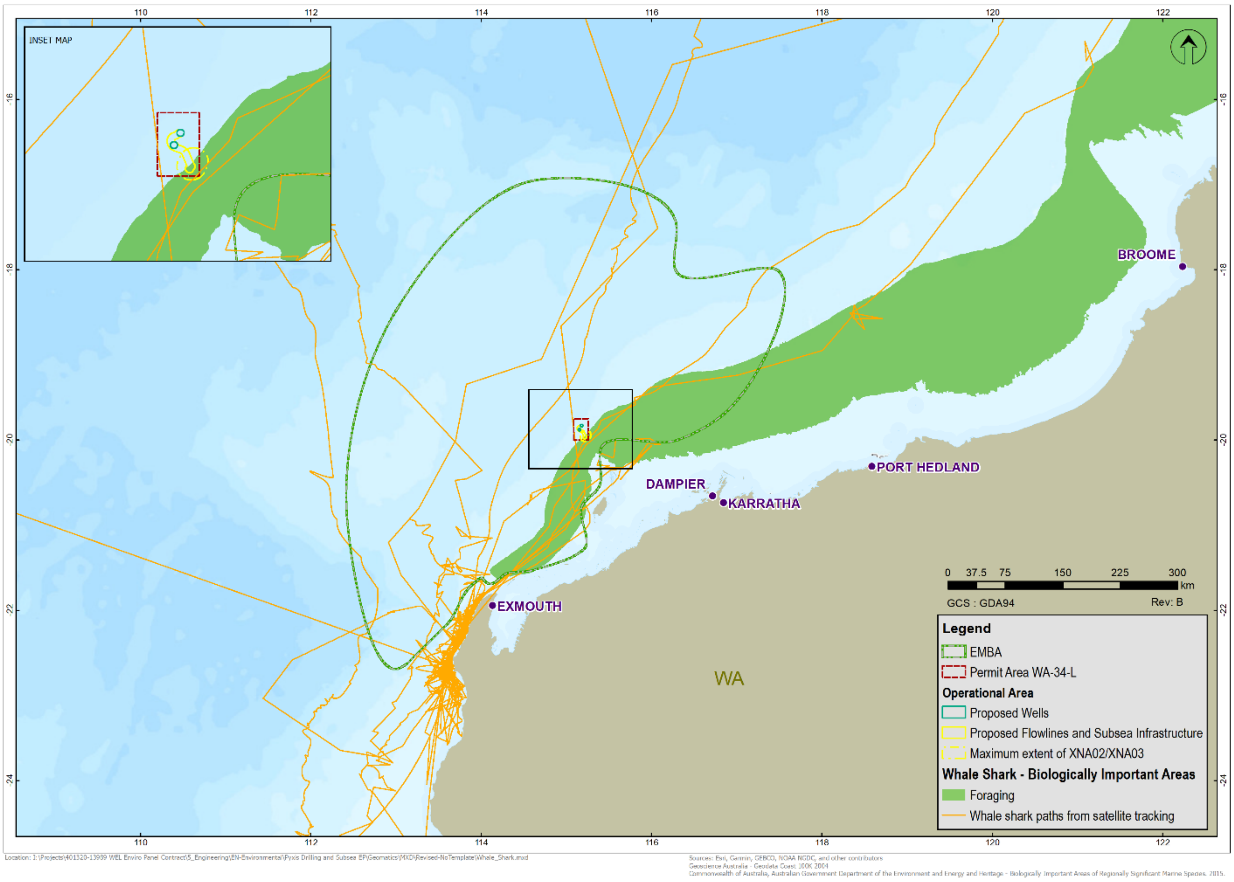


Figure 4-13: Permit Area and satellite tracks of whale sharks tagged between 2005 and 2008 (Meekan and Radford, 2010)

Grey Nurse Shark (West Coast Population)

The grey nurse shark has a broad distribution in inner continental shelf waters, primarily in sub-tropical to cool temperate waters. Off Western Australia, the grey nurse shark occurs primarily in south-west coastal waters between 20 and 140 m depth (Chidlow et al., 2006). Grey nurse sharks have been documented as aggregating in specific areas (typically reefs); however, no clear aggregation sites have been identified off Western Australia (Chidlow et al., 2006). Grey nurse sharks may occur within continental shelf areas of the Permit Area; however, due to the largely soft sediment, low complexity benthic habitat in this area, their occurrence is likely to be infrequent and restricted to individuals transiting the area between any aggregation areas. Within the EMBA, grey nurse sharks are likely to occur across shallow continental shelf waters and may be more prevalent around reefs.

Giant Manta Ray

The giant manta ray is broadly distributed in tropical waters of Australia and was identified as potentially occurring within the Permit Area. The species primarily inhabits near-shore environments along productive coastlines with regular upwelling, but they appear to be seasonal visitors to coastal or offshore sites including offshore island groups, offshore pinnacles and seamounts (Marshall et al., 2011). The Permit Area is not located in or adjacent to any known key aggregation areas for the species (e.g. feeding or breeding). However, the Ningaloo Coast, about 190 km south-west of the Permit Area and outside the EMBA, is an important area for giant manta rays in autumn and winter (Preen et al., 1997). Occurrence of giant manta rays within the Permit Area is likely to be infrequent, and restricted to individuals transiting the area.

Reef Manta Ray

The reef manta ray is commonly sighted inshore, within a few kilometres of land, but is also found around offshore coral reefs, rocky reefs and seamounts (Marshall et al., 2009). In contrast to the giant manta ray, long-term sighting records of the reef manta ray at established aggregation sites suggest this species is more resident in tropical waters and may exhibit smaller home ranges, philopatric movement patterns and shorter seasonal migrations than the giant manta ray (Deakos et al., 2011; Marshall et al., 2009). A resident population of reef manta rays has been recorded at Ningaloo Reef (about 205 km from the Permit Area and outside the EMBA), and the species has been shown to have both resident and migratory tendencies in eastern Australia (Couturier et al., 2011). The reef manta ray may infrequently occur in continental shelf waters of the Permit Area while transiting between suitable habitats within the EMBA.

Narrow Sawfish

The narrow sawfish occurs from the northern Arabian Gulf to Australia and north to Japan. Like other sawfish in the family *Pristidae*, the narrow sawfish prefers shallow coastal, estuarine and riverine habitats, although may occur in waters up to 40 m deep (D'Anastasi et al., 2013). In Australia, the species may have a broad tropical distribution from approximately North West Cape in Western Australia to southern Queensland.

Like other sawfish species, the narrow sawfish has experienced considerable decline in numbers due to human activities, including fishing and habitat loss/damage (Cavanagh et al., 2003). They are not currently listed as threatened but are commonly caught as bycatch, and constituted over half of sawfish bycatch in the Northern Prawn Fishery in 2013 (Morgan et al., 2010a) (this fishery does not overlap the EMBA). The species was not identified as occurring within the Permit Area. Given their depth and habitat preference, narrow sawfish are not expected to occur within the Permit Area and would only be infrequently encountered within the shallower waters of the EMBA.

Dwarf Sawfish

Dwarf sawfish are found in Australian coastal waters extending north from Cairns around the Cape York Peninsula in Queensland to the Pilbara coast (Kyne et al., 2013). Dwarf sawfish typically inhabit shallow (2 to 3 m) silty coastal waters and estuarine habitats, occupying relatively restricted areas and moving only small distances (Stevens et al., 2008). Juvenile dwarf sawfish use estuarine habitats in north-western Western Australia as nursery areas (Thorburn et al., 2008; Threatened Species Scientific Committee, 2009), and migrate to deeper waters as adults. The majority of capture locations for the species in Western Australian waters have occurred within King Sound (outside the EMBA; 930 km from the Permit Area) and the lower reaches of the major rivers that enter the sound, including the Fitzroy, Mary and Robinson rivers (Morgan et al., 2010b). Individuals have also been recorded from Eighty Mile Beach (outside the EMBA; 480 km from the Permit Area), and occasional individuals have also been taken from considerably deeper water from trawl fishing (Morgan et al., 2010b). The species is therefore unlikely to occur within the Permit Area or EMBA.

Green Sawfish

The green sawfish was once widely distributed in coastal waters along the northern Indian Ocean, although it is believed that northern Australia may be the last region where significant populations exist (Stevens et al., 2005). Within Australia, green sawfish are currently distributed from approximately the Whitsundays in Queensland, across northern Australian waters to Shark Bay in Western Australia (Commonwealth of Australia, 2015b). Preferred habitat for green sawfish includes shallow coastal waters and tidal creeks (Chevron Australia Pty Ltd, 2014). Despite records of the species in deeper offshore waters, green sawfish typically occur in the inshore fringe with a strong association with mangroves and adjacent mudflat habitats (Commonwealth of Australia, 2015b; Stevens et al., 2005). Movements within these preferred habitats are correlated with tidal movements (Stevens et al., 2008).

The Multi-species Recovery Plan for Sawfish and River Sharks (Commonwealth of Australia, 2015b) indicates ‘known to occur’ distribution includes offshore waters of the North West Shelf, with ‘known’ pupping areas in coastal waters north of Port Hedland to Roebuck Bay and pupping ‘likely to occur’ south of Port Hedland, Exmouth Gulf and North West Cape. Green sawfish are unlikely to be present in the Permit Area or EMBA.

4.5.2.4 Birds

Oceanic Seabirds and/or Migratory Shorebirds

The Permit Area may be occasionally visited by migratory and oceanic birds but does not contain any emergent land that could be used as roosting or nesting habitat. The closest emergent facility is the Pluto platform located about 15 km from the Permit Area. One BIA, a breeding area for wedge-tailed shearwaters, overlaps the Permit Area and is discussed further in the relevant species section below. The NWMR lies within the East Asian-Australasian flyway for migratory birds; species migrating between East Asia and Australia may be present between late spring and early autumn (**Table 4-6**). Eleven species of birds considered to be MNES were identified as potentially occurring within the Permit Area (**Table 4-3**) including:

- red knot
- curlew sandpiper
- southern giant-petrel
- eastern curlew
- common sandpiper
- common noddy

- sharp-tailed sandpiper
- pectoral sandpiper
- lesser frigatebird
- streaked shearwater
- osprey.

Based on the results of two survey cruises and other unpublished records, Dunlop et al. (1988) recorded the occurrence of 18 species of seabirds over the North West Shelf Province. These included a number of species of petrel, shearwater, tropicbird, frigatebird, booby and tern, as well as the silver gull. Of these, eight species occur year round and the remaining ten are seasonal visitors. From these surveys, it was noted that seabird distributions in tropical waters were generally patchy, except near islands. Migratory shorebirds may be present in or fly through the region between July and December and again between March and April as they complete migrations between Australia and offshore locations (Bamford et al., 2008; Commonwealth of Australia, 2015c). The EMBA does not include any shoreline habitats. Within the wider region outside the EMBA, the Ningaloo Coast hosts seabird and migratory shorebird habitat (**Section 4.7**). Note that no Ramsar wetlands were identified within the Permit Area or EMBA. The nearest Ramsar wetland is Eighty Mile Beach, over 450 km east of the Permit Area and beyond the EMBA.

Red Knot

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. Both Australia and New Zealand host significant numbers of red knots during their non-breeding period (Bamford et al., 2008). As with other migratory shorebirds, the species occurs in coastal wetland and intertidal sand or mudflats, none of which are located in the Permit Area or the EMBA.

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 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. Their presence in the Permit Area and EMBA is likely to be restricted to when they transit through the area during their seasonal migration periods.

Southern Giant Petrel

The southern giant petrel is widespread throughout the Southern Ocean and breeds on six subantarctic and Antarctic islands within Australia (Patterson et al., 2008). The species is found mainly over Antarctic waters and migrates into subtropical waters during winter months. No critical habitat associated with the southern giant petrel has been identified for the Permit Area or the EMBA. The presence of this species within the Permit Area and EMBA is likely to be infrequent as individuals traverse the area during winter months. This is supported by the National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011–2016, which identifies critical habitat for foraging in waters south of 25 degrees (DSEWPaC, 2011).

Eastern Curlew

The eastern curlew is Australia's largest shorebird and a long-haul flyer. The eastern curlew migrates annually to Russia and north-eastern China to breed, arriving back in Australia in August to feed on crabs and molluscs in intertidal mud flats (Bamford et al., 2008). No critical habitats for the eastern curlew have been identified in the Permit Area or EMBA and their presence is likely to be restricted to them transiting through the area during their seasonal migration periods.

Common Sandpiper

The common sandpiper is a small, migratory bird with a very large range through which it migrates annually between breeding grounds in the northern hemisphere (Europe and Asia) and non-breeding areas in the Asia-Pacific region (Bamford et al., 2008). In Australia, the species congregates in large flocks and forages in shallow waters and tidal flats between spring and autumn. Specific critical habitat in Australia has not been identified due to the species' broad distribution (Bamford et al., 2008). The presence of the common sandpiper within the Permit Area and EMBA is likely to be restricted to when they transit through during seasonal migration periods.

Common Noddy

The common noddy is the largest species of noddy found in Australian waters. The species is widespread in tropical and subtropical areas beyond Australia. This seabird typically forages in coastal waters around nesting sites, taking prey such as small fish, but may occur longer distances out to sea. Nesting occurs broadly across tropical and subtropical Australia in coastal areas, particularly on islands such as the Houtman Abrolhos island group (Burbidge and Fuller, 1989) (outside the EMBA, 950 km from the Permit Area). The common noddy is thought to undertake seasonal movements, with some nesting sites abandoned during the non-breeding season (which is protracted between spring and autumn). The species may occur within the Permit Area (although the Permit Area does not constitute critical habitat for the species) and the EMBA, particularly around offshore and coastal islands.

Sharp-tailed Sandpiper

Like other species of sandpiper, the sharp-tailed sandpiper is a migratory wading shorebird and undertakes long distance seasonal migrations between breeding grounds in the northern hemisphere and over-wintering areas in the southern hemisphere (Bamford et al., 2008). The species may occur in Australia between spring and autumn. The species is unlikely to occur within the Permit Area and only infrequently in the EMBA as they transit through, particularly near offshore islands.

Pectoral Sandpiper

Similar to other species of sandpiper, the pectoral sandpiper breeds in the northern hemisphere during the boreal summer, before migrating long distances to feeding grounds in the southern hemisphere. The species occurs throughout mainland Australia between spring and autumn. The pectoral sandpiper prefers coastal and near-coastal environments such as wetlands, estuaries and mudflats which are not present within the Permit Area or EMBA.

Lesser Frigatebird

The lesser frigatebird is usually seen in tropical or warmer waters around the coast of north Western Australia, the Northern Territory, Queensland and northern New South Wales (DSEWPaC, 2012d). Within the NWMR, the lesser frigatebird is known to breed on Adele, Bedout and West Lacepede islands, Ashmore Reef and Cartier Islands (outside the EMBA) (DSEWPaC, 2012d). The lesser frigatebird feeds mostly on fish and sometimes cephalopods and all food is taken while the bird is in flight. Lesser frigate birds generally forage close to breeding colonies. A foraging BIA lies outside the EMBA, about 300 km east of the Permit Area; the BIA is centred on Bedout Island. The species is unlikely to be found within the Permit Area or EMBA.

Streaked Shearwater

The streaked shearwater is a migratory seabird with a broad distribution in the western Pacific Ocean. The species nests on offshore islands in temperate East Asia, including Japan and the Korean peninsula. During winter months the species migrates south, as far as northern Australia, where it occurs around islands and inshore waters. The species may occur in the Permit Area and EMBA during winter months.

Osprey

The osprey is a medium-sized raptor that is widely distributed around Australia in coastal and wetland habitats. The species also occurs throughout south-eastern Asia (Indonesia, Philippines, Palau Islands, New Guinea, Solomon Islands and New Caledonia). Osprey feed almost exclusively on fish, typically capturing prey observed while flying by plunging feet first into the water (Clancy, 2005). While listed as migratory, adults are generally restricted to a foraging area surrounding their nests. Egg laying in Australia is protracted between April and February (Olsen and Marples, 1993), which may be due to the extended geographic range of the species within Australia and discrete genetic populations that may constitute subspecies (Olsen and Marples, 1993). Given the species' preference for coastal and wetland environments, it is unlikely to occur within the Permit Area and would only be infrequently observed in the EMBA.

4.6 Socio-economic and Cultural

4.6.1 Cultural Heritage

4.6.1.1 European and/or Indigenous Sites of Significance

There are no known sites of Indigenous or European cultural heritage significance overlapping the Permit Area or EMBA which does not touch any shorelines.

Within the wider region, Ningaloo Reef, Exmouth, Barrow Island, Montebello Islands, and the Kimberley coast and the adjacent foreshores have a long history of occupancy by Aboriginal communities.

4.6.1.2 Historic Shipwrecks

No known shipwrecks have been recorded within the Permit Area based on a review of the National Shipwreck Database (**Table 4-8**); however, there are a number of wrecks listed in the Australian National Shipwrecks Database which are recorded as being located within close proximity. Most of these are listed as having an unreliable generic location. As the subsea infrastructure associated with the Permit Area was mostly commissioned before 2012 when production commenced, and no shipwrecks were identified during or since this time in the area, it is reasonable to assume these shipwrecks are outside the Permit Area. **Table 4-8** summarises listed shipwrecks within 50 km from the Permit Area.

Table 4-8: Recorded historical shipwrecks within 50 km of the Permit Area and within the EMBA (DoEE, 2018)

Vessel name	Year wrecked	Wreck location*	Latitude (°D.DD)	Longitude (°D.DD)	Distance from closest point of the Permit Area (km)
Curlew	1911	At Onslow, Montebello Islands	-20.00	115.17	<1
Marietta	1905	Barrow Island	-20.00	115.17	<1
Vianen	1628	Barrow Island Area	-20.00	115.17	<1
Wild Wave (China)	1873	Montebello Islands	-20.00	115.17	<1
Tanami	-	Trial Rocks	-20.28	115.37	34
Trial	1622	Trial Rocks	-20.29	115.38	34

4.6.1.3 National and Commonwealth Heritage Listed Places [5]

There are no heritage listed sites within or immediately adjacent to the Permit Area.One Commonwealth Heritage listed place occurs within the EMBA: the Ningaloo Marine Area – Commonwealth waters (about 205 km southwest of the Permit Area). Additionally, one World Heritage place occurs within the EMBA, the Ningaloo Coast (about 189 km southwest of the Permit Area).

The closest gazetted and proposed National and Commonwealth heritage places in the wider region, include:

National Heritage Places:

- Dampier Archipelago (including Burrup Peninsula) Indigenous Heritage Place (about 140 km south of the Permit Area)
- Barrow Island and the Montebello-Barrow Islands Marine Conservation Reserves Nominated Heritage Place (about 45 km south of the Permit Area)
- the Ningaloo Coast National Heritage Place (about 206 km south-west of the Permit Area).

Commonwealth Heritage Places:

- Learmonth Air Weapons Range Facility Heritage Place (about 295 km south-west of the Permit Area).

The significant values of the World Heritage, Commonwealth Heritage and National Heritage Listed Places are outlined in **Section 4.7**.

4.6.2 Ramsar Wetlands

No Ramsar wetlands overlap the Permit Area or EMBA.

4.6.3 Fisheries – Commercial

4.6.3.1 Commonwealth and State Fisheries

A number of Commonwealth and State fisheries are located within the Permit Area and EMBA. **Table 4-9** provides further detail on the fisheries that have been identified through desk-based

[5] World Heritage designations are addressed in **Section 4.7**.

assessment and consultation (**Section 5**). **Figure 4-14** and **Figure 4-16** provide the designated fisheries management areas in relation to the Permit Area.

Table 4-9: Commonwealth and State fisheries of relevance to the Petroleum Activities Program

Fishery	Overlap Permit Area/EMBA		Description
	Permit Area	EMBA	
Commonwealth Managed Fisheries			
Western Skipjack Fishery	✓	✓	**Description:** The combined western and eastern skipjack tuna (*Katsuwonus pelamis*) fisheries encompass the entire Australian Exclusive Economic Zone (EEZ), including the Permit Area and EMBA. The target species has historically been used for canning, and with the closure of canneries at Eden and Port Lincoln effort in the fishery has declined and there have been no active vessels operating since 2009 (Patterson et al., 2018). Given the fishery has been inactive for a number of years and the distribution of effort when the fishery was active, fishing for skipjack tuna in the Permit Area is highly unlikely. Should the fishery commence efforts in the area in the future, fishing effort in the Permit Area and EMBA is considered to be unlikely given the historical fishery was concentrated off southern Australia. **Fishery boundary distance from Permit Area:** Overlaps Permit Area. **Vessels:** Not applicable (fishery inactive).
Western Tuna and Billfish Fishery	✓	✓	**Description:** The West Tuna and Billfish Fishery is currently active, running throughout the year. The fishery zoning extends to the Australian EEZ boundary in the Indian Ocean, overlapping the Permit Area and EMBA. The fishery targets four pelagic species, which are all highly mobile: • broadbill swordfish (*Xiphias gladius*) • bigeye tuna (*Thunnus obesus*) • yellowfin tuna (*T. albacares*) • albacore tuna (*T. alalunga)* The number of vessels operating in the alalunga fishery has declined in recent years, with less than five vessels operating in the fishery since 2005 (Patterson and Stephan, 2014; Williams et al., 2017; Patterson and Bath, 2018). Effort data shows fishing effort is concentrated off south-west Western Australia and South Australia (Patterson and Bath, 2018). The fishing methods used by the fishery are mainly pelagic longline and some minor-line. No significant effort in the vicinity of the Permit Area has been documented. Given the current effort level and recent distribution of effort, it is unlikely fishing by the West Tuna and Billfish Fishery will occur within the Permit Area or EMBA. **Fishery boundary distance from Permit Area:** Overlaps Permit Area. **Vessels:** Four vessels (three pelagic longline, one minor longline) (Patterson and Bath, 2018).

Fishery	Overlap Permit Area/EMBA		Description
	Permit Area	EMBA	
Southern Bluefin Tuna Fishery	✓	✓	**Description:** The Southern Bluefin Tuna Fishery boundary overlaps the Permit Area, but current effort within the fishery is largely confined to southern Australia, with the vast majority of effort occurring in the Great Australian Bight (Australian Fisheries Management Authority, 2010; Patterson et al., 2016). Southern bluefin tuna are known to spawn in the north eastern Indian Ocean (Davis et al., 1990; Matsuura et al., 1997). The species has been heavily exploited by commercial fisheries worldwide. The fishery employs both longlining and purse seine net fishing methods. Given the current distribution of fishing effort and fishing methods used by the industry, fishing for bluefin tuna is unlikely to occur in the Permit Area or EMBA. **Fishery boundary distance from Permit Area:** Overlaps Permit Area. **Vessels:** Six purse seine vessels, 16 longline vessels (Patterson et al., 2018).
North-West Slope Trawl Fishery	✓	✓	**Description:** 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 Australian Fishing Zone (200 nautical miles from the coastline, which is the boundary of the EEZ. The NWSTF traditionally targets scampi and deep water prawns. Fishing for scampi occurs over soft, muddy sediments or sandy habitats, typically at depths of 350–600 m using demersal trawl gear on the continental slope (Woodhams and Bath, 2017a). Activity in the fishery commenced in 1985, peaking at 21 active vessels in 1986–87 (Woodhams and Bath, 2017a). There is currently high non-participation among licence holders and fishing activity has steadily declined since the fishery was established. Only one to two vessels have operated since the 2012–2013 fishing season (Woodhams and Bath, 2017a; Patterson and Bath, 2018). The total area of waters fished in 2014–15 did not include the Permit Area, and efforts were focused in waters beyond the 200 m isobath (Woodhams and Bath, 2017a). Given recent and historical fishing efforts and the presence of subsea infrastructure, it is unlikely the NWSTF will operate within the Permit Area but fishing may occur within the EMBA. **Fishery boundary distance from Permit Area:** Overlaps Permit Area. **Vessels:** Two vessels (Patterson and Bath, 2018).
Western Deepwater Trawl Fishery	x	✓	**Description:** The Western Deepwater Trawl Fishery is permitted to operate only in deep waters from the 200 m isobath, as far north as the North West Cape, outside of the Permit Area but within the EMBA. This fishery targets a number of deep water, demersal finfish and crustacean species. The nominated fishing grounds are extensive; however, most of the fishing effort is south and offshore of the North West Cape. Areas of medium and high density fishing activity are located to the south of Ningaloo Reef and west of Shark Bay, beyond the 200 m isobath (Georgeson et al., 2014). **Fishing boundary distance from the Permit Area:** The Western Deepwater Trawl Fishery management boundary is located about 112 km west of the Permit Area. **Vessels:** One vessel (ABARES, 2018).

Fishery	Overlap Permit Area/EMBA		Description
	Permit Area	EMBA	
State Managed Fisheries			
Specimen Shell Managed Fishery	✓	✓	**Description:** The Specimen Shell Managed Fishery can operate in Western Australia state waters, adjacent to the Permit Area and within the EMBA. The fishery targets specimen shells for display, collection, cataloguing and sale. Collection is predominantly by hand when diving or wading in shallow, coastal waters though a deeper water collection aspect to the fishery has been initiated using ROVs operating at depths up to 300 m (Hart et al., 2018). The fishery encompasses the entire WA coastline but effort is concentrated in areas adjacent to the largest population centres such as Broome, Karratha, Shark Bay, Mandurah, Exmouth, Capes area, Albany and Perth (Hart et al., 2018). **Fishery boundary distance from Permit Area:** Overlaps Permit Area. **People active:** Thirty one authorisation holders in this fishery with around seven licences recording consistent activity; the number of people employed regularly in the fishery is likely to be around 11 (Hart et al., 2018).
Pilbara Demersal Scalefish Fishery (fish trawl, trap and line)	✓	✓	**Description:** The State-regulated Pilbara Demersal Scalefish Fishery is managed as part of the North Coast Demersal Scalefish Fishery. The fishery comprises several management units in the Pilbara and Kimberley regions, targeting a range of low and high value finfish species. The Pilbara Demersal Scalefish Fishery is managed through area closures, gear restrictions and individual effort allocations (Newman et al., 2018). Gear used in the Pilbara Demersal Scalefish Fishery includes trawl, trap and line fishing, with trawl fishing accounting for the bulk of landings (Gaughan and Santoro, 2018). The managed fishery boundary overlaps the Permit Area and wider EMBA, although the fishery management area overlapping the Permit Area is closed to trawl fishing. Fishing may occur within the Permit Area; however, the majority of fishing is likely to be undertaken using traps. **Fishery boundary distance from Permit Area:** Overlaps Permit Area though trawl fishing is not permitted within the Permit Area. **Vessels:** Ten active in 2016 (two trawl (outside Permit Area), three trap and five line fishery vessels) (Gaughan and Santoro, 2018).Consultation with WAFIC (**Table 5-3) c**onfirmed impact to Pilbara Trap fishers would be minimal and key impacted fishery would be Pilbara Line fishery.
Onslow Prawn Managed Fishery	✓	✓	**Description:** The Onslow Prawn Managed Fishery encompasses a portion of the continental shelf off the Pilbara. The fishery targets a range of penaeids (primarily king prawns) which typically inhabit soft sediments <45 m water depth. Fishing is performed using trawl gear over unconsolidated sediments (sand and mud). Total prawn catches in 2016 were about three tonnes, considerably lower than other prawn fisheries (total north coast prawn landings in 2016 were 175 tonnes) (Kangas et al., 2018). Considering fishing effort would concentrate in depths <45 m, interaction between participants in the fishery during the Petroleum Activities Program are unlikely. **Fishery boundary distance from Permit Area:** Overlaps Permit Area. **Vessels:** One vessel (Kangas et al., 2018).

Fishery	Overlap Permit Area/EMBA		Description
	Permit Area	EMBA	
Marine Aquarium Managed Fishery	✓	✓	**Description:** The Marine Aquarium Managed Fishery can operate in all State waters, with effort typically concentrated around the Capes region, Perth, Geraldton, Exmouth and Dampier (Newman et al., 2018). The fishery is diver-based, which typically restricts effort to safe diving depths (<30 m) and therefore interaction with participants are not expected during the Petroleum Activities Program. **Fishery boundary distance from Permit Area:** Overlaps Permit Area. **Licences:** Eleven licences were active in 2016 (Newman et al., 2018).
West Australian Abalone Fishery	✓	✓	**Description:** The West Australian Abalone Fishery includes all coastal waters from the Western Australian and South Australian border to the Western Australian and Northern Territory border. The fishery is concentrated on the south coast (greenlip and brownlip abalone) and the west coast (Roe's abalone). Abalone are harvested by divers, limiting the fishery to shallow waters (typically <30 m). No commercial fishing for abalone north of Moore River (Zone 8 of the managed fishery) has occurred since 2011–2012 (Strain et al., 2018); interactions with participants in the fishery will not occur during the Petroleum Activities Program. **Fishery boundary distance from Permit Area:** Overlaps Permit Area. **Vessels:** Twenty-two vessels active in Roe's abalone fishery (Strain et al., 2018).
Pearl Oyster Managed Fishery	✓	✓	**Description**: The Western Australian Pearl Oyster Fishery is the only remaining significant wild-stock fishery for pearl oysters in the world. Pearl oysters (*Pinctada maxima*) are collected by divers in shallow coastal waters (>23 m) along the North West Shelf and Kimberley, which are mainly used to culture pearls (Hart et al., 2018). The fishery is separated into four zones. The Permit Area overlaps Zone 1. Fishing recently recommenced in Zone 1 after a hiatus of several years (Hart et al., 2018). The portion of the total catch in Zone 1 was minor in 2017 (<1%) (Hart et al., 2018). Given the fishery is diver-based (i.e. restricted to safe diving depths), interaction with fishery participants during the Petroleum Activities Program are very unlikely. **Fishery boundary distance from Permit Area:** Overlaps Permit Area. **Divers**: 19,699 diver hours (Hart et al., 2018).
West Coast Deep Sea Crustacean Managed Fishery	✓	✓	**Description:** The West Coast Deep Sea Crustacean Managed Fishery extends north from Cape Leeuwin to the WA/NT border in water depths great than 150 m within the Australian Fishing Zone, including the Permit Area. The fishery targets deep water crustaceans, with the vast majority (>99%) of the catch landed in 2016 comprised of crystal crabs (How and Yerman, 2018). Two vessels operated in the fishery in 2016, using baited pots operated in a longline formation in the shelf edge waters mostly in depths between 500 and 800 m (How and Yerman, 2018). Fishing effort was concentrated between Fremantle and Carnarvon. Given fishing effort is concentrated beyond the Permit Area and EMBA, interaction between participants in the fishery during the Petroleum Activities Program are unlikely. **Fishery boundary distance from Permit Area:** Overlaps Permit Area.

Fishery	Overlap Permit Area/EMBA		Description
	Permit Area	EMBA	
			Vessels: Two active in 2016 (How and Yerman 2018).
South West Coast Salmon Managed Fishery	✓	✓	**Description:** The South West Coast Salmon Managed Fishery operates on various beaches south of the metropolitan area and includes all Western Australian waters north of Cape Beaufort except Geographe Bay. This fishery uses beach seine nets to take Western Australian salmon (*Arripis truttaceus*). No fishing takes place north of the Perth metropolitan area, despite the managed fishery boundary extending to Cape Beaufort (Western Australia/Northern Territory border). No interactions with participants in the fishery will occur during the Petroleum Activities Program. **Fishery boundary distance from Permit Area:** Overlaps Permit Area. **Vessels:** Not applicable (shore-based).
Mackerel Managed Fishery	✓	✓	**Description:** The Mackerel Managed Fishery targets Spanish mackerel (*Scomberomorus commerson*) using near-surface trawling gear from small vessels in coastal areas around reefs, shoals and headlands. Jig fishing is also used to capture grey mackerel (*S. semifasciatus*), with other species from the genera Scomberomorus (Molony et al., 2015). 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). The majority of the catch is taken from waters off the Kimberley coast (Lewis and Jones, 2018), reflecting the tropical distribution of mackerel species (Molony et al., 2015). The majority of 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 prior to spawning (Mackie et al., 2003). Interactions with participants in the fishery is unlikely. **Fishery boundary distance from Permit Area:** Overlaps Permit Area. **Vessels:** Not stated for 2016, though 33 people were directly employed in the Mackerel Managed Fishery during the mackerel fishing season, primarily from May–November (Lewis and Jones, 2018); 14 vessels in 2014 (Molony et al., 2015). Consultation with WAFIC (Table 5-3) confirmed Mackerel fishers would not be impacted due to water depth at proposed located for XNA03 and XNA03.
Nickol Bay Prawn Managed Fishery	x	✓	**Description:** The Nickol Bay Prawn Managed Fishery operates in nearshore and offshore waters of the Pilbara region along the NWS, outside of the Permit Area but within the EMBA region. The major species caught for this fishery are the banana prawn, king prawn and tiger prawn. The season for this fishery extends from March to November, with several specific areas restricted to May to September to protect nursery areas (Sporer et al., 2014). 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 & Santoro, 2014). **Fishing boundary distance from the Permit Area:** 157 km east of the Permit Area. **Vessels:** The precise number of vessels is unreported, though low effort produced a catch of 17 t in 2016 (Kangas et al., 2018a).

Fishery	Overlap Permit Area/EMBA		Description
	Permit Area	EMBA	
West Coast Rock Lobster Fishery	x	✓	**Description**: The West Coast Rock Lobster Fishery operates outside of the Permit Area but within the EMBA, targeting the western rock lobster (Panulirus cygnus) from Shark Bay south to Cape Leeuwin using baited traps (pots). In 2008, it was determined that the allocated shares of the West Coast Rock Lobster resource would be 95% for the commercial sector, 5% to the recreational sector, and one tonne to customary fishers. The commercial fishery has been Australia's most valuable single-species wild capture fishery. In 2012/2013, the fishery moved to an Individually Transferable Quota fishery. 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 in water depths of less than 20 m. In 2016, 226 vessels reported a total catch of 6086 t (Gaughan and Santoro, 2018). **Fishing boundary distance from the Permit Area**: 193 km south-west of the Permit Area. **Vessels**: 226 vessels (Gaughan and Santoro, 2018).

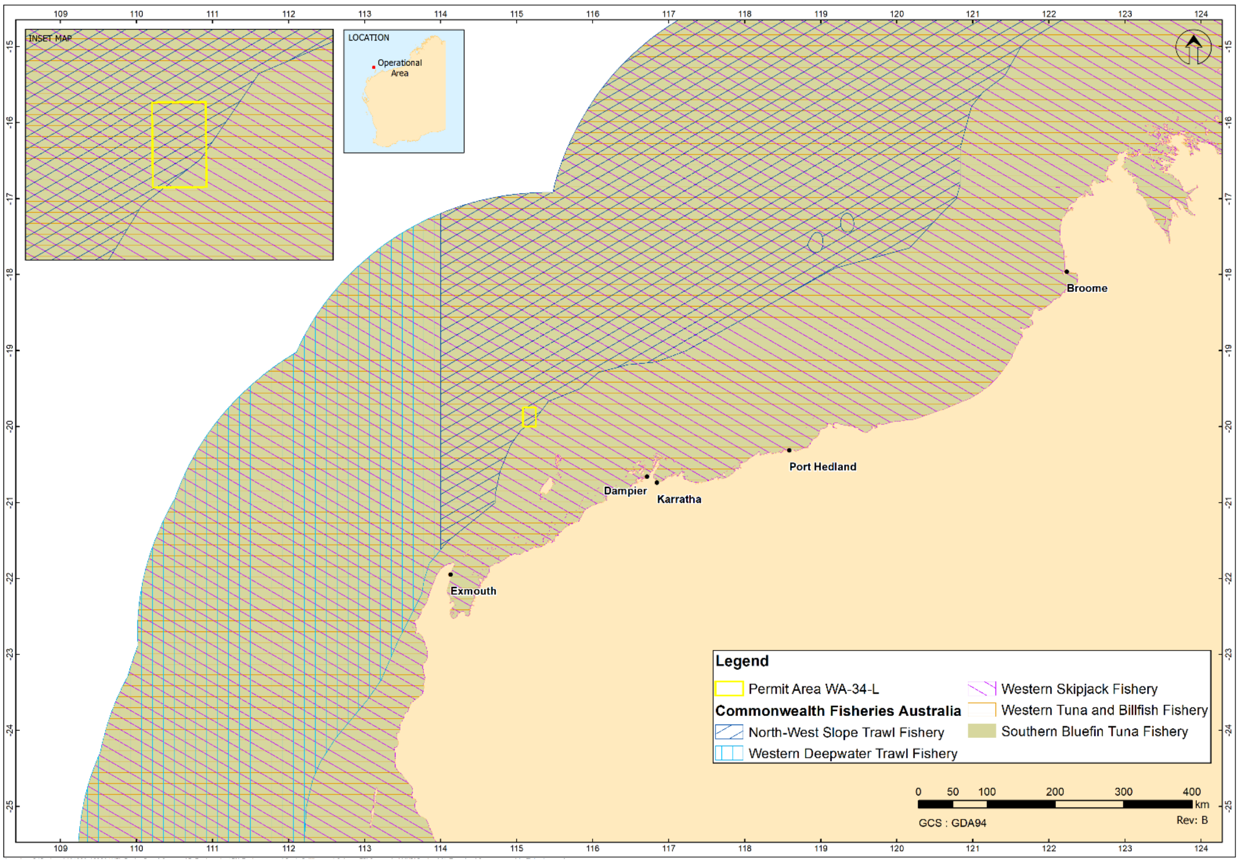


Figure 4-14: Location of Commonwealth fisheries in relation to the Permit Area

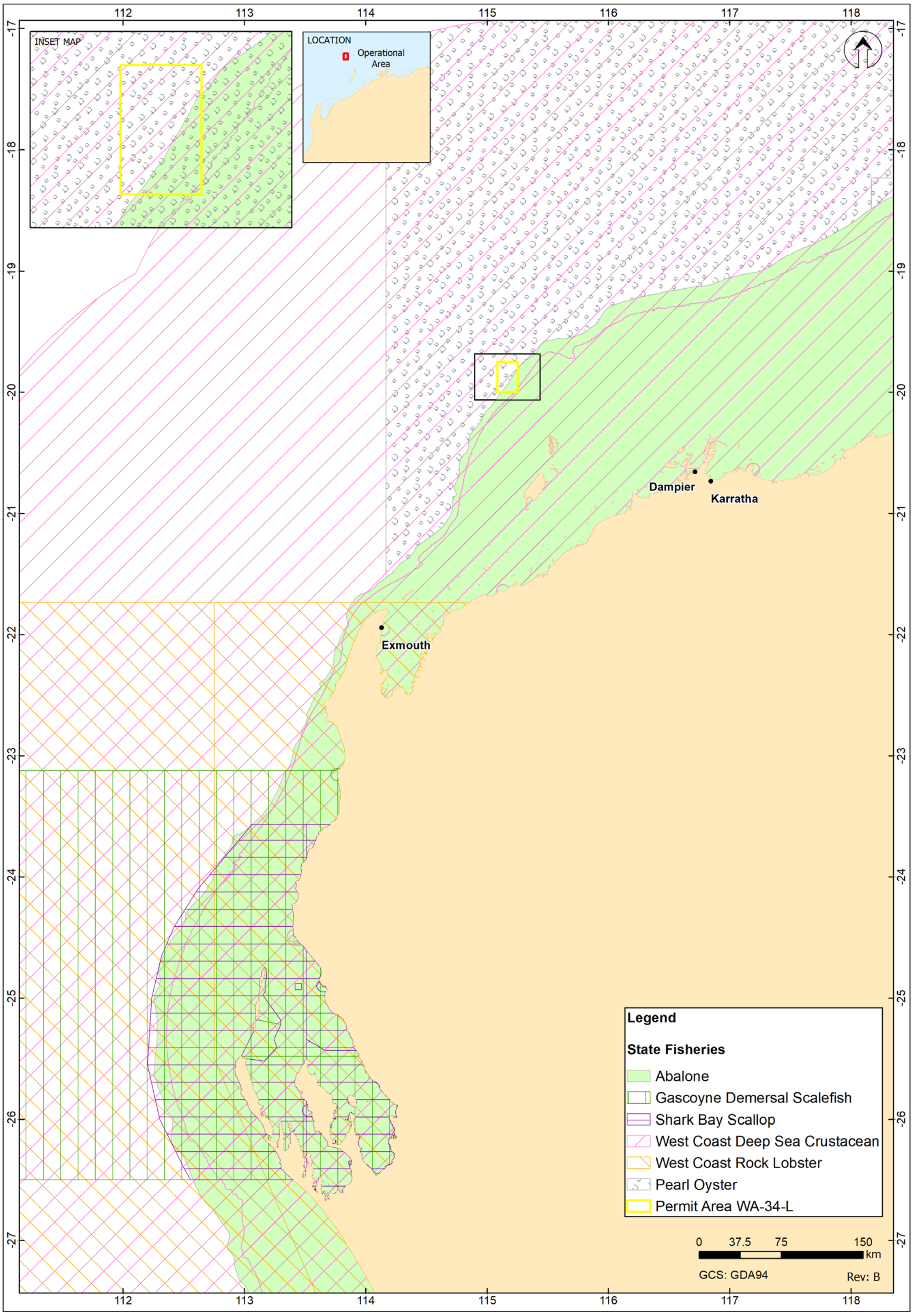


Figure 4-15: Location of State fisheries in relation to the Permit Area (one of two)

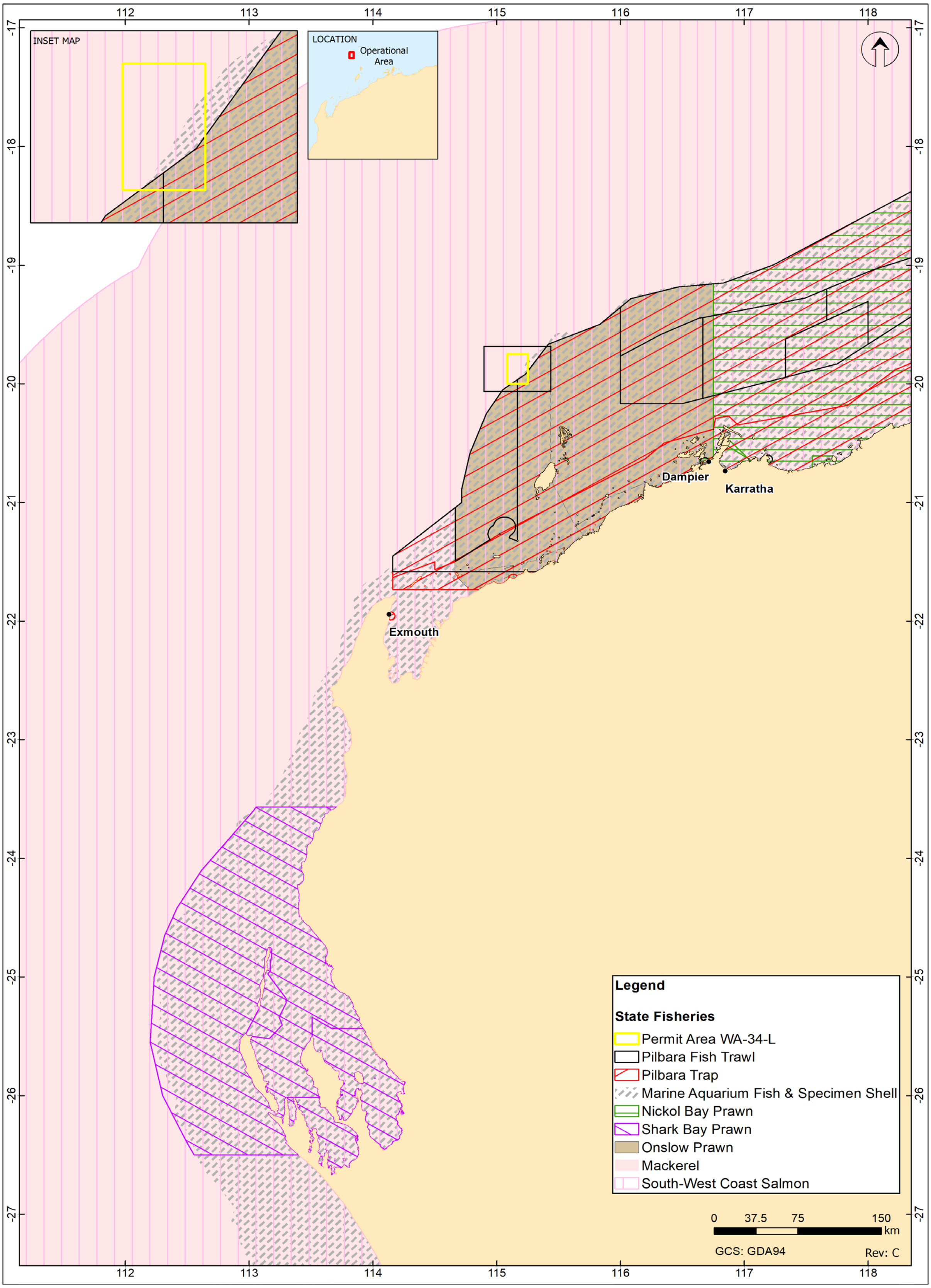


Figure 4-16: Location of State fisheries in relation to the Permit Area (two of two)

4.6.3.2 Aquaculture

There are no aquaculture operations within the Permit Area as these operations are typically restricted to shallow coastal waters. Aquaculture in the region consists primarily of culturing hatchery-reared and wild-caught oysters (*Pinctada maxima*) for producing pearls, which is primarily centred around Broome and the Dampier Peninsula (outside the EMBA). Leases typically occur in shallow coastal waters at depths of less than 20 m (Fletcher et al., 2006). There are existing pearl aquaculture leases at the Montebello Islands, within the Flying Foam Passage in the Dampier Archipelago and within Exmouth Gulf (Fletcher et al., 2017), all outside the EMBA. Other types of aquaculture leases are also found near the Montebello Islands, Dampier Archipelago, the Exmouth Gulf and near Onslow, all outside the EMBA.

Primary spawning of the pearl oyster occurs from mid-October to December. A smaller secondary spawning occurs in February and March (Fletcher et al., 2006).

4.6.4 Fisheries – Traditional

There are no traditional or customary fisheries within the Permit Area, as these are typically restricted to shallow coastal waters and/or areas with structures such as reef. However, it is recognised that Barrow Island and Montebello Islands, the closest islands to the Permit Area, have a known history of fishing when areas were occupied (as from historical records) (CALM, 2005; Department of Environment and Conservation, 2007).

4.6.5 Tourism and Recreation

No tourist activities take place specifically within the Permit Area and, given the distance to the nearest access node from the Permit Area (>160 km to the Dampier boat ramp on the Burrup Peninsula), recreational fishing effort is not expected; however, it is acknowledged that there are growing tourism and recreational sectors in Western Australia and these sectors have expanded over the last couple of decades. Growth and the potential for further expansion in tourism and recreational activities is recognised for the Pilbara and Gascoyne regions, with the development of regional centres and a workforce associated with the resources sector (SGS Economics & Planning, 2012).

Tourism is the largest revenue earner of all the major industries of the Gascoyne region and contributes significantly to the local economy in terms of both income and employment. In 2016 there was an average of 341,000 visitors with a visitor spend of $304 million (Gascoyne Development Commission, 2018). The main marine nature-based tourist activities are concentrated around and within the Ningaloo World Heritage Area (about 190 km south-west of the Permit Area). Activities include recreational fishing, snorkelling and scuba diving, and wildlife watching and encounters (including whale sharks, manta rays, humpback whales and turtles) (Schianetz et al., 2009).

The Montebello Islands State Marine Park (about 45 km from the Permit Area and outside the EMBA), is the closest location for tourism with some charter boat operators taking visitors to these islands (Department of Environment and Conservation, 2007). Recreational fishing in the Pilbara and Gascoyne regions is mainly concentrated around the coastal waters and islands and has grown considerably with the expanding regional centres, seasonal tourism and increasing residential and fly in/fly out workforce, particularly in the Pilbara region (Fletcher et al., 2017). Some recreational fishing has historically taken place at Rankin Bank (about 25 km west of the Permit Area).

4.6.6 Shipping

The NWMR supports significant commercial shipping activity, the majority of which is associated with the mining and oil & gas industries (**Figure 4-17**).

AMSA has introduced a network of marine fairways across the NWMR of WA to reduce the risk of vessel collisions with offshore infrastructure. The fairways are not mandatory but AMSA strongly recommends commercial vessels remain within the fairway when transiting the region. No fairways overlap the Permit Area (**Figure 4-17**).

Ports in the region are nodes of increased vessel activities; active ports in the vicinity of the Permit Area include:

- Dampier (about 170 km south)
- Barrow Island (about 90 km south)
- Port Walcott (about 215 km south)
- Onslow (about 180 km south)
- Port Hedland (about 350 km south-east).

There are no ports within the EMBA.

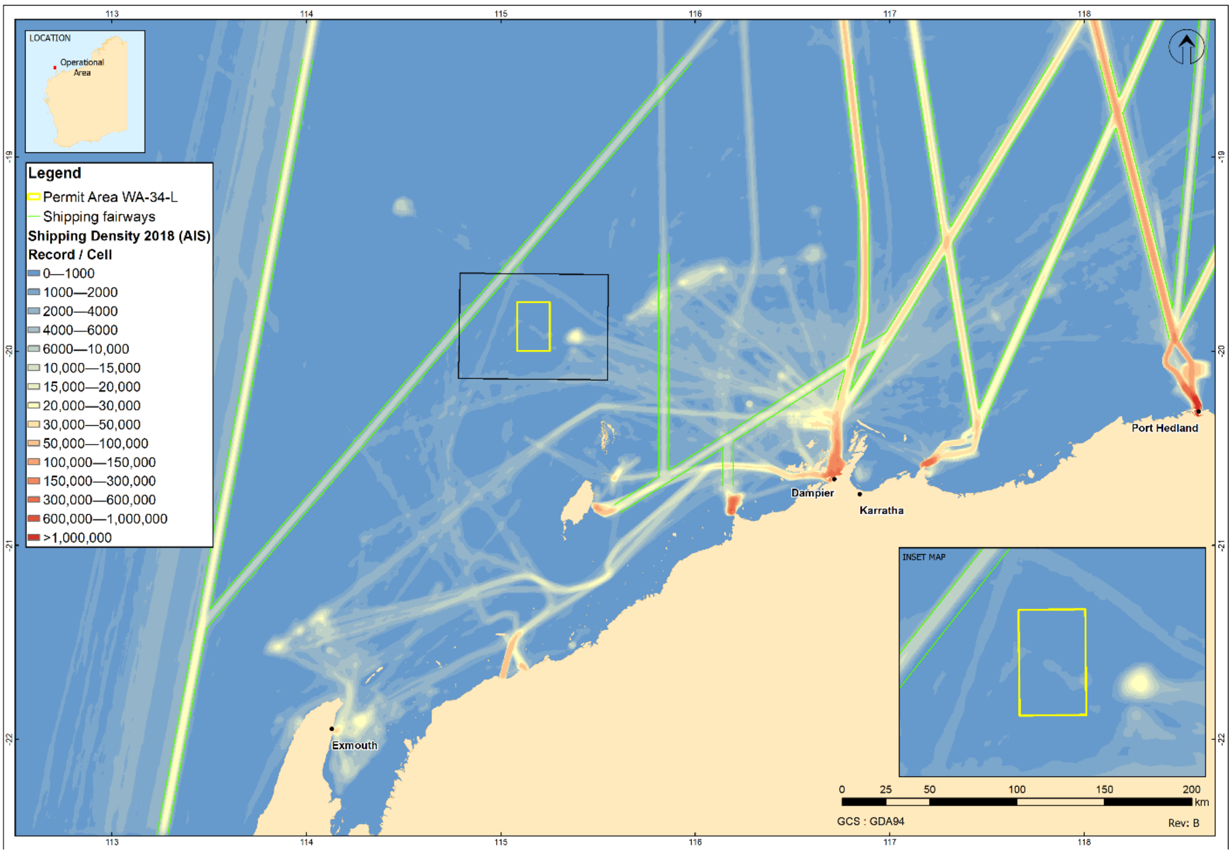


Figure 4-17: Vessel density map for the Permit Area from 2016, derived from AMSA satellite tracking system data

4.6.7 Oil and Gas Infrastructure

The Permit Area is located within an area of established oil and gas operations in the broader NWMR. **Table 4-10** lists other facilities located in proximity to the Permit Area. Several facilities (platforms and floating production, storage and offloading vessels (FPSOs) and platforms) are currently operating in the vicinity of the Permit Area (**Table 4-10** and **Figure 4-18**).

Subsea infrastructure associated with the Pluto platform are also located within the Permit Area and listed in **Section 3.9.1**.

Table 4-10: Other oil and gas facilities in the vicinity of the Permit Area

Facility name and operator	Approximate distance from Permit Area (km)	Direction
Wheatstone Platform (Chevron)	15	East
Pluto platform (Woodside)	15	East
Wonnich (Santos)	60	South
Goodwyn (Woodside)	65	East
John Brooks (Quadrant)	50	South
North Rankin Complex (Woodside)	75	East

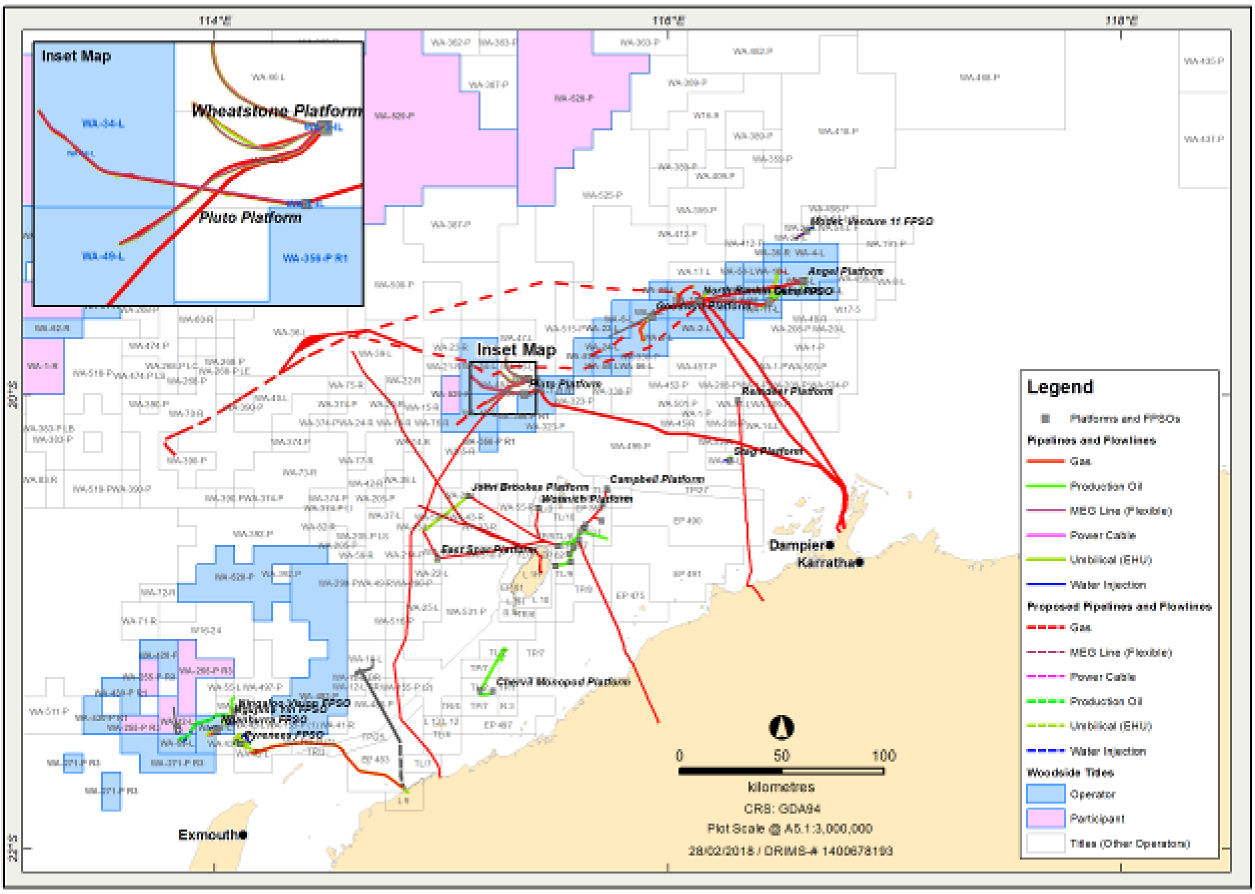


Figure 4-18: Oil and gas infrastructure with reference to the location of the Permit Area

4.6.8 Defence

There are designated Department of Defence practice areas in the offshore marine waters off Ningaloo and the North West Cape, of which a military flying training area partially overlaps the Permit Area (**Figure 4-19**). A Royal Australian Air Force base located at Learmonth, on North West Cape, lies about 295 km south-west of the Permit Area.

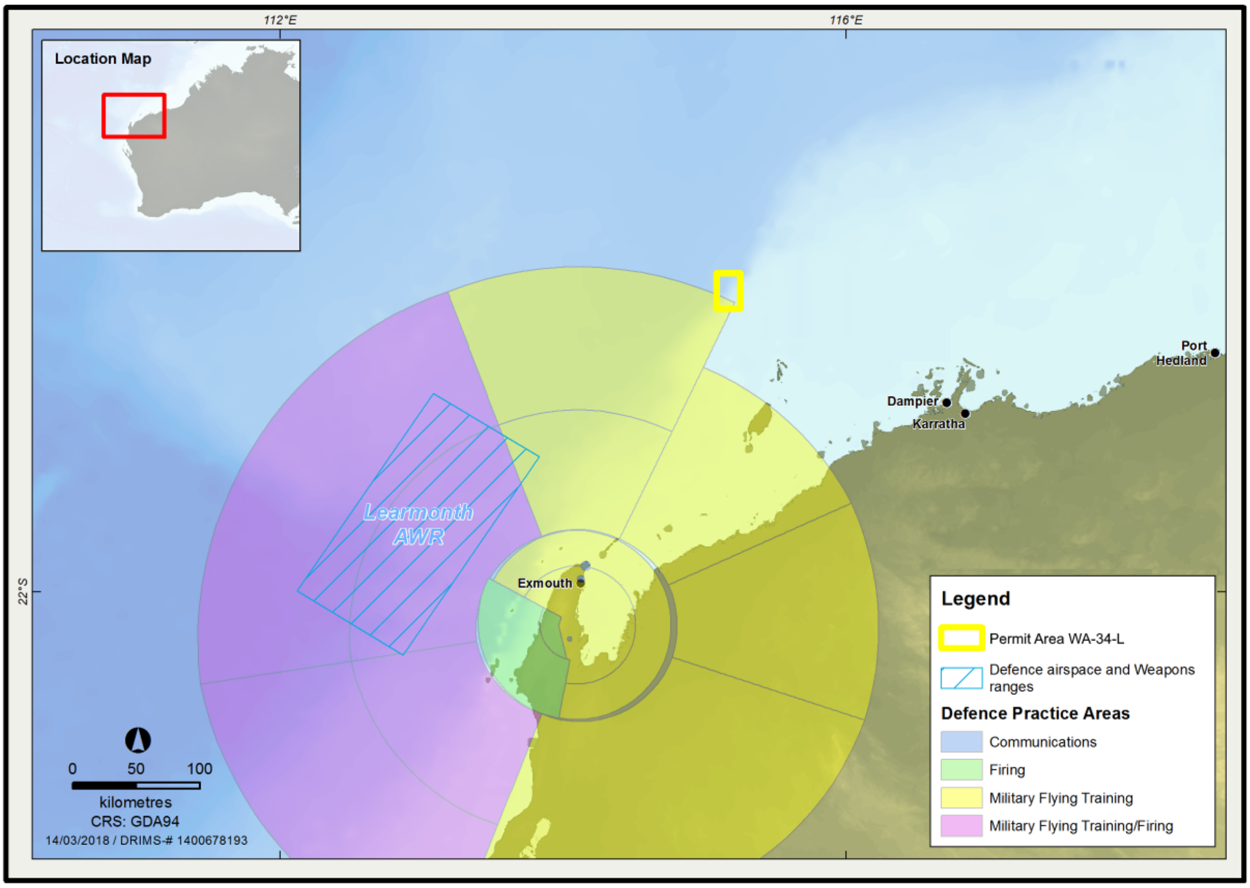


Figure 4-19: Department of Defence Demarcated Marine Offshore Areas for military and defence practice with reference to the location of the Permit Area

4.7 Values and Sensitivities

The values and sensitivities of the Permit Area and EMBA are presented in this sub-section of the existing environment description. The offshore environment of the NWMR contains environmental assets (such as habitat and species) of high value or sensitivity including Commonwealth offshore waters, as well as the wider regional context including coastal waters and habitats such as the Montebello/Barrow Islands and the Ningaloo World Heritage Area, and the associated resident, temporary or migratory marine life including species such as marine mammals, turtles and birds (**Section 4.5.2**).

Many sensitive receptor locations are protected as part of Commonwealth and State managed areas and have been allocated conservation objectives (International Union for Conservation of Nature (IUCN) Protected Area Category) based on the Australian IUCN reserve management principles in Schedule 8 of the *EPBC Regulations 2000*.

In particular, the North-West Marine Parks Network Management Plan 2018 (Director of National Parks (DNP), 2018) provides for managing the network of Australia Marine Parks (AMP) in the North-West Network. The plan states that detailed implementation plans will be developed in the future to set out management actions and identify performance indicators for the North-West Network. However, the plan assigns an IUCN category to each marine park of the North-West Network, divides some marine parks into zones with their own category, and sets out the objectives for each zone. Zoning takes into account the purposes for which the marine parks were declared, the objectives of the plan, the values of the marine park, and the requirements of the EPBC Act and EPBC Regulations. The management approach applied to activities within these zones is also described in the plan. While the Permit Area does not overlap any AMP, one does overlap the EMBA. The plan states that actions required to respond to oil pollution incidents, including environmental monitoring and remediation, in connection with mining operations authorised under the OPGGS Act, may be conducted in all zones without an authorisation issued by the Director, provided that the actions occur in accordance with an environment plan that has been accepted by NOPSEMA, and the Director is notified in the event of oil pollution within a marine park, or where an oil spill response action must be taken within a marine park, so far as reasonably practicable, prior to response action being taken.

The next section outlines the values and sensitivities of the established and proposed Marine Protected Areas (MPAs) and other sensitive areas in the EMBA (listed in **Table 4-11**, shown in **Figure 4-20**). These areas are also considered in the environmental risk evaluation of planned and unplanned activities associated with the Petroleum Activities Program.

Table 4-11: Summary of established and proposed MPAs and other sensitive locations in the Permit Area and EMBA

	Distance from Permit Area to Values/ Sensitivity boundaries (km)	IUCN Protected Area Category
Nearest Habitats of Significant Conservation Value		
Continental Slope Demersal Fish Communities KEF	Overlapping Permit Area	Not applicable
Ancient Coastline at 125 m Depth Contour KEF	0.2	Not applicable
Montebello Australian Marine Park	0.2	VI – Multiple Use Zone
Established Australian Marine Parks		
Gascoyne Australian Marine Park	306	IV – Habitat Protection Zone
	159	VI – Multiple Use Zone
Ningaloo Australian Marine Park	205	IV – Recreational Use Zone
State Marine Parks and Nature Reserves		
None overlapping the Permit Area or EMBA		
World Heritage Areas		
The Ningaloo Coast	189	Not applicable
KEFs		
Continental Slope Demersal Fish Communities KEF	Overlapping Permit Area	Not applicable
Ancient Coastline at 125 m Depth Contour KEF	0.2	Not applicable
Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	160	Not applicable
Commonwealth waters adjacent to Ningaloo Reef	205	Not applicable
Exmouth Plateau (North-west)	72	Not applicable
Glomar Shoals (North-west)	138	Not applicable
Other sensitivities		
Rankin Bank	25	N/A

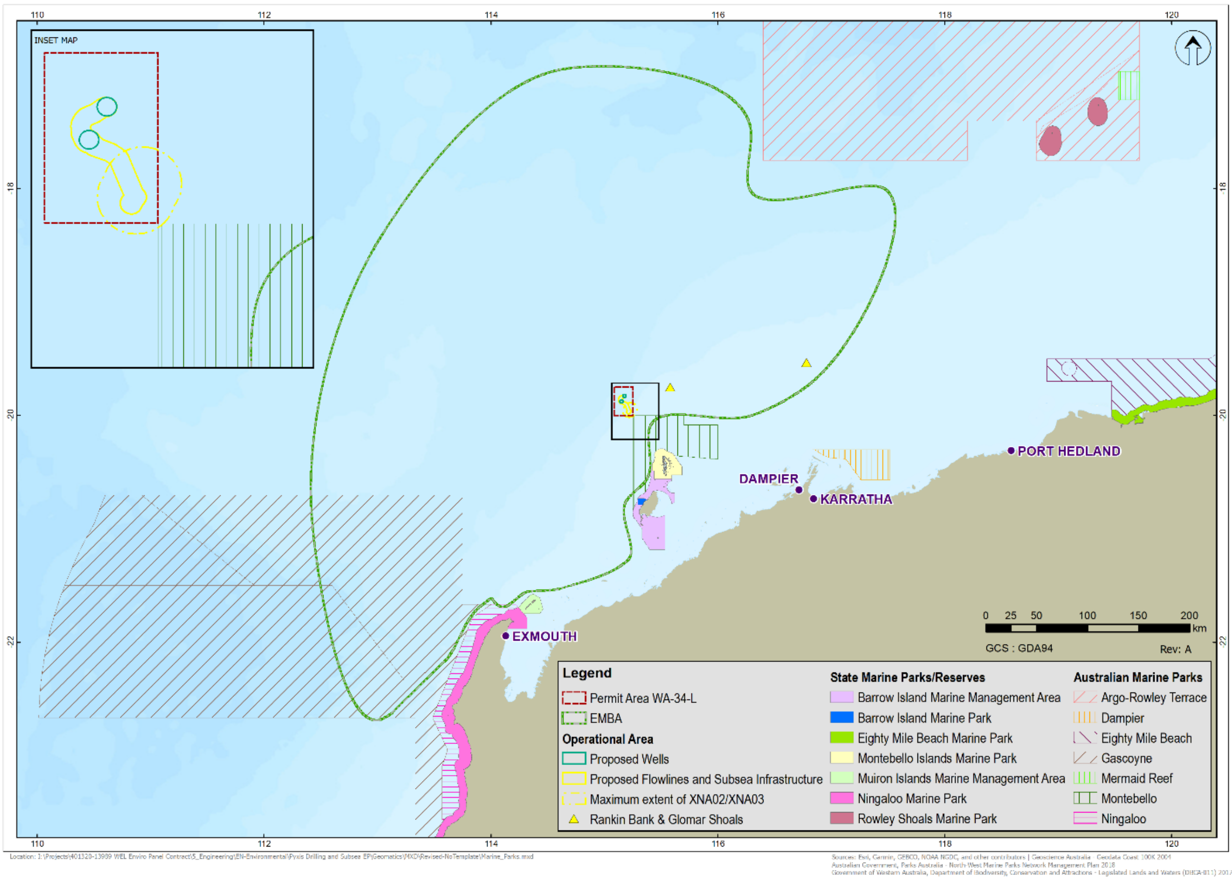


Figure 4-20: Established and proposed Commonwealth and State MPAs in relation to the Permit Area

4.7.1 Montebello/Barrow/Lowendal Islands

The marine and coastal environments of the Montebello/Barrow/Lowendal Islands group represent a unique combination of offshore islands, intertidal and subtidal coral reefs, mangroves, macroalgal communities and sheltered lagoons, and are considered a distinct coastal type with very significant conservation values (Department of Environment and Conservation, 2007). The following provides information about the Montebello AMP which overlaps the EMBA. Though not overlapping the Permit Area or EMBA, information about additional surrounding state marine parks and management areas is also provided considering their proximity to the EMBA.

4.7.1.1 Montebello Australian Marine Park

The Montebello AMP is adjacent to the Montebello Marine Park/Barrow Island Marine Park/Barrow Island Marine Management Area, providing a contiguous marine park covering both State and Commonwealth waters. The entire Montebello AMP, an area of 341,300 ha, is designated a multiple use zone (IUCN Category VI), allowing for long-term protection and maintenance of the AMP in conjunction with sustainable use, including oil and gas exploration activities. It is located within 1 km of the Permit Area.

Major conservation values within the Montebello AMP include (DoEE, n.d.; DNP, 2018):

- habitats, species and ecological communities associated with the North West Shelf Province
- BIAs for a range of MNES (**Section 4.5.2**)
- two historic shipwrecks: the *Trial* and the *Tanami*

- diverse social values including tourism, fishing, mining and recreation
- foraging areas adjacent to important nesting sites for marine turtles
- part of the migratory pathway of the protected humpback whale
- examples of the seafloor habitats and communities of the NWMR as well as the Pilbara (offshore) mesoscale bioregion (Heap et al., 2005)
- one KEF for the region, the Ancient Coastline at 125 m Depth Contour (**Section 4.7.3.2**)
- the park includes shallow shelf environments with depths ranging from 15 to 150 m and provides protection for shelf and slope habitats, as well as pinnacle and terrace seafloor features. This includes Tryal Rocks which can emerge from the water.

The Montebello AMP is managed under the North-west Marine Parks Network Management Plan (**Section 1.10.2**).

4.7.1.2 Montebello Marine Park/Barrow Island Marine Park/Barrow Island Marine Management Area

The Montebello Islands Marine Park, Barrow Island Marine Park and Barrow Island Marine Management Area are located 40 km, 80 km and 55 km respectively from the Permit Area at their closest point and, with the Montebello AMP, are the closest sensitive environments to the Permit Area. The marine parks and management area are jointly managed and cover a combined area of 1770 km². A sanctuary zone covers the entire 41 km² Barrow Island Marine Park. The Barrow Island Marine Management Area covers 114,500 km² and includes most of the waters surrounding Barrow Island and Lowendal Islands, except for the port areas around Barrow and Varanus islands. Key conservation and environmental values within the reserves include (Department of Environment and Conservation, 2007):

- a complex seabed and island topography consisting of subtidal and intertidal reefs, sheltered lagoons, channels, beaches, cliffs and rocky shores
- pristine sediment and water quality, supporting a healthy marine ecosystem
- undisturbed intertidal and subtidal coral reefs and bommies with a high diversity of hard corals
- important mangrove communities, particularly along the Montebello Islands, which are considered globally unique as they occur in offshore lagoons
- extensive subtidal macroalgal and seagrass communities
- important habitat for cetaceans and dugongs
- nesting habitat for marine turtles
- important feeding, staging and nesting areas for seabirds and migratory shorebirds
- rich finfish fauna with at least 456 species
- historical culture of the pearl oyster (*Pinctada maxima*) in the reserves producing some of the highest quality pearls in the world.

These islands support significant colonies of wedge-tailed shearwaters and bridled terns. The Montebello Islands support the biggest breeding population of roseate terns in Western Australia. Ospreys, white-bellied sea-eagles, eastern reef egrets, Caspian terns and lesser crested terns also breed in this area. Observations suggest an area to the west of the Montebello Islands may be a minor zone of upwelling in the NWMR, supporting large feeding aggregations of terns. There is also some evidence that the area is an important feeding ground for Hutton's shearwaters and soft-plumaged petrels. Barrow Island is ranked equal tenth among 147 sites in Australia that are important for migratory shorebirds. Barrow, Lowendal and Montebello islands are internationally significant sites for six species of migratory shorebirds, supporting more than 1% of the East Asian-Australasian Flyway population of these species (DSEWPaC, 2012d).

The Montebello Islands Marine Park/Barrow Island Marine Park/Barrow Island Marine Management Area is contiguous with the Montebello AMP. The intertidal habitats of the Montebello/Barrow/ Lowendal Islands group are influenced by the passage of tropical cyclones that shape sandy beaches (RPS Bowman Bishaw Gorham, 2007). The dominant habitats on the exposed west coasts of islands in the area are sandy beaches, rocky shores and cliffs. The predominant physical habitats of the sheltered east coasts of islands are sand flats, mud flats, rocky pavements and platforms (RPS Bowman Bishaw Gorham, 2007).

4.7.1.3 Barrow Island Nature Reserve

The Barrow Island Nature Reserve is a Class A Nature Reserve covering about 235 km² and extends to the low water mark adjacent to the Montebello Islands/Barrow Island Marine Parks. It is located about 75 km from the Permit Area outside the EMBA. The islands surrounding Barrow Island including Boodie, Double and Middle islands make up the Boodie, Double and Middle Islands Nature Reserve, covering 587 ha (Department of Parks and Wildlife (DPaW), 2015). Together, these two nature reserves are commonly referred to as the Barrow Group Nature Reserves (DPaW, 2015).

The Barrow Island coastline consists of dry creek beds, beaches, clay and salt flats, mangroves, intertidal flats and reefs and is bordered by high cliffs on the western side. Key conservation values within the reserves include (DPaW, 2015):

- the second largest island off the WA coast
- important biological refuge site because of isolation from certain threatening process on the mainland
- contains flora that are restricted in distribution and at or near the limit of their range
- high number of fauna species with high conservation value
- extensive hydrogeological karst system that supports a subterranean community of high conservation significance
- regionally and nationally significant rookeries for green and flatback turtles
- important habitat for migratory shorebirds and also used by these species as a staging and destination terminus
- significant habitat values such as intertidal mudflats, rock platforms, mangroves, rock piles and cliffs, clay pans and caves
- a significant fossil record that indicates local historical biodiversity and evolution
- a history of Aboriginal and other Australian use including 13 registered aboriginal cultural heritage sites.

4.7.1.4 Lowendal Islands Nature Reserve

The Barrow Island Marine Management Area includes the waters around the Lowendal Islands, which covers 1145 km². The Lowendal Islands Nature Reserve incorporates the islands of the Lowendal Archipelago, around 15 km south of Montebello Islands and 80 km from the Permit Area outside the EMBA.

The Lowendal Islands group is made up of 34 islands and islets, with the largest being Varanus Island at 0.83 km². The islands are limestone rocks that extend a few metres above the sea level and have sparse vegetation (DSEWPaC, 2012b).

Key conservation values within the reserve include:

- feeding and breeding habitat for the shorebirds including the common greenshank, common sandpiper and the red-necked stint
- foraging habitat for hawksbill turtles
- supports resident populations of common bottlenose dolphins and Indo-Pacific humpback dolphins
- critical nesting and internesting habitat for hawksbill turtles (Varanus Island), and supports an important flatback turtle rookery
- supports seabird colonies for species such as the wedge-tailed shearwaters and bridled terns
- foraging and staging area for migratory shorebirds (DSEWPaC, 2012b) and internationally significant site for six species of migratory shorebirds, supporting more than 1% of the East Asian-Australasian Flyway population for these species
- seagrass habitat for dugongs.

4.7.2 Ningaloo Coast and Gascoyne

4.7.2.1 The Ningaloo Coast World and National Heritage Area

The Ningaloo Coast WHA includes North West Cape and the Muiron Islands, and was inscribed under criteria (vii) and criteria (x) by the World Heritage Committee onto the World Heritage Register in June 2011. The Ningaloo Coast WHA is located about 189 km south west of the Permit Area but within the EMBA. The statement of Outstanding Universal Value for the Ningaloo Coast was based on the natural criteria and recognised that it contained:

- land seascapes comprised of mostly intact and large-scale marine, coastal and terrestrial environments
- lush and colourful underwater scenery and its contrast with the arid and rugged land
- annual aggregation of whale sharks, one of the largest in the world
- important aggregations of other fish species and marine mammals
- high marine diversity, including an unusual diversity of marine turtle species
- rare and diverse subterranean creatures found nowhere else in the southern hemisphere
- diversity of reptiles and vascular plants in the drylands.

The Ningaloo Coast WHA is recognised as being of outstanding conservation value, supporting a rich array of habitats and a diverse and abundant marine life (DoE, 2014d). The region has a high diversity of marine habitats including coastal mangrove systems, lagoons, coral reef, open ocean, continental slope and the continental shelf (MPRA, 2005). The dominant feature of the Ningaloo Coast WHA is Ningaloo Reef, the largest fringing reef in Australia. Ningaloo Reef supports both tropical and temperate species of marine fauna and flora and more than 300 species of coral (MPRA, 2005).

The Ningaloo Coast WHA provides important nesting habitat for four species of marine turtle found in Western Australia. The North West Cape and Muiron Islands are major nesting sites for loggerhead turtles, with about 400 and 600 females nesting annually on the Ningaloo Coast (particularly North West Cape area) and Muiron Islands, respectively (Department of Environmental Protection, 2001). The North West Cape is also a major nesting habitat for hawksbill and green turtles, with an estimated 1000–1500 green turtles nesting in the area annually (DEC, 2009). The Muiron Islands are minor nesting sites for flatback and hawksbill turtles (DEC, 2009).

Each year, the largest congregation of whale sharks anywhere in the world takes place off the coast of the Ningaloo WHA. It is estimated that between 300 and 500 whale sharks visit each year between March and July, coinciding with the annual mass coral spawning events.

It is these natural heritage values, iconic wilderness, seascapes, wildlife and biodiversity which are major attractions of the WHA and therefore the main driver for tourism on the North West Cape. All properties inscribed on the World Heritage List must have adequate management to ensure their protection, thus the Ningaloo WHA is managed via the Australian Marine Park and State Marine Park (see subsections below).

Ningaloo Australian Marine Park

The Ningaloo Australian Marine Park covers 2435 km² and is about 10 km north of Exmouth. It is contiguous with the Western Australian Ningaloo Marine Park. The Ningaloo Australian Marine Park is located about 205 km south-west of the Permit Area but within the EMBA. The Ningaloo Australian Marine Park adds additional protection to the Ningaloo Reef, which lies in State waters within the State managed Marine Park. Water depths range from shallow water of 30 m depth to oceanic waters at 1000 m deep. Major conservation values of the reserve include (Director of National Parks, 2013):

- foraging areas adjacent to important breeding areas for migratory seabirds, whale sharks and marine turtles
- important nesting sites for marine turtles
- part of the migratory pathway of the humpback whale
- shallow shelf environments with depths ranging from 15 to 150 m, providing protection for the shelf and slope habitats, as well as pinnacle and terrace sea-floor features
- examples of the seafloor habitats and communities of the Central Western Shelf Transition.

The reserve has international and national significance due to its diverse range of marine species and unique geomorphic features. The reserve provides essential biological and ecological links that sustain the biodiversity and ecological processes, including supplying nutrients to reef communities from deeper waters further offshore, to the Ningaloo Reef ecosystem.

4.7.2.2 Gascoyne Australian Marine Park

The Gascoyne AMP covers about 81,766 km² and includes waters from less than 15 m depth to 6000 m depth. The Gascoyne AMP lies about 145 km south west of the Permit Area but within the EMBA. Conservation values identified within the reserve include:

- foraging areas for migratory seabirds (including the wedge-tailed shearwater), hawksbill and flatback turtles and whale sharks
- a continuous connectivity corridor from 15 to over 5000 m
- seafloor features including canyon, terrace, ridge, knolls, deep hole/valley and continental rise
- sponge gardens in the south of the reserve adjacent to Western Australian coastal waters
- examples of the ecosystems of the Central Western Shelf Transition, the Central Western Transition and the North West Province provincial bioregions as well as the Ningaloo meso-scale bioregion (Director of National Parks, 2013).

The reserve contains three key conservation values for the region:

1. canyons on the slope between the Cuvier Abyssal Plain and the Cape Range Peninsula (associated enhanced productivity, aggregations of marine life and unique sea-floor feature)
2. Exmouth Plateau (unique seafloor feature associated with internal wave generation)
3. continental slope demersal fish communities (high species diversity and endemism which is the most diverse slope bioregion in Australia with over 500 species recorded of which 76 are endemic to the area).

The reserve boundary is adjacent to the existing Commonwealth portion of the Ningaloo MPA.

4.7.3 Key Ecological Features

KEFs are the parts of the marine ecosystem 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.

One KEF, the continental slope demersal fish communities, overlaps the Permit Area and another one, the Ancient Coastline at 125 m Depth Contour, intersects the EMBA close to the Permit Area (within 1 km). KEFs also present within the EMBA include the Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula, Commonwealth waters adjacent to Ningaloo Reef, Exmouth Plateau (North-west) and Glomar Shoals (North-west) (**Figure 4-21**).

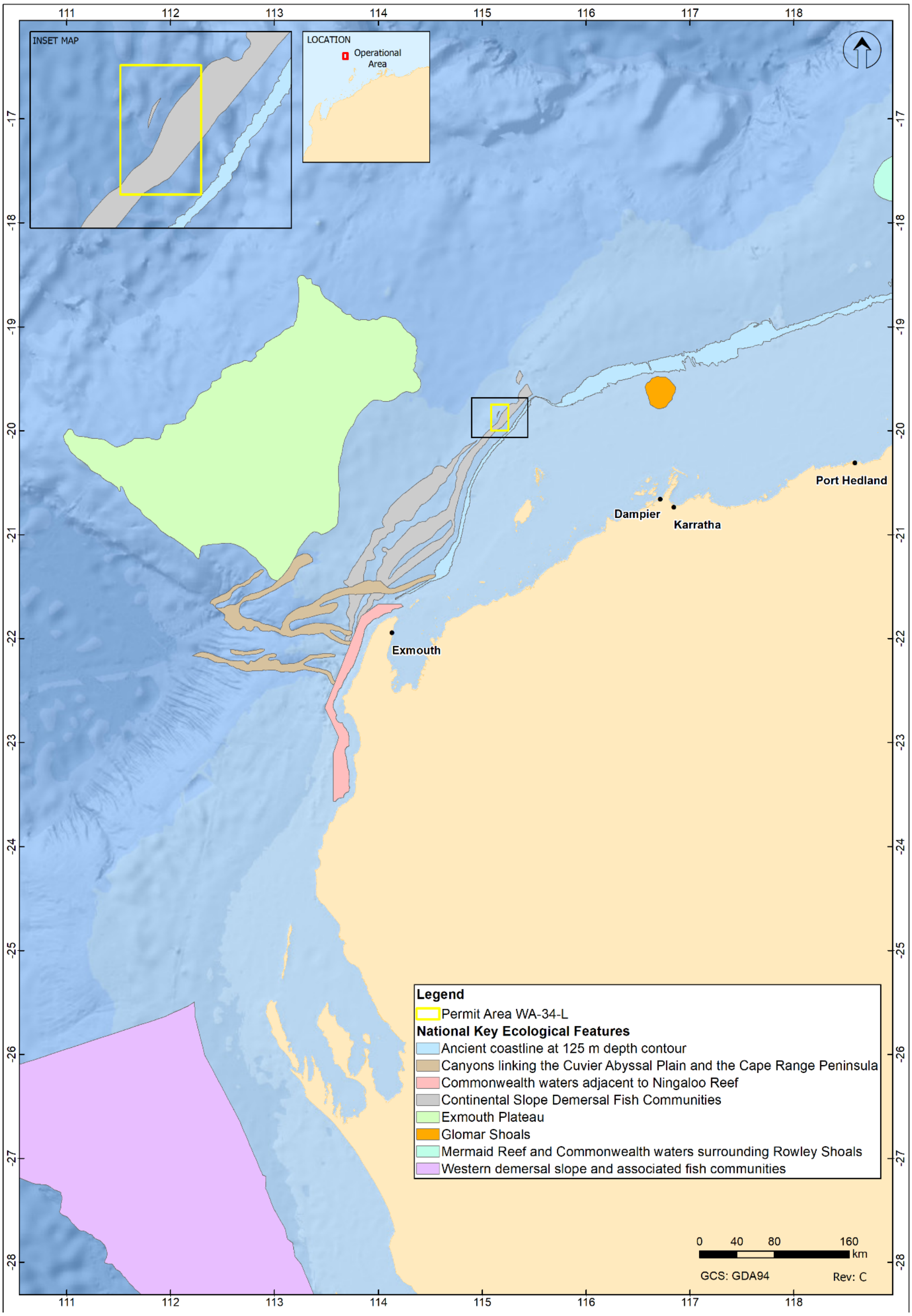


Figure 4-21: KEFs in relation to the Permit Area

4.7.3.1 Continental Slope Demersal Fish Communities

The continental slope demersal fish communities in the region have been identified as a KEF of the NWMR (DSEWPaC, 2012d) and overlaps the Permit Area. The continental slope between North West Cape and the Montebello Trough has been identified as one of the most diverse slope assemblages in Australian waters, with over 508 fish species and the highest number of endemic species (76) of any Australian slope habitat (DEWHA, 2008). Additional features relating to the fish populations of this area are as follows:

- Continental slope demersal fish communities have been identified as a KEF of the NWMR due to the notable diversity of the demersal fish assemblages and high levels of endemism (DSEWPaC, 2012d).
- The North West Cape region is a transition area for demersal shelf and slope fish communities between the tropical dominated communities to the north and temperate communities to the south (Last et al., 2005). The benthic shelf and slope communities offshore of the North West Cape comprise both tropical and temperate fish species with a north-south gradient (DEWHA, 2008).
- The fish fauna of the North West Cape region, like the ichthyofauna of many regions, exhibits decreasing species richness with depth (Last et al., 2005). Fish species diversity has been shown to be positively correlated with habitat complexity, with more complex habitats (e.g. coral reefs) typically hosting higher species richness than simpler habitats such as bare, unconsolidated muddy sediments (Gratwicke and Speight, 2005). A total of 500 finfish species from 234 genera and 86 families have been recorded within the Ningaloo Marine Park, and 393 species were identified at study sites of the Muiron Islands (CALM, 2005). The offshore sediment habitats of the Permit Area are expected to support lower fish species richness than other shallower, more complex habitats in the coastal areas of the region.

4.7.3.2 Ancient Coastline at 125 m Depth Contour

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, which forms the Ancient Coastline at 125 m Depth Contour KEF (the Ancient Coastline). The Ancient Coastline KEF passes within 1 km south-east of the Permit Area, extending along a line approximated by the 125 m isobath (**Figure 4-21**). 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).

4.7.3.3 Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula

The canyons that link the Cuvier Abyssal Plain with the Cape Range Peninsula lie off the north west coast of Australia, over 160 km south-west of the Permit Area but within the EMBA. The canyons are believed to support the productivity and species richness of Ningaloo Reef. 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, seasnakes, sharks, predatory fish and seabirds are known to occur in the area due to the enhanced productivity (Sleeman et al., 2007).

4.7.3.4 Commonwealth waters adjacent to Ningaloo Reef

The Commonwealth waters adjacent to Ningaloo Reef KEF lies adjacent to the 3 nm State waters limit along Ningaloo Reef and includes the Ningaloo Australian Marine Park. See **Section** 4.7.2.1 for further information for the values and sensitivities associated with this KEF.

4.7.3.5 Exmouth Plateau

The Exmouth Plateau is a large, mid-slope, continental margin plateau that lies off the north-west coast of Australia, located to the west of the Permit Area with its closest point approximately 72 km north-west of the Permit Area. It ranges in depth from about 800 to 3500 m and is a major structural element of the Carnarvon Basin. The plateau is bordered by the Rankin Platform and the Exmouth sub-basin of the Northern Carnarvon Basin to the east, the Argo Abyssal Plain to the north, and the Gascoyne and Cuvier Abyssal Plains to the north west and south west. The plateau is recognised as a KEF because it is an area of enhanced biological productivity that supports a range of species (TGS, 2011).

The Exmouth Plateau has a relatively uneven seabed, which includes pinnacles and canyon systems in the northern section. The canyon systems are recognised as a distinct feature and are localised areas of high biological productivity (TGS, 2011). Biological productivity on the top of the Exmouth Plateau is comparatively low due to tropical oligotrophic waters, with increased productivity identified around the plateau boundaries as a result of internal waves and upwelling (TGS, 2011). The sediments of the plateau are assumed to consist of abyssal red clays, which indicate that benthic communities are likely to include filter feeders and epifauna, including sea cucumbers, polychaetes and sea pens (TGS, 2011). Pelagic species are likely to include nekton, small pelagic fish and large predators such as billfish, sharks and dolphins (TGS, 2011). Protected and migratory species are also known to pass through the region including whale sharks, cetaceans and marine turtles.

4.7.3.6 Glomar Shoals

The Glomar Shoals are about 138 km west of the Permit Area but within the EMBA. These submerged shoals are large (768 km^2), complex bathymetrical features on the outer western shelf of the West Pilbara. The largest shoal rises on all sides from 80 m depth and shallows gradually to include a plateau region situated within 40 m of the surface. The shoals are relatively shallow with water depths reaching 22–28 m at its shallowest point. Together with Rankin Bank, these remote shallow water areas represent regionally unique habitats and are likely to play an important role in the productivity of the Pilbara regions (AIMS, 2014; Abdul Wahab et al 2018).

The Glomar Shoals have been identified as a KEF of the continental shelf within the NWMR, based on their regionally important habitat supporting high biological diversity and high localised productivity (Falkner et al., 2009). On a regional level, the Glomar Shoals are also known to be an important area for a number of commercial and recreational fish species (DSEWPaC, 2012a).

The Glomar Shoals were surveyed by AIMS in 2013 as part of a co-investment project between Woodside and AIMS to better understand the habitats and complexity of Rankin Bank and Glomar Shoals. The research included collecting continuous coverage multibeam data to produce a bathymetry dataset, underwater towed camera transects to assess benthic communities, and BRUVS sampling of the fish assemblages (AIMS, 2014; Abdul Wahab et al 2018).

The shoals have relatively high seafloor temperatures and high biological productivity. The benthic community composition and distribution of Glomar Shoals was assessed, quantitatively, using the images from the towed video system. Results from the 2013 AIMS survey show that the benthic habitats of Glomar Shoals are characterised by sand/silt substrate and low epibenthic cover (about 53% total cover), with soft corals and sponges the most abundant fauna. The most abundant benthic organisms were plants, with turf algae present on many substrates. Hard corals at Glomar Shoals are not a major habitat type and overall abundance is very low (0.4%), with small patches of 10% cover in its shallowest regions. Corals appeared healthy, with no areas of coral mortality identified (AIMS, 2014; Abdul Wahab et al 2018). Overall, the benthic habitats of Glomar Shoals are considered pristine and similar to other shoals within the NWMR.

The fish abundance and diversity of the demersal fish communities of Glomar Shoals are influenced by the seabed habitat type, with genera associated with sandy habitats common, including threadfin breams (Nerripterus spp.) and triggerfish (Abalisters spp.). Species richness and abundance are influenced by habitat depth and the degree of coral cover. In general, the fish abundance and diversity of Glomar Shoals are considered comparable with other regional Australian reefs and the North West submerged shoals and banks.

4.7.4 Other Sensitive Areas

4.7.4.1 Rankin Bank

Rankin Bank is on the continental shelf, about 25 km from the Permit Area at its closest point. While not a KEF, Rankin Bank, along with the Glomar Shoals KEF, is the only large, complex bathymetrical feature on the outer western shelf of the West Pilbara and represents habitats that are likely to play an important role in the productivity of the Pilbara region (AIMS, 2014). Rankin Bank consists of three submerged shoals delineated by the 50 m depth contour with water depths of about 18–30.5 m (AIMS, 2014).

Rankin Bank represents a diverse marine environment, predominantly composed of consolidated reef and algae habitat (~55% cover), followed by hard corals (~25% cover), unconsolidated sand/silt habitat (~16% cover), and benthic communities composed of macroalgae, soft corals, sponges and other invertebrates (~3% cover) (AIMS, 2014). Hard corals are a significant component of the benthic community of some parts of the bank, with abundance in the upper end of the range observed elsewhere on the submerged shoals and banks of north-west Australia (Heyward et al., 2012).

A recent study involving multibeam and towed video surveys at Rankin Bank and Glomar Shoals found coral cover at Rankin Bank comparable to that of other shallow reefs. The study reported that the benthic communities at Rankin Bank (hard corals, sponges and sand) influence fish communities in the area, resulting in higher abundance and diversity of fish species associated with shallow, hard coral habitats (Wahab et al., 2018). Wahab et al (2018) also reported that across depths, benthic taxa cover was up to 30 times greater at Rankin Bank than at Glomar Shoals, a defined KEF, and that fish communities were twice as abundant and 1.5 times as diverse than at Glomar Shoals (Heyward et al., 2012).

Rankin Bank has been shown to support a diverse fish assemblage (AIMS, 2014). This is consistent with studies showing a strong correlation between habitat diversity and fish assemblage species richness (Gratwicke and Speight, 2005; Last et al., 2005). The habitat surrounding Rankin Bank (<50 m) was mapped by AIMS on behalf of Woodside (AIMS, 2014) and hosts filter feeding communities in areas of consolidated substrate interspersed by sand. Refer to **Section 4.5.1** for information about filter feeding communities.

5 STAKEHOLDER CONSULTATION

5.1 Summary

Woodside is committed to consulting relevant stakeholders to ensure stakeholder feedback informs our 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.

Consultation activities for activities were conducted on the basis of approximate locations for the proposed four production wells, with advice provided to relevant stakeholders that the exact location of the XNA02 and XNA03 wells were subject to change. Woodside committed to advising relevant stakeholders of these locations once planning was finalised.

5.2 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 performed 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 performed 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 performed 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**.

5.3 Stakeholder Consultation Objectives

In support of this Environment Plan, Woodside has sought to:

- ensure all relevant stakeholders are identified and engaged in a timely and effective manner
- develop and make available to stakeholders communications material 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.

5.4 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 – Rev 5 – June 2018*
- *GN1847 – Responding to public comment on environment plans – Rev 0 – April 2019*
- *GN1344 – Environment plan content requirements – Rev 4 – April 2019*
- *GN1488 – Oil pollution risk management – Rev 2 – February 2018*.

Australian Government

- *Offshore Petroleum and Greenhouse Gas Activities: Consultation with Australian Government agencies with responsibilities in the Commonwealth Marine Area*.

Australian Fisheries Management Authority

- *Petroleum industry consultation with the commercial fishing industry*.

Department of Agriculture and Water Resources

- *Fisheries and the Environment – Offshore Petroleum and Greenhouse Gas Act 2006*.

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 before or during the proposed activity. These stakeholders will be contacted, provided 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
Australian Government department or agency		
Australian Customs Service – Border Protection Command	Yes	Responsible for coordinating maritime security.
Australian Fisheries Management Authority	Yes	Responsible for managing Commonwealth fisheries. It is highly unlikely there has been recent effort by Commonwealth fishery licence holders in the area, however we have chosen to consult in the unlikely event there has been effort
Australian Hydrographic Office (AHO)	Yes	Maritime safety and responsible for Notice to Mariners.
Australian Maritime Safety Authority	Yes	Statutory agency for vessel safety and navigation and legislated responsibility for oil pollution response in Commonwealth waters.
Department of Agriculture and Water Resources (DAWR)	Yes	Responsible for implementing Commonwealth policies and programmes to support the agriculture, fisheries, food and forestry industries. While the proposed activity is unlikely to impact Commonwealth fisheries as fishing effort has historically occurred outside the Operational Area (see **Table 4-9**), Woodside notes the Department's interest in unplanned activities, such as the introduction of invasive marine species (IMS), and has provided information about the proposed activity.
Department of Defence (DoD)	Yes	Operational Area is within a Defence activity area.
Department of the Environment and Energy	No	Responsible for designing and implementing Australian Government policy and programs to protect and conserve the environment, water and heritage, promote climate action, and provide adequate, reliable and affordable energy. The proposed activity does not trigger any of the DoEE's functions, interests or activities.
Department of Industry, Innovation and Science	Yes	Department of relevant Commonwealth Minister, required to be consulted under the Regulations.
Director of National Parks	Yes	Management of Commonwealth marine parks. While planned activities do not affect the functions, interests or activities of the DNP, Woodside notes DNP's interest in unplanned activities, such as an oil spill has provided information about the proposed activity.
Western Australian Government department or agency		
Department of Biodiversity, Conservation and Attractions, Parks and Wildlife Service	No	Responsible for managing Western Australia's parks, forests and reserves. Planned activities do not impact the Department'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.

Stakeholder	Relevant to activity	Reasoning
Department of Primary Industries and Regional Development (DPIRD)	Yes	Responsible for managing State fisheries.
Department of Transport (DoT)	Yes	Legislated responsibility for oil pollution response in State Waters.
Commonwealth fisheries*		
North-West Slope Trawl Fishery	Yes	While the fishery overlaps the Operational Area it is highly unlikely there has been recent activity in the area, however we have chosen to consult in the unlikely event there has been effort
Southern Bluefin Tuna Fishery	No	While the fishery overlaps the Operational Area there has been no recent fishing effort in the area and focused on NSW and South Australia.
Western Deepwater Trawl Fishery	No	While the fishery overlaps the Operational Area there has been no recent fishing effort in the area.
Western Skipjack Fishery	No	While the fishery overlaps the Operational Area it is an inactive fishery.
Western Tuna and Billfish Fishery	Yes	While the fishery overlaps the Operational Area it is highly unlikely there has been recent activity in the area, however we have chosen to consult in the unlikely event there has been effort.
State fisheries*		
Mackerel Managed Fishery – Pilbara (Area 2)	No	Fishery overlaps the Operational Area and there has been recent fishing effort in the area. Western Australian Fishing Industry Council (WAFIC) advised that water depths are too deep for mackerel fishers and that mackerel fishers did not need to be consulted.
Marine Aquarium Managed Fishery	No	Fishery overlaps the Operational Area but typical water depth for fishing not relevant to the area.
Onslow Prawn Managed Fishery	No	Fishery overlaps the Operational Area but typical water depth for fishing not relevant to the area.
Pearl Oyster Managed Fishery	Yes	Zone 1 of the fishery overlaps the Operational Area and there has been recent fishing effort in this zone.
Pilbara Demersal Scalefish Managed Fisheries:		
• Pilbara Trawl	No	Fishery overlaps the Operational Area but the fishery management area overlapping the Operational Area is closed to trawl fishing.
• Pilbara Trap	Yes	Fishery overlaps the Operational Area and there has been recent fishing effort.
• Pilbara Line	Yes	Fishery overlaps the Operational Area and there has been recent fishing effort.

Stakeholder	Relevant to activity	Reasoning
South West Coast Salmon Managed Fishery	No	Fishery overlaps the Operational Area but no recent fishing effort in the area.
Specimen Shell Managed Fishery	No	Fishery overlaps the Operational Area but shell collection method and typical water depth for collection not relevant to the area.
West Australian Abalone Fishery	No	Fishery overlaps the Operational Area but no recent fishing effort in the area.
West Coast Deep Sea Crustacean Managed Fishery	No	Fishery overlaps the Operational Area but no recent fishing effort in the area.
Industry		
Chevron	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	Yes	Represents the interests of commercial fishers with licences in Commonwealth waters. It is highly unlikely there has been recent effort by Commonwealth fishery licence holders in the area, however Woodside have chosen to consult in the unlikely event there has been effort.
Pearl Producers Association (PPA)	Yes	Represents the interests of the Australian South Sea Pearling industry. Potential for interaction with pearl fishers.
Recfishwest	No	Represents the interests of recreational fishers in Western Australia. Activities are unlikely to impact recreational fishers given distance from shore.
Western Australian Fishing Industry Council	Yes	Represents the interests of commercial fishers with licences in State waters. Potential for interacting with commercial fishers.
Community and environmental representative organisations		
Australian Conservation Foundation	No	Australian national environmental organisation. While the proposed activity does not directly impact the organisation, Woodside has provided information about the activities in line with consultation for previous EPs and before introducing new transparency arrangements.
International Fund for Animal Welfare	No	Global animal welfare and conservation charity that works to rescue individual animals, safeguard populations, preserve habitat and advocate for greater protections. While the proposed activity does not directly impact the organisation, Woodside has provided information about the activities in line with consultation for previous EPs and prior to the introduction of new transparency arrangements.

Stakeholder	Relevant to activity	Reasoning
Wilderness Society	No	Australian, community-based, not-for-profit non-government environmental advocacy organisation. While the proposed activity does not directly impact the organisation, Woodside has provided information about the activities in line with consultation for previous Environment Plans and prior to the introduction of new transparency arrangements.
World Wide Fund for Nature	No	International non-governmental organisation working to preserve the wilderness and reduce human impact on the environment. While the proposed activity does not directly impact the organisation, Woodside has provided information about the activities in line with consultation for previous EPs and before introducing new transparency arrangements.

** Fisheries have been identified as being relevant on the basis of fishing licence overlap with the proposed activity area, as well as consideration of fishing effort data, fishing methods and water depth.* ***Table 4-9*** *provides a detailed assessment of Commonwealth and State fisheries within or adjacent to the Operational Area.*

5.5 Stakeholder Consultation Plan

Consultation activities undertaken for the proposed activity are outlined in **Table 5-2**.

Table 5-2: Stakeholder consultation activities

Activity		Timing	Information Provided
Consultation – all relevant stakeholders		15 April 2019	• Email advising of proposed activity and consultation Information Sheet. • Website publication of the consultation Information Sheet at www.woodside.com.au/sustainability/transparency/consultation-activities. • Provision of toll free 1800 phone number.
Consultation – stakeholders requiring bespoke information	AHO	26 July 2019	• Email advising of proposed activity, consultation Information Sheet and shipping lane map relevant to proposed activity.
	AMSA	15 April 2019	• Email advising of proposed activity, consultation Information Sheet and shipping lane map relevant to proposed activity.
	Chevron	15 April 2019	• Email advising of proposed activity, consultation Information Sheet and titles map relevant to proposed activity.
	DAWR	13 June 2019	• Email advising no expected impacts from planned activities to Commonwealth Fisheries. Information Sheet provided, which includes management measures to prevent introducing IMS.
	DoD	15 April 2019	• Email advising of proposed activity, consultation Information Sheet and defence areas map relevant to proposed activity.
	DNP	13 June 2019	• Email advising of no expected impacts from planned activities to the values of an AMP. Information Sheet provided, as well as advice on response planning in the event of an unplanned event that may impact marine park values, such as an oil spill.

Activity		Timing	Information Provided
		23 August 2019	• Follow up email asking if further information is required or whether DNP would like to discuss the proposed activity.
	DPIRD	15 April 2019	• Email advising of proposed activity, consultation Information Sheet and State fisheries map relevant to proposed activity.
	PPA	15 April 2019	• Email advising of proposed activity including potential impacts to commercial fishers and proposed management/mitigation measures, consultation Information Sheet and State fisheries map relevant to proposed activity.
	WAFIC	15 April 2019	• Email advising of proposed activity including potential impacts to commercial fishers and proposed management/mitigation measures, consultation Information Sheet and State fisheries map relevant to proposed activity.
	AFMA	23 August 2019	• Email to advising of proposed activity, consultation Information Sheet and Commonwealth fisheries map relevant to the proposed activity.
	CFA	23 August 2019	• Email to advising of proposed activity, consultation Information Sheet and Commonwealth fisheries map relevant to the proposed activity.
Consultation – relevant State fishery licence holders: • Pearl Oyster Managed Fishery • Pilbara Trap Fishery • Pilbara Line Fishery		15 April 2019	• Letter to licence holders advising of proposed activity including potential impacts to commercial fishers and proposed management / mitigation measures. • Email to Pilbara Line licence holders advising of proposed activity including potential impact to commercial fishers and proposed management/mitigation measures.
Consultation – relevant Commonwealth fishery licence holders: • North West Slope and Trawl Fishery • Western Tuna and Billfish Fishery		23 August 2019	• Email to licence holders advising of proposed activity, consultation Information Sheet and Commonwealth fisheries map relevant to the proposed activity.
Oil Pollution Consultation – DoT		15 April 2019	• Email advising of proposed activity and commitment for further consultation once oil spill planning for this activity is finalised.
		17 June 2019	• Email and a copy of the Oil Pollution First Strike Plan.
Oil Pollution Consultation – AMSA		18 June 2019	• Email and a copy of the Oil Pollution First Strike Plan.

5.6 Consultation Feedback

A summary of stakeholder feedback and Woodside's responses is outlined in **Table 5-3**, with copies of consultation material outlined in **Table 5-2** included in **Appendix F**.

Table 5-3: Stakeholder consultation feedback Summary

Stakeholder	Stakeholder feedback summary	Woodside response summary
WAFIC	On 15 April 2019 WAFIC emailed Woodside thanking Woodside for consultation that was fishing specific, noting the overlap of the proposed activity with the Mackerel, Pilbara Trap and Pilbara Trawl fisheries. WAFIC stated there would be no negative interactions with the PYA01 and PL-PYA02 wells and recommended Woodside consult the Pearl Producers Association for the XNA02 and XNA03 wells. WAFIC stated that for the XNA02 and XNA03 wells Mackerel fishers would not be impacted due to the water depth, the impact for Pilbara Trap fishers would be minimal and the key impacted fishery would be the Pilbara Line fishery. WAFIC requested Woodside to acknowledge the right of access for commercial fishers, give right of way to commercial fisher, respect and protect the rights of fishers (outside of exclusion zones) and to do the utmost not to disrupt commercial fishing activity or fish schooling/aggregation near the proposed activity and with support and supply vessels transiting fishing grounds. WAFIC confirms its expectation and a formal response that there will be no recreational fishing from any Woodside, Woodside contractor or subcontractor / support vessels throughout the activity. WAFIC requested that Woodside's communication strategy with its extended staff / contractors /subcontractors ensures all agreed activities in the EP (such as the recreational fishing commitment and consideration for Pilbara Line fishers) have been clearly communicated to this broad network.	Woodside notes WAFIC's feedback and consultation approach and potential interactions with State Fisheries. Woodside notes WAFIC's feedback that no negative interactions were expected at the PYA01 and PL-PYA02 well locations. On 15 April 2019 Woodside emailed the Pearl Producers Association about the proposed activities. Woodside notes WAFIC's feedback that no negative interactions were expected for Mackerel Fishery licence holders at the XNA02 and XNA03 well locations (**Table 4-9**). On 15 April 2019 Woodside mailed Trap and Liner Fishery licence holders a letter, Information Sheet and State Fisheries map. Woodside notes WAFIC's feedback and commits to minimising disruption to commercial fishing. Woodside notes WAFIC's feedback and commits to no recreational fishing from any Woodside, Woodside contractor or subcontractor / support vessels during the activity. Woodside notes WAFIC's feedback and commits to communicating with staff, contractors and subcontractors on its commitments above to disruption to commercial fishing and no recreational fishing during the activity.

	On 19 July 2019 WAFIC advised it had received an auto notification on the EP. WAFIC sought feedback on requests that Woodside and contractors and sub-contractors acknowledge the right of access for commercial fishers and to do the uptmost to not disrupt fishing activity or disruption of fish schooling aggregations. WAFIC also referred to broader points for reference including: • Expectation there be no recreational fishing from any Woodside, contractor or subcontractor vessels, seeking formal confirmation of this request. Ensuring Woodside's communication strategy ensures all agreed activities in the EP have been clearly communicated.	Woodside advised: • All vessels on charter to Woodside comply with the International Rules for the Prevention of Collision at Sea (as enacted through flag state). In observance of good seamanship all support vessels will avoid any close and or disruptive engagement with any commercial fishing activity. This statement will be incorporated into the environment plan. • Woodside provides campaign specific Environment Plan inductions with each vessel chartered to ensure awareness of the key Environment Plan commitments. We also maintain signed records of vessel crew contractors participation in vessel marine inductions to ensure that all vessel crew are aware of the key commitments that Woodside make in the environment plan. In addition, Woodsides Charterers instructions describe the Master's obligation to comply with all Environment Plan requirements including campaign environmental compliance. This will be included in the environment plan. • Woodside prohibits recreational fishing activities at Woodside terminals and supply bases or within the 500m zone of a Woodside operated facility. Contractor and sub-contractors implement their own policies regarding recreational fishing from their vessels, some of which include a total ban. • Stakeholder comments are summarised and included in section 5 of the environment plan. As above the specific points will be included in the relevant sections of the public environment plan.
	On 14 August 2019 WAFIC thanked Woodside for its response and responding to the specific points raised. It advised recreational fishing issues covers all EPs and will discussed outside of this EP.	No further engagement required specific to this EP.

AMSA	On 18 April 2019 AMSA emailed Woodside providing information on marine vessel traffic given the locations four proposed wells. AMSA requested that AMSA's Joint Rescue Coordination Centre be notified 24-48 hours before operations commence and provided details of information required by the Centre in that communication. AMSA requested that the Australian Hydrographic Office be contacted through datacentre@hydro.gov.au no less than four working weeks before operations commence for the promulgation of related notices to mariners. AMSA requested Woodside access for future activities AMSA's spatial data gateway and Spatial@AMSA portal to download digital data sets and maps to obtain a vessel traffic showing vessel Automatic Identification System (AIS) data for your area of interest.	Woodside notes AMSA's provision of vessel traffic information, noting traffic in petroleum licence WA-34-L which is operated by Woodside. Woodside will notify AMSA's Joint Rescue Coordination Centre 24-48 hours before operations commence for each survey. Woodside will notify the AHO no less than four working weeks before operations commence. Woodside note's AMSA's request for Woodside to access AMSA's spatial data gateway and portal for planning future activities.
DoT	On 17 May 2019 DoT emailed Woodside requesting consultation in line with its Offshore Petroleum Industry Guidance Note – Marine Oil Pollution if there is a risk of a spill impacting State waters from proposed activities.	On 17 June 2019 Woodside emailed DoT and provided advice of oil spill planning arrangements and a copy of the Oil Pollution First Strike Plan.
DPIRD	On 15 May 2019 DPIRD emailed Woodside acknowledging Woodside's advice and provided the following feedback: DPIRD requested Woodside engage with the following representative bodies as appropriate: • Western Australian Fishing Industry Council (WAFIC); • Pearl Producers Association of WA; • Recfishwest; and • Relevant Traditional Owner groups DPIRD requested that Woodside consult individual commercial fishers and charter operators with an entitlement to fish in the affected area. The Department provided advice on how to access government data to identify relevant fisheries and understand fish stocks in the proposed activity area.	On 19 June 2019 Woodside emailed DPIRD, providing the following feedback: Woodside provided advice to the Department about fisheries and representative organisations consulted for the activity and has for this EP provided information to WAFIC, PPA and Recfishwest. Woodside is not aware of Traditional Owner fishing in the Operational Area. Woodside confirmed that the following State Fisheries had been consulted for the proposed activity: • Pearl Oyster • Pilbara Fish Trap • Pilbara Line fishery Woodside also confirmed that these licence holders had been advised of commercial fishing risks from planned petroleum activities, as well as

		proposed mitigation and/or management measures. Key fishing industry risks are: • Vessel interaction • Seabed disturbance • Underwater noise • Marine discharges Charter operators were not consulted given the distance of the activity from shore.
	DPIRD provided details on how to identify relevant fisheries and understand fish stocks for the area, requesting that any assumptions regarding interpretation of DPIRD data should be made clear in the EP and provided to relevant to stakeholders. DPIRD provided contact details for Departmental officers and timeframe in which to be contacted in the event of a marine pollution event were provided by the Department. The Department also requested Woodside collect and maintain marine baseline data and consider spawning grounds and nursery areas for key fish species when developing an Oil Pollution Emergency Plan. DPIRD requested that Woodside include in the EP activities and mitigation measures to manage environmental impacts arising from subsea installation. DPIRD expected Woodside to include in its impact assessment the risk to aquatic resources for all life stages.	Woodside provided advice on oil spill arrangements, notifications and development of oil spill plans, which included consideration of potential impacts to spawning grounds and nursery areas. Woodside confirmed it had identified and assessed potential risks and impacts to active commercial fishers, fishing activity, the commercial fishing resource and the marine environment in the development of the proposed EP for this activity. Woodside advised it had endeavoured to reduce these risks to ALARP level. Woodside confirmed it had identified and assessed potential risks and impacts to active commercial fishers, aquatic resources (all stages) and the marine environment in the development of the EP for the proposed activity.
DNP	On 28 August 2019 DNP responded thanking Woodside for its enquiry regarding the notification on 13 June 2019, and that it wold respond as quickly as possible. On 29 August 2019 DNP responded thanking Woodside for the opportunity to comment and noted the planned activities do not overlap any Australian marine parks. DNP requests notification if the EP is approved and if approved, notification prior to activities occurring for the Pluto drilling and at the conclusion of that activity. Notification information should be consistent with the guidance note. DNP requested it be made aware of oil/gas pollution incidences which occur within a marine park or are likely to impact on a marine park as soon as possible. Notification should be provided to the 24 hour Marine Compliance Duty Officer and it include: - Titleholder details	Woodside provided advice that it notes and will meet the notification requirements requested by DNP.

	- Time and location of the incident (including name of marine park likely to be effected) - Proposed response arrangements as per the Oil Pollution Emergency Plan (e.g. dispersant, containment, etc.) - Confirmation of providing access to relevant monitoring and evaluation reports when available; and - Contact details for the response coordinator.	
AHO	On 26 July 2019, the Maritime Data Management Area of AHO acknowledged receipt of the information provided, noting the data will be registered, assesses, prioritised and validated in preparation for updating Navigational Charting products.	No further action required.

5.7 Ongoing Stakeholder Consultation

Woodside is committed to the engagements shown in **Table 5-4** based on stakeholder feedback.

Table 5-4: Ongoing stakeholder consultation

Stakeholder	Activity
AMSA	Woodside will notify AMSA's Joint Rescue Coordination Centre 24–48 hours before operations commence for each survey.
	Woodside will notify the AHO no less than four working weeks before operations commence.
DMIRS	Woodside will provide DMIRS activity commencement and cessation notifications.
DNP	Woodside will notify DNP should the EP be approved and prior to activities occurring for the Pluto drilling and at the conclusion of the activity.

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

6.1 Overview

This section presents the impact and risk analysis, evaluation and environment performance outcomes, environmental performance standards and measurement criteria for the Petroleum Activities Program, using the methodology described in **Section 1.10.2** of the EP.

6.2 Impact and Risk Analysis and Evaluation

As required by Regulations 13(5) and 13(6) of the Environment Regulations, the following analysis and evaluation demonstrates that the identified impacts and risks 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 impact assessment for planned activities has been based on the size of the Operational Area.

The WA-34-L specific ENVID workshop was conducted on 12 February 2019. Attendees included Project Environmental Advisors, Environmental Engineers, Project Manager, Subsea Installation Engineer, Subsea Engineer Drilling Engineers, Corporate Affairs and Security and Emergency Management.

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

- planned activities (routine and non-routine) which have the potential for inherent environmental impacts
- unplanned events (accidents, incidents or emergency situations) with an environmental consequence, termed risks.

Within these categories, impact and risk assessment groupings are based on environmental aspects[6] such as emissions and physical presence. In all cases, the worst case risk was assumed.

The ENVID (performed in accordance with the methodology described in **Section 1.10.2**) identified 19 sources of environmental impacts and risks. A summary of the ENVID is provided in **Table 6-1**.

The impact and risk analysis and evaluation for the Petroleum Activities Program indicate that all current environmental risks and impacts associated with the activity are reduced to ALARP and are of an acceptable level, as discussed further in **Sections 6.6** and **6.7**.

6.2.1 Cumulative Impacts

Existing subsea infrastructure within the Permit Area are described in **Section 3.9.1** and the closest petroleum facilities are described in **Section 4.6.7**. Woodside has assessed the cumulative impacts of the Petroleum Activities Program in relation to other relevant petroleum activities which could realistically result in overlapping temporal and spatial extents. Woodside is not aware of any other petroleum activities[7] within Permit Area WA-34-L within the proposed time of the Petroleum Activities Program. Additionally, Woodside will not conduct concurrent drilling operations within WA-34-L under this EP.

[6] An environmental aspect is an element of the activity that can interact with the environment.

[7] Cumulative impacts from the Petroleum Activities Program is addressed under each relevant impact in **Section 6.6.**

Given the distance between the location of the Operational Area and the petroleum facilities in the region, no cumulative risks or impacts will credibly occur.

Table 6-1: Environmental risk analysis and summary

Aspect	EP Section	Risk Rating				Acceptability of Impact/Risk
		Impact/ Consequence	Potential Impact/Consequence Level	Likelihood	Current Risk Rating	
Physical presence: Disturbance to other users	**6.6.1**	F	Social and Cultural – no lasting effect (<1 month), localised impact not significant to areas/items of cultural significance.	-	-	Broadly acceptable
Physical presence: Disturbance to benthic habitat from MODU anchoring, drilling operations, subsea infrastructure installation, sediment mobilisation and ROV operations	**6.6.2**	E	Environment – Slight, short term local impact (<1 year) on species, habitat (but not affecting ecosystems function), physical or biological attributes.	-	-	Broadly acceptable
Routine acoustic emissions: Generation of noise from project vessels, MODU positioning equipment and helicopter transfers.	**6.6.3**	F	Environment – No lasting effect (<1 month); localised impact not significant to environmental receptors (e.g. protected species).	-	-	Broadly acceptable
Routine and non-routine discharges: MODU and project vessels	**6.6.4**	F	Environment – No lasting effect (<1 month); localised impact not significant to environmental receptors (e.g. water quality).	-	-	Broadly acceptable
Routine and non-routine discharges: Drill cuttings and drilling fluids (WBM and NWBM)	**6.6.5**	D	Environment – Minor, short term local impact (1–2 years) on species, habitat (but not affecting ecosystems function), physical or biological attributes.	-	-	Broadly acceptable
Routine and non-routine discharges: cement, cementing fluids, grout, subsea well fluids and unused bulk products	**6.6.6**	E	Environment – Slight, short term local impact (<1 year) on species, habitat (but not affecting ecosystems function), physical or biological attributes.	-	-	Broadly acceptable
Routine and non-routine discharges: Flowline and subsea installation fluids	**6.6.7**	E	Environment – Slight, short term local impact (<1 year) on species, habitat (but not affecting ecosystems function), physical or biological attributes.	-	-	Broadly acceptable
Routine atmospheric emissions: Fuel combustion, flaring, incineration and venting	**6.6.8**	F	Environment – No lasting effect (<1 month); localised impact not significant to environmental receptors (e.g. air quality).	-	-	Broadly acceptable

Aspect	EP Section	Risk Rating				Acceptability of Impact/Risk
		Impact/ Consequence	Potential Impact/Consequence Level	Likelihood	Current Risk Rating	
Routine light emissions: External lighting on MODU and project vessels	**6.6.9**	F	Environment – No lasting effect (<1 month); localised impact not significant to environmental receptors (e.g. species).	-	-	Broadly acceptable
Accidental hydrocarbon release: Loss of well integrity	**6.7.2**	B	Environment – Major, long term impact (10–50 years) on highly valued ecosystems, species, habitat, physical or biological attributes. Reputation/brand – National concern and/or international interest. Medium to long-term impact (5–20 years) to reputation and brand. Venture and/or asset operations restricted.	1	M	Acceptable if ALARP
Accidental hydrocarbon release: Vessel collision	**6.7.3**	D	Environment – Minor, short-term impact (1–2 years) on species, habitat (but not affecting ecosystems), physical or biological attributes.	1	M	Broadly acceptable
Accidental hydrocarbon release: Bunkering	**6.7.4**	E	Environment – Slight, short-term impact (<1 year) on species, habitat (but not affecting ecosystems function), physical or biological attributes.	2	L	Broadly acceptable
Unplanned discharges: Drilling fluids	**6.7.5**	E	Environment – Slight, short-term impact (<1 year) on species, habitat (but not affecting ecosystems function), physical or biological attributes.	1	L	Broadly acceptable
Unplanned discharges: Deck and subsea spills	**6.7.6**	E	Environment – no lasting effect (<1 month), localised impact not significant to environmental receptors (e.g. water quality).	1	L	Broadly acceptable
Unplanned discharges: Loss of solid hazardous and non-hazardous wastes/equipment	**6.7.7**	F	Environment – No lasting effect (<1 month); localised impact not significant to environmental receptors (e.g. water quality).	2	L	Broadly acceptable
Physical presence: Vessel collision with marine fauna	**6.7.8**	E	Environment – Slight, short term local impact (<1 year) on species, habitat (but not affecting ecosystems function), physical or biological attributes.	1	L	Broadly acceptable
Physical presence: Disturbance to seabed from loss of station keeping	**6.7.9**	E	Environment – Slight, short term local impact (<1 year) on species, habitat (but not affecting ecosystems function), physical or biological attributes.	1	L	Broadly acceptable
Physical presence: Dropped object resulting in seabed disturbance	**6.7.10**	F	Environment – No lasting effect (<1 month); localised impact not significant to environmental receptors (e.g. benthic habitats).	2	L	Broadly acceptable

Aspect	EP Section	Risk Rating				Acceptability of Impact/Risk
		Impact/ Consequence	Potential Impact/Consequence Level	Likelihood	Current Risk Rating	
Physical presence: Accidental introduction and establishment of IMS	**6.7.11**	D	Environment – No credible risk identified. Reputation and Brand – Minor, short-term impact (1–2 years) to reputation and brand. Close scrutiny of asset level operations or future proposals.	0	L	Broadly acceptable

6.3 Environmental Performance Outcomes, Standards and Measurement Criteria

Regulation 13(7) of the Environment Regulations requires that an EP includes environmental performance outcomes, environmental performance standards and measurement criteria that address legislative and other controls to manage the environmental risks of the activity to ALARP and acceptable levels.

EPOs, EPSs and MC for the Petroleum Activities Program have been identified to allow the measurement of Woodside's environmental performance and the implementation of this EP to determine whether the environmental performance outcomes and standards have been met.

The EPOs, EPSs and MC specified are consistent with legislative requirements and Woodside's standards and procedures. They have been developed based on the Codes and Standards, Good Industry Practices and Professional Judgement outlined in **Section 1.10.2**, as part of the acceptability and ALARP justification process.

The EPOs, EPSs and MC are presented throughout this section and in **Appendix D** (Oil Spill Preparedness and Response). A breach of these environmental performance outcomes or standards constitutes a 'Recordable Incident' under the Environment Regulations (refer to **Section 7.8.4**).

6.4 Presentation

The environmental impact and risk analysis and evaluation (ALARP and acceptability), environmental performance outcomes, standards and measurement criteria are presented in the following tabular form throughout this section. Italicised/green text in the following example denotes the purpose of each part of the table with reference to the relevant sections of the Environment Regulations and/or this EP.

Context <Description of the context for the impact/risk. Regulation 13(1, 13(2) and 13(3)>		
Description of the Activity – Regulation 13(1)	*Description of the Environment – Regulations 13(2)(3)*	*Consultation – Regulation 11A*

Impacts/Risks Evaluation Summary – *Summary of ENVID outcomes*														
Source of Impact/Risk *Regulation 13(1)*	***Environmental Value Potentially Impacted*** *Regulations 13(2)(3)*							***Evaluation*** ***Section 2.6** and **Section 2.7***						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-economic***	***Decision Type***	***Impact/Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Summary of source of risk														

Description of Source of Impact/Risk
Description of the identified impact/risk including sources or threats that may lead to the risk or identified event. Regulation 13(1).

Impact/Risk Assessment
Discussion and assessment of the potential impacts/risks to the identified environment value(s). Regulation 13(5)(6). *Potential impacts/risks to environmental values have been assigned and discussed based on Woodside's Environmental Consequence Definitions for Use in Environmental Risk Assessments (**Table 2-3**).*

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)*** [8]	***Benefit in Impact/Risk Reduction*** [9]	***Proportionality***	***Control Adopted***
ALARP Tool Used – Section 2.6.1.4 and Section 2.7.1				
Summary of control considered to ensure that the impacts and risks are continuously reduced to ALARP. *Regulation 13(5) (c)*	*Technical/logistical feasibility of the control.* *Cost/sacrifice required to implement the control (qualitative measure).*	*Qualitative commentary of impact/risk that could be averted/ environmental benefit gained if the cost/sacrifice is made and the control is adopted.*	*Proportionality of cost/sacrifice versus environmental benefit. If proportionate (benefits outweigh costs) the control will be adopted. If disproportionate (costs outweigh benefits) the control will not be adopted.*	*If control is adopted.* *Reference to Control # provided.*
ALARP Statement: *Made on the basis of the environmental risk assessment outcomes, use of the relevant tools appropriate to the decision type (**Section 2.6** and **Figure 2-4**) and a proportionality assessment. Regulation 10A(b).*				

[8] Qualitative measure.

[9] Measured in terms of reduction of likelihood, consequence and current risk rating.

Demonstration of Acceptability
Acceptability Statement: *Made on the basis of the application of the process described in* ***Section 2.7.2***, ***Figure 2-7***, *taking into account internal and external expectations, risk to environmental thresholds and use of environment decision principles. Regulation 10A (c)*

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO# S: *Specific performance which addresses the legislative and other controls that manage the activity and against which performance by Woodside in protecting the environment is measured.* M: *Performance against the outcome is measured by measuring implementation of the controls via the measurement criteria.* A: *Achievability/feasibility of the outcome demonstrated via discussion of feasibility of controls in ALARP demonstration. Controls are directly linked to the outcome.* R: *The outcome is relevant to the source of risk and the potentially impacted environmental value.* T: *The outcome states the timeframe during which the outcome will apply or by which it will be achieved.*	**C#** *Identified control adopted to ensure the impacts and risks are continuously reduced to ALARP.* *Regulation 13(5)(c)*	**PS**# *Statement of the performance required of a control measure.* *Regulation 13(7)(a)*	**MC**# *Measurement criteria for determining whether the outcomes and standards have been met.* *Regulation 13(7) (c)*

6.5 Potential Environment Risks Not Included Within the Scope of this Environment Plan

The ENVID identified environmental risks that were assessed as not being applicable (refer to **Section 2.5**) within or outside the Operational Area as a result of the Petroleum Activities Program, and therefore were determined to not form part of this EP. These are described in the following sections for information only.

6.5.1 Shallow/Near-Shore Activities

The Petroleum Activities Program is located in water depths >100 m and at a distance about 50 km from the nearest landfall (Montebello Islands). Consequently, risks associated with shallow/ near-shore activities such as vessel anchoring and risks of grounding were assessed as not credible.

6.5.2 Loss of Containment from Existing Subsea Pipelines

A subsea loss of containment from a rupture of live flowlines/pipelines within or close to the Permit Area (see **Section 4.6.7**) could occur should loss of station keeping of the MODU from mooring failure result in anchor drag across a pipeline/flowline. The Pluto production flowline/export pipeline occurs within and close to the Permit Area and could credibly be ruptured, resulting in loss of inventory as described in the next sections.

6.5.2.1 Pluto Production Flowline/Export Pipeline

A worst case credible hydrocarbon release scenario has been defined in the Pluto Facility Operations EP as the rupture of the subsea export pipeline. This could result in a release to the environment of up to 1800 m^3 of Pluto condensate.

Under Regulation 31(1) of the Environment Regulations, the accepted Pluto Facility Operations EP provides a full description and assessment of impacts and risks. Management controls and response capabilities are also detailed in that EP. Additional controls for operating the MODU are provided below.

6.5.3 Loss of Containment from Abandoned Wellheads

Several existing wellheads occur within the Operational Area for this EP that have been plugged and abandoned in accordance with applicable legislation at the time of the activity. Barriers are in place down the wells, so if a wellhead was inadvertently damaged or removed, through dropped objects or anchor drag, no loss of containment would occur. Therefore, the scenario of loss of containment from existing wellheads is not considered credible and is not assessed further.

6.6 Planned Activities (Routine and Non-routine)

6.6.1 Physical Presence: Interference with or Displacement of Third Party Vessels

Context		
Project vessels **– Section 3.5** Subsea infrastructure – **Section 3.9** Wellhead assembly left in-situ – **Section 3.11.8**	Socio-economic environment – **Section 4.6**	Stakeholder consultation – **Section 5**

Impacts Evaluation Summary														
Source of Impact	***Context***							***Evaluation***						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Impact***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Displacement of other users – proximity of MODU and vessels causing interference with or displacement to third party vessels (commercial fishing and commercial shipping)							X	A	F	-	-	LCS GP PJ	Broadly Acceptable	EPO 1
Presence of subsea infrastructure (including wellhead left in-situ) causing interference with or displacement to third party vessels (commercial fishing)							X	A	F	-	-	LCS GP PJ		EPO 1
Proximity of helicopters causing interference with other aerial operations							X	A	F	-	-	LCS GP PJ		EPO 1

Description of Source of Impact

Presence of MODU and Vessels and Subsea Infrastructure

Woodside proposes to drill up to four new production wells, and may also intervene, workover or re-drill up to eight existing production wells or any of the proposed new production wells within Permit Area WA-34-L. Only one well will be drilled at a time, therefore, a MODU will be present within the Permit Area for about 280 days and may be present for about 70 additional days per well if re-drilling is required.

Subsea installation vessels will be used to install and pre-commission the flowlines and subsea infrastructure following the completion of drilling the new wells. This is expected to take a cumulative duration of about 240 days (including mobilisation, demobilisation and contingency). Flowlines and subsea infrastructure will remain in place.

The Petroleum Activities Program is not planned to be executed as a single campaign or in a consecutive sequence; therefore, the presence of the MODU, subsea installation vessels and other vessels may occur at any time during the five year approval period of the EP, notwithstanding the constraints described above.

Other vessels may also be required during the activities, including subsea support vessel for light well intervention vessels (LWIV) and other support vessels. Some vessels will need to transit in and out of the Operational Area to port for emergency and routine operations. The support vessels will make about two to four trips per week during drilling operations.

The presence of the MODU, subsea installation vessels, subsea support vessel for LWIV and other support vessel movements could present a navigational hazard to shipping and commercial fishing activities in the Operational Area.

As outlined in **Section 3.11.8**, at the end of production life, the wellhead assembly may be left in-situ, if routine removal techniques are unsuccessful. Additionally, for technical reasons, the lower section of a well may be abandoned, prior to sidetracking, or in the event that a re-spud is required. The wellhead left in-situ could potentially interfere with third party activities (in particular, trawl fishing activities).

As outlined in **Sections 3.11.7** and **3.11.8**, wells may need to be abandoned if a re-spud is required. This is considered a contingent activity and if a well is abandoned due to re-spud, routine techniques will be used to remove the wellhead(s). Wellhead assemblies may be left in-situ if these routine removal techniques are unsuccessful. If a wellhead is left in-situ, it could potentially interfere with third party activities (particularly fishing activities).

Impact Assessment

Potential Impacts to Socio-Economic Environment

Displacement or Interference with Commercial Fishing Activities

The Permit Area overlaps four Commonwealth and nine State managed fisheries. However, only the Pilbara Demersal Scalefish Managed Fisheries (Pilbara Trawl, Trap and Line) are considered to be active in the vicinity of the Operational Area (**Sections 4.6.3** and **5.4**). The Pilbara Trawl is closed to fishing within the Permit Area. WAFIC also advised that impacts to Pilbara Trap fishers would be minimal, with the key impacted fishery being the Pilbara Line Fishery (**Section 5.4**). The Operational Area is located in water depths ranging from about 170–990 m, the shallower extent of which is within the depth range where typical fishing effort occurs for the Pilbara Line Fishery. Therefore, interactions with participants in the commercial fishery have the potential to occur.

The presence of commercial fishing vessels in the Operational Area would likely be short term, potentially resulting in a minor interference (navigational hazard) and localised displacement/avoidance by commercial fishing vessels within the immediate vicinity of the MODU, subsea installation vessels, subsea support vessels for LWIV or other vessels. In observance of good seamanship all support vessels will avoid any close and or disruptive engagement with any commercial fishing activity. There was no direct response from commercial fisheries during the stakeholder consultation period. The potential impact is considered to be minor and temporary.

Potential impacts to commercial fishing in the event the wellhead assembly remains in-situ are snag hazards of fishing equipment such as trawl nets that operate along the seabed. However, Zone 1 of the Pilbara Trawl Fishery is currently closed to trawl fishing and therefore impacts are unlikely.

Displacement of Recreational Fishing

Stakeholder consultation did not identify any key recreational fishing activity within the Operational Area. Recreational fishing in the region is concentrated around the coastal waters and islands of the NWMR such as the Montebello Islands (about 50 km southeast of the Permit Area). Due to the distance offshore and water depths, recreational fishing is unlikely to occur in the Operational Area. In the event that recreational fishing effort occurred within the Operational Area while drilling is being undertaken, displacement as a result of the Petroleum Activities Program would be minimal and relate only to the petroleum safety zones (500 m radius) that would be in place. Additionally, fishing activity may be excluded from the immediate area around the subsea locations during installation activities (if required). Therefore, the potential impact is considered to be slight and would be limited to only short term impacts.

Given the distance of the Operational Area offshore and depth greater than 170 m, snagging hazards to recreational fishing equipment as a result of the wellhead remaining in-situ are considered unlikely.

Displacement to Commercial Shipping

The presence of the MODU, installation vessels and support vessels could potentially cause temporary disruption to commercial shipping. The Operational Area does not overlap with any designated shipping fairways in the region although commercial vessel traffic is relatively high (**Figure 4-17**). Shipping in the area is mainly related to the resources industry, and particularly associated with the Woodside-operated North Rankin Complex. The potential impacts associated with this Petroleum Activities Program may include displacement of vessels as they make slight course alterations to avoid the MODU, subsea installation vessels, subsea support vessels for LWIV or other vessels. Therefore, the potential impact is considered to be isolated and temporary.

AMSA did not raise specific concerns about the Petroleum Activities Program (**Section 5.4**) and noted that some heavy vessels traverse through Permit Area WA-34-L.

Given the water depth of the proposed wells (>170 m), impacts to commercial shipping as a result of the wellhead remaining in-situ are not considered credible.

Interference with Existing Oil and Gas Infrastructure

The Operational Area is contained within the WA-34-L Permit Area. Interactions with operators of other nearby facilities (**Section 4.6.7**) are unlikely except as a result of project based vessel movements to and from the Permit Area not covered within this EP.

Interference with Other Aerial Operations

The Operational Area is located within the northern tip of one of the designated defence practice areas of the Royal Australian Air Force base located at Learmonth (**Section 4.6.8**). While it is unlikely helicopter activities from the Petroleum Activities Program could interfere with defence activities, the use of helicopters to transfer crew has the potential to interact with defence activities; therefore, defence stakeholders were notified but no feedback was received (**Section 5**).

Cumulative Impacts

There are no cumulative impacts from drilling activities, as no wells will be drilled concurrently. However, there may be cumulative impacts to commercial fisheries from concurrent drilling and subsea installation activities. Of the fisheries considered active in the vicinity of the Operational Area, potential cumulative impacts to vessels associated with the Pilbara Line Fishery that overlaps the Operational Area would be slight and short-term.

Summary of Potential Impacts to Environmental Value(s)

Given the adopted controls, it is considered that physical presence of the MODU, subsea installation vessels, subsea support vessels for LWIV or other vessels, interference with other aerial operations will be localised with no lasting impact to shipping and commercial/recreational fishing interests (i.e. Reputation and Brand Impacts – F).

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
No controls identified.				
Good Practice				
Australian Hydrographic Service (AHS) will be notified of activities and movements no less than four working weeks prior to scheduled activity commencement date.	F: Yes. CS: Minimal cost. Standard practice.	Notification to AHS will enable them to generate navigation warnings (Maritime Safety Information Notifications (MSIN) and Notice to Mariners (NTM) (including AUSCOAST warnings where relevant)).	Benefits outweigh cost/sacrifice. Control is also Standard Practice.	Yes **C 1.1**
Notify DPIRD (Western Australia) (formerly the WA Department of Fisheries) of activities within three months of drilling.	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 AMSA Joint Rescue Coordination Centre (JRCC) of activities and movements 24–48 hours before operations commence.	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 1.3**
Routine removal of wellheads will be attempted in the event of a respud.	F: Yes. CS: Additional cost. Standard practice.	Routine removal of wellheads may reduce the likelihood of interfering with other marine users.	Benefits outweigh cost/sacrifice. Control is also Standard Practice.	Yes **C 2.1**
Professional Judgement – Eliminate				
Limit drilling activities to avoid peak shipping and	F: No. Shipping occurs year-round and cannot be avoided. SIMOPS with	Not considered, control not feasible.	Not considered, control not feasible.	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
commercial fishing activities.	fishing seasons cannot be eliminated as exact timings for all activities are not confirmed. CS: Not considered, control not feasible.			
Professional Judgement – Substitute				
No additional controls identified.				
Professional Judgement – Engineered Solution				
Over-trawl protection on subsea infrastructure.	F: Yes. Over-trawl protection could mitigate against the potential for commercial fishing trawl gear to damage subsea infrastructure and/or result in loss of trawl gear. CS: Significant additional cost.	Reduce the potential for snagging of trawl nets if a wellhead is left in-situ following abandonment during drilling. However, given the low level of trawling activity occurring in the Operational Area, the benefit is low.	Disproportionate. Significant additional costs.	No

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; **Section 2.6.1**), Woodside considers the adopted controls appropriate to manage the impacts of the physical presence of the MODU, subsea installation vessels, LWIV, associated support vessels, helicopters and potentially wellhead assemblies left in-situ,(if required) on other users, such as commercial fisheries, recreational fishing, shipping and defence.

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, physical presence of the MODU, subsea installation vessels, subsea support vessels for LWIV or other vessels, helicopters and potentially wellhead assemblies left in-situ, as contingency may result in minor and generally short-term impacts to commercial fishing, recreational fishing, shipping and defence. Further opportunities to reduce the impacts have been investigated above. The adopted controls are considered good oil-field practice/industry best practice and meet requirements of Australian Marine Orders, and expectations of AMSA and AHS provided in consultation with stakeholders.

The potential impacts are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts of physical presence of the Petroleum Activities Program to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 1 Marine users aware of the Petroleum Activities Program.	**C 1.1** Notify AHS of activities and movements no less than four working weeks prior to the scheduled activity commencement date.	**PS 1.1** Notification to AHS of activities and movements to allow generation of navigation warnings (Maritime Safety Information Notifications (MSIN) and Notice to Mariners	**MC 1.1.1** Consultation records demonstrate that AHS has been notified prior to commencement of an activity to allow generation of navigation

		(NTM) (including AUSCOAST warnings where relevant)).	warnings (MSIN and NTM (including AUSCOAST warnings where relevant)).
	C 1.2 Notify DPIRD (Western Australia) (formally the WA Department of Fisheries) of activities within three months of drilling.	**PS 1.2** Notification to Department of Primary Industries and Regional Development in order to inform other marine users of the activities to reduce activities interfering with other marine users for longer than necessary.	**MC 1.2.1** Consultation records demonstrate that Department of Primary Industries and Regional Development has been notified prior to commencement of drilling.
	C 1.3 Notify AMSA JRCC of activities and movements 24–48 hours before operations commence.	**PS 1.3** Notification to AMSA JRCC to prevent activities interfering with other marine users. AMSA's JRCC will require the MODU's details (including name, callsign and Maritime Mobile Service Identity), satellite communications details (including INMARSAT-C and satellite telephone), area of operation, requested clearance from other vessels and need to be advised when operations start and end.	**MC 1.3.1** Consultation records demonstrate that AMSA JRCC has been notified prior to commencement of the activity within required timeframes.
EPO 2 Routine removal of wellheads will be attempted during Petroleum Activity Program in the event of a respud.	**C 2.1** Routine removal of wellheads will be attempted in the event of a respud.	**PS.2.1** Removal of wellheads attempted during the Petroleum Activity Program in the event of a respud.	**MC 2.1.1** Records demonstrate routine removal of wellheads was attempted.

6.6.2 Physical Presence: Disturbance to Benthic Habitat from MODU Anchoring, Drilling Operations, ROV Operation and Subsea Infrastructure

Context	
Project vessel-based activities **– Section 3.7** Drilling activities **– Section 3.8** Subsea installation and pre-commissioning activities – **Section 3.9** Wellhead assembly left in-situ **– Section 3.11.8**	Biological environment – **Section 4.5** Values and sensitivities – **Section 4.7**

Impacts 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***	***Impact***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Disturbance to seabed from drilling operations					X		X	A	F	-	-	GP PJ	Broadly Acceptable	EPO 2
Disturbance to seabed from ROV operation (including localised sediment relocation from sediment mobilisation techniques)					X		X	A	F	-	-			
Disturbance to seabed from MODU station keeping (MODU mooring, including anchor holding testing)					X		X	A	E	-	-			
Disturbance to seabed from subsea installation of infrastructure (initiation anchor deployment, flowlines, manifolds and umbilicals, stabilisation systems (concrete mattresses and sand bags)					X		X	A	F	-	-			
Disturbance to seabed from wellhead remaining in-situ at the end of production life (if required)					X		X	A	F	-	-			

Description of Source of Impact

Drilling

Drilling activities will result in direct seabed disturbance of about 100 m radius around each new well location due to the installation of the BOP and conductor. The generation and discharge of cuttings and drilling fluids are not considered in this section; refer to **Section 6.6.5** for an assessment of drill cuttings and drilling fluids.

MODU Anchoring and Anchor Holding Testing

Seabed disturbance will result from the anchor holding testing and MODU anchor mooring system, including placement of anchors and chain/wire on the seabed, potential dragging during tensioning and recovery of anchors. Suction piling may be required for installing the anchors. Overall, the mooring of the MODU and anchor holding testing activities will result in localised, small-scale seabed disturbance in the benthic habitats described in **Section 4.5.1**. Mooring may require a 12 point pre-laid mooring system at each well location depending on the time of year; however, for drilling activities outside of cyclone season, a standard eight point system is more likely. There are four proposed production well locations for the Petroleum Activities Program (**Table 3-2**), equating to the need for 48 anchor installations, assuming all implement the 12 point mooring system.

Woodside may also need to intervene, workover or re-drill the existing eight Pluto and Xena production wells (PLA01 to PLA07 and XNA01) and four proposed production wells within Permit Area WA-34-L.

The planned anchoring activities will be within the parameters defined in the *Anchoring of Vessels and Floating Facilities Environment Plan Reference Case* (Department of Industry, Innovation and Science, undated) for all anchoring activities performed by vessels and floating facilities (excluding FPSOs and Floating LNG vessels) during the petroleum activities program including:

- installation of moorings, buoys, equipment or other infrastructure for a period of up to two years
- wet storage on seabed of anchor chains, etc. during activities up to two years
- activities with total areas of seabed disturbance less than 13,000 m²
- locations of water depth greater than 70 m. This boundary is set to exclude areas of sensitive primary producer habitats (e.g. corals, seagrass) that occur in shallower waters.

Subsea Installation Activities

Subsea installation of the infrastructure components described in **Table 3-6** will result in temporary disturbance and suspension of sediment causing increased turbidity, and impacts to benthic habitats during the installation process.

The installation of subsea infrastructure and supporting structures (including FLET, wellheads, jumpers, manifolds, skids, concrete mattresses) may result in localised disturbance to benthic habitats in the form of loss of habitat and a scour around the subsea infrastructure during the lifespan of the equipment.

Commencement of the flowline installation generally requires tension to the flowline as it transitions from the installation vessel to the seabed. Therefore, commencement of the flowline Installation may start with landing the end of flowline termination head into the manifold connection system or initiation anchor.

The initiation anchor may consist of a suction pile, drag anchor or clump weight/dead-man anchor. The dead-man anchor will weigh about 15 t with about 1100 m of 7 cm diameter wire to initiate the pipe-lay. The flukes of this type of anchor are able to flip over depending on which way it lands on the seabed, and it is anticipated that there will be no need to reset the anchor. This will cause localised and temporary impacts to water quality from increased turbidity and may cause localised and temporary impacts to benthic habitats.

If using the manifold, when the termination end is fully landed, the flexible will be continuously laid using vertical lay system and at the same time, ROV will be monitoring the touch down point on the seabed as well as the flexible lay back radius. In the event, the flexible needs to make a turn, a temporary small bulkabag filled with individual sand bags will be deployed to act as the turning bollard and to be recovered when installation completed.

Span rectification may be required through the installation of structures such as concrete mattresses positioned at the identified free span location by the use of ROV. The dimensions for each concrete mattress are expected to be 12 m by 3 m. Post-lay span rectification may involve placing grout bags on the seabed, with the extent of any impact limited to the footprint of the installed flowline.

An array of underwater acoustic positioning transponders will be placed on the seafloor and are critical for the accurate positioning of the flowline and pre-lay structures. Long base line transponders may be moored to the seabed by a clump weight. The standard clump weights used will likely weigh about 80 kg. At the completion of installation, the LBL transponders will be recovered via an acoustic release mechanism, leaving only the concrete clump weight on the seafloor.

Wet storage of infrastructure components on the seabed, where required, would also result in localised disturbance to the seafloor.

ROV

The use of the ROV during Petroleum Program Activities may result in temporary seabed disturbance and suspension of sediment causing increased turbidity as a result of working close to, or occasionally on, the seabed. ROV used close to or on the seabed is limited to that required for effective and safe subsea activities. The footprint of a typical ROV is about 2.5 m × 1.7 m.

Additionally, it is anticipated that the ROV will be used to displace sediment via jetting (or similar) to create a corridor/short trench to submerge flowline/umbilicals for crossing via other pipeline/subsea infrastructure. An ROV may be used to relocate sediment material around the well location to help manage cement or cuttings flow. Sediment relocation techniques are described in **Section 3.11.9**. This will cause localised and temporary impacts to water quality from increased turbidity and may cause localised and temporary impacts to benthic habitats.

Wellhead Remains In-Situ

Wells may need to be abandoned in the event that a re-spud is required or at the end of production life and if routine wellhead removal techniques are unsuccessful. If the wellhead remains in-situ there would be localised seabed disturbance around the wellhead location.

Impact Assessment
Potential Impacts to Ecosystems/Habitats

Deepwater Benthic Habitats

Drilling operations, MODU mooring (including anchor hold testing), subsea installation activities and ROV operations are likely to result in localised physical modification to the seabed and disturbance to soft sediment.

The Operational Area overlaps a section of the Continental Slope Demersal Fish Communities KEF. The Operational Area is expected to consist primarily of soft, fine, unconsolidated sediments, which are typical of the broader NWMR. As discussed in **Section 4.5.1.4**, benthic communities of the Operational Area associated with this substrate show typical low diversity representative of the wider region. Results from the geotechnical and geophysical survey of the nearby Pluto field indicated hard substrate for two areas of seabed (**Section 4.4.3**). The main area of exposed hard substrate, sea cliffs, occurs in about 1000 m depth where the continental slope meets the abyssal plain. The bottom of the rocky cliffs is situated in about 1050 m water depths with an almost vertical wall extending 20 m up to about 1030 m at the surveyed location. The rock appears to be sedimentary with clear bands or layers occurring in the rock profile. No epifauna was observed on the exposed rock cliffs. From about 1030 m to 880 m, rock and mud stone outcrops occur, interspersed with large areas of soft sediment. Observations of the ROV's manipulator arm indicated that the mudstone was very soft, disintegrating very easily.

The only other exposed hard substrate known to occur in the Permit Area is a series of rock pinnacles located about 300 m water depth. The pinnacles provided a structure for a diversity of fauna including fish and invertebrates. Many tens of fish were observed gathered around these pinnacles, most probably belonging to either the Glaucosomidae or Pricanthidae families. Crinoids, hydroids and ophiuroids were also common. Other species visible on the mounds include anemones, soft corals, small crustacean like shrimp and some larger brachyurans, possibly *Cyrtomaia suhmii.* Where the seabed gradients were less steep, sediments accumulated and large anemones and batfish were observed. The only potential impact to the rock pinnacles and associated fauna may occur during the laying of the flowline, between Pluto infill well (PL-PYA02) and the existing Xena Tee. The indicative pipeline route is approximately 110 m east of the rock pinnacles (**Figure 4-8)** however is subject to refinement during detailed engineering. Further pre-lay surveys are planned to be undertaken to identify sensitive areas to avoid any direct impacts.

Physical impacts from drilling activities (excluding impacts from routine and non-routine discharges such as drill cuttings assessed in **Section 6.6.5**) are expected to be for the most part confined to sediment burrowing infauna and surface epifauna invertebrates, particularly filter feeders, inhabiting the seabed directly around the well location, typically within 100 m of the well (Gates and Jones, 2012; Hughes et al., 2010). Impacts from the installation of subsea infrastructure are expected to be confined to sediment burrowing infauna and surface epifauna invertebrates, particularly filter feeders, inhabiting the seabed directly around the installation site. These impacts are expected to be localised due to the size (10 and 12 inch) and length of the flowlines (~14 km and ~12 km), the size of the subsea infrastructure (Table 3-6) and the widespread representation of the infauna communities within the Operational Area and the broader NWMR. Significant impacts to these broadly represented communities are not expected.

ROV activities near the seafloor and associated sediment relocation activities for submerging a part of the flowline for crossing may result in slight and short-term impacts to deepwater biota, detailed above, as a result of elevated turbidity and the clogging of respiratory and feeding parts (turbidity) of filter feeding organisms. However, elevated turbidity would only be expected to be very localised, short-term and temporary, and is therefore not expected to have any significant impact to environment receptors, particularly given the low densities of benthic organisms at the water depths of the Operational Area. The closest coral reef habitat is at Rankin Bank, about 25 km from the Permit Area.

Additionally, the ROV may be used to relocate sediment material around the well location to help manage cement or cuttings flow and to create a short corridor to submerge flowlines and umbilicals for crossings. This will cause localised and temporary impacts to water quality from increased turbidity, and may cause localised and temporary impacts to benthic habitats. During contingent operations, an ROV-mounted suction pump/dredging unit may be used to relocate sediment/cuttings around the wellhead to keep the area clear and safe for operations and equipment. This may generate plumes of suspended sediment during pumping and cause disturbance to benthic fauna in the immediate area. Any plumes are expected to dissipate and are not considered likely to impact on corals (closest coral reef habitat is Rankin Bank about 25 km from the Permit Area). Impacts to demersal fish communities would be minor with temporary avoidance of the disturbed area.

In the unlikely event the wellhead cannot be removed, over time the cement surrounding the wellhead will likely become buried in sediment as a result of prevailing ocean currents. Over time, the steel wellhead structure will corrode and marine fouling is expected to accumulate, whereby a marine life structure may remain above the seafloor. The wellhead remaining in-situ is expected to have a localised non-significant impact to environment receptors. No further impacts to benthic habitats are likely.

Survey findings at the Goodwyn facility (McLean et al., 2017), showed that the presence of subsea infrastructure (pipeline) resulted in the development of demersal fish communities that would otherwise not occur in the Permit Area. Generally speaking, the structures that are located in shallower water (<135 m) had a greater diversity of fish compared to habitats at 350 m depth, where the number of fish species and abundance declined markedly (McLean et al., 2018). The study by Bond et al. (2018) also confirmed that compared to adjacent natural seabed habitats, pipeline fish fauna were characterised by higher relative abundance and biomass of commercially important species. The additional subsea infrastructure to be installed as part of the Petroleum Activities Program is likely to provide additional hard substrates which would be colonised over time by epifauna and provide habitat for demersal fish communities.

Based on the above assessment, seabed disturbance is unlikely to impact on the ecological value of the Continental Slope Demersal Fish Communities KEF or any commercial fishers that may operate in the area.

Cumulative Impacts

Given the number of wells planned to be drilled during the Petroleum Activities Program, there is the potential for cumulative disturbance to the seabed and benthic communities. Cumulative seabed disturbance associated with the Petroleum Activities Program is expected to be restricted to an accumulation of disturbance areas from overlapping well footprints (in the event well locations are within hundreds of metres of each other) and subsea infrastructure installation sites. Recovery from any such cumulative impacts is expected to be relatively rapid due to the expected re-colonisation from adjacent sediments.

As benthic habitats within the Operational Area are well represented throughout the North West Shelf and wider NWMR, cumulative impacts associated with seabed disturbance from overlapping well footprints are not expected to significantly increase the risk to benthic habitats present within the Operational Area, including those of the Continental Slope Demersal Fish Communities KEF and commercial fishers.

Summary of Potential Impacts to Environmental Value(s)

Given the adopted controls, seabed disturbance from the Petroleum Activities Program will result in localised, slight and short-term impacts to benthic habitat and communities (i.e. Environment Impact – E).

Demonstration of ALARP

Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
No additional controls identified.				
Good Practice				
Project-specific Basis of Well Design, which includes an assessment of seabed sensitivity.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of anchoring occurring in areas of high sensitivity. Assessment of seabed topography reduces the likelihood of anchor drag leading to seabed disturbance.	Benefits outweigh cost/sacrifice.	Yes **C 3.1**
Project-specific Mooring Design Analysis.	F: Yes. CS: Additional costs associated with upgraded MODU mooring design.	The mooring design analysis determines the number and spread of anchors required based on sediment type and seabed topography, reducing the likelihood of anchor drag leading to seabed disturbance.	Benefits outweigh cost/sacrifice.	Yes **C 3.2**
LBL or USBL positioning technology used.	F: Yes. CS: Minimal cost. Standard practice.	Use of positioning technology to position infrastructure on the seabed with accuracy will reduce seabed disturbance.	Benefits outweigh cost/sacrifice.	Yes **C 3.3**
Environmental monitoring of the seabed prior to and following the Petroleum Activities Program to assess any impacts to seabed.	F: Yes. CS: Significant. Monitoring of the seabed, particularly the deep waters of the Operational Area, would have significant additional costs to obtain and analyse data with the spatial	Environmental monitoring would not result in any additional information of the seabed above the Woodside Well Location and Site Appraisal Data Sheet	Control grossly disproportionate. Monitoring will not reduce the consequence or likelihood of any impacts to the seabed, and the	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
	resolution to accurately assess changes to the seabed habitat.	and mooring design analysis. Therefore, no additional reductions in likelihood or consequence would occur.	cost associated with the level of monitoring required to accurately assess any impacts greatly outweighs the benefits gained. Although adoption of this control could be used to verify EPOs alternative controls identified also allow demonstration that the environmental outcome has been met based on the nature of the activity (i.e. predictable impacts) and relatively low sensitivity of the area.	
Routine removal of wellheads will be attempted in the event of a respud	F: Yes CS: Additional cost. Standard practice.	Routine removal of wellheads may reduce the likelihood of interfering with other marine users	Benefits outweigh cost/sacrifice. Control is also standard practice	Yes **C 2.1**
Professional Judgement – Eliminate				
Only use DP MODU (no anchoring required).	F: No. CS: No. It is feasible to use a DP MODU for the Pyxis wells but unlikely for the Xena wells due to shallower depths. Woodside has a demonstrated capacity to manage the environmental risks and impacts from mooring to a level that is ALARP and acceptable.	Not assessed, control not feasible.	Not assessed, control not feasible.	No
Do not use ROV close to, or on, the seabed.	F: No. The use of ROVs (including work close to or occasionally landed on the seabed) is critical as the ROV is the main tool used to guide and manipulate equipment during drilling. ROV usage is already limited to only that required to conduct the work effectively and safely. Due to visibility and operational issues, ROV work on or close to the seabed is avoided unless necessary.	Not assessed, control not feasible.	Not assessed, control not feasible.	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
	CS: Not assessed, control not feasible.			
Prelay survey undertaken prior to installation of flowlines. Based on outcomes of prelay survey, route varied as required to avoid rock pinnacles.	F: Yes CS: Minimal cost. The cluster of rock pinnacles is located within the defined Operational Area approximately 110 m east of the indicative flowline route. Cost would be minimal to avoid rock pinnacles.	Eliminates physical impacts to the rock pinnacles.	Benefits outweigh cost/sacrifice.	Yes **C 3.4**
Professional Judgement – Substitute				
No additional controls identified.				
Professional Judgement – Engineered Solution				
No additional controls 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, **Section 2.6.1**), Woodside considers the adopted controls appropriate to manage the impacts of benthic habitat disturbance from MODU station keeping, drilling operations, subsea infrastructure installations and ROV operations. 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 benthic habitats may result in slight and short term effects on habitat (but not affecting ecosystems function). Further opportunities to reduce the impacts have been investigated above. The adopted controls are considered good oil-field practice/industry best practice and meet the requirements of Woodside's relevant systems and procedures. The potential impacts are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts of disturbance to benthic habitat to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 2 Routine removal of wellheads will be attempted during Petroleum Activity Program in the event of a respud.	**C 2.1** Routine removal of wellheads will be attempted in the event of a respud.	**PS.2.1** Removal of wellheads attempted during the Petroleum Activity Program in the event of a respud.	**MC 2.1.1** Records demonstrate routine removal of wellheads was attempted.
EPO 3 No infrastructure installed in rock pinnacles.	**C 3.1** Project-specific Basis of Well Design, which includes an assessment of seabed sensitivity.	**PS 3.1** MODU well site locations consider seabed sensitivities.	**MC 3.1.1** Records confirm Basis of Well Design includes the assessment of seabed sensitivities.

	C 3.2 Project-specific Mooring Design Analysis.	**PS 3.2** Seabed disturbance from MODU mooring limited to that required to ensure adequate MODU station keeping capacity.	**MC 3.2.1** Records demonstrate Mooring Design Analysis completed and implemented during anchor deployment.
	C 3.3 LBL or USBL positioning technology used.	**PS 3.3** Subsea infrastructure will be positioned in the planned location [10] where impacts have been assessed.	**MC 3.3.1** Records confirm LBL transponders or USBL in place and functioning correctly.
	C 3.4 Pre-lay survey undertaken prior to installation of flowlines. Based on outcomes of prelay survey, route will be varied as require to avoid rock pinnacles.	**PS 3.4** No installation of flowline/s along defined rock pinnacles.	**MC 3.4.1** As build surveys verify no flowlines/s installed along rock pinnacles.

[10] Acceptable tolerance is considered to be ±100 m,noting commitment to avoid sensitive rock pinnacles

6.6.3 Routine Acoustic Emissions: Generation of Noise from Project Vessels, MODU, Positioning Equipment, Helicopter Transfers and Flaring

Context	
Project vessels **– Section 3.5**	Biological environment – **Section 4.5**

Impacts 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***	***Impact***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***[11]
Generation of acoustic signals from MODU (drilling operations), support vessels and installation vessels during normal operations						X	X	A	F	-	-	GP PJ	Broadly Acceptable	N/A
Generation of acoustic signals from dynamic positioning systems on MODU/project vessels						X	X	A	F	-	-	GP PJ		N/A
Generation of atmospheric noise from helicopter transfers						X		A	F	-	-	GP PJ		N/A
Generation of noise from flaring						X		A	F	-	-	GP PJ		N/A

Description of Source of Impact

The MODU, installation vessels, support vessels and helicopters will generate noise both in the air and underwater, due to the operation of thrusters' engines, propeller movement, drilling operations, etc. These noises will contribute to and can exceed ambient noise levels which range from around 90 dB re 1 µPa (root square mean sound pressure level (RMS SPL)) under very calm, low wind conditions, to 120 dB re 1 µPa (RMS SPL) under windy conditions (McCauley, 2005).

MODU Noise

Noise associated with a moored MODU will be restricted to drilling activities, such as drill pipe operations and on board machinery. A range of broadband values (59 to 185 dB re 1 µPa at 1 m (RMS SPL)) have been quoted for various MODUs (Simmonds et al., 2004), where noise is likely to be between 100 to 190 dB re 1 µPa at 1 m (RMS SPL) during drilling and between 85 to 135 dB re 1 µPa at 1 m (RMS SPL) when not actively drilling. McCauley (1998) recorded received noise levels about 117 dB re 1 µPa at 1 m (RMS SPL) at 125 m from a moored MODU while actively drilling (with support vessel on anchor). Austin et al. (2016) recorded source levels of 168.6, 170.1 and 174.9 dB re 1 µPa·m for a moored drilling unit, a moored semi-submersible and a moored drillship whilst drilling.

DP MODU underwater noise measurements taken for the *Maersk Discoverer* drill rig used on the North West Shelf (Woodside, 2011) showed the system emitted tonal signals between 200 Hz and 1.2 kHz, which is within the auditory bandwidth of cetaceans. The measured source level was between 176 and 185 dB re 1 µPa at 1 m. Source levels for MODU's similar to the proposed MODU under DP for this petroleum activities program included those reported in Martin et al. (2019) and MacDonnell (2017). Martin et al. (2019) reported a source level of 181.5 dB re 1 µPa·m, along with 75th and 90th percentiles of 183.7 and 186.3 dB re 1 µPa·m respectively, while the Stena IceMAX drillship (which included Support Vessel noise) was estimated to have a broadband source level of 188 dB re µPa·m (SPL; MacDonnell,

[11] There are no specific controls or EPOs identified for noise generated from project vessels, MODU, positioning equipment and helicopter transfers. However, MODU and vessel power generation equipment will be maintained in accordance with preventative maintenance programs to optimise equipment efficiency and thus reduce excess noise generation; e.g. MODU and vessel engines to be maintained as per manufacturer's specification.

(2016). For this assessment a precautionary source value of 191 dB re 1 uPa at 1m was adopted which is considered representative of a MODU with a support vessel nearby.

The MODU is expected to be on location for about 70 days for each well.

Installation Vessel and Support Vessel Noise

The main source of noise from a DP vessel (such as installation vessels) relates to the use of DP thrusters and frequencies and sound levels are expected to be similar to those from a DP drill ship (e.g. MODU). DP MODU underwater noise measurements taken for the *Maersk Discoverer* drill rig used on the North West Shelf (Woodside, 2011) showed the system emitted tonal signals between 200 Hz and 1.2 kHz, which is within the auditory bandwidth of cetaceans. The measured source level was between 176 and 185 dB re 1 µPa at 1 m.

Support vessels and installation vessels will use DP while the vessel is maintaining position. McCauley (1998) measured underwater broadband noise equivalent to about 182 dB re 1 µPa at 1 m (RMS SPL) from a support vessel holding station in the Timor Sea; it is expected that similar noise levels will be generated by support vessels used for this Petroleum Activities Program.

Note that all support vessels, and the installation vessel, are required to comply with EPBC Regulation 2000 – Part 8 Interacting with Cetaceans to reduce the likelihood of collisions with cetaceans (refer to **Section 6.7.8**). Implementing this control may incidentally reduce the noise generated by vessels in proximity to cetaceans, as vessels will be travelling slower and slower vessel speeds may reduce underwater noise from machinery noise (main engines) and propeller cavitation.

Generation of Noise from Helicopter Transfers

Helicopter engines and rotor blades are recognised as a source of noise emissions, which may result in behavioural disturbance to marine fauna. Activities relevant to the Operational Area will relate to the landing and take-off of helicopters on the MODU or vessel helidecks. Helicopter flights are at their lowest (i.e. closest point to the sea surface) during these periods of take-off and landing from helidecks, which constitutes a relatively short phase of routine flight operations. During these critical stages of helicopter operations, safety operations are the priority.

Noise levels for typical helicopters used in offshore operations (Eurocopter Super Puma AS332) at 150 m separation distance have been measured at up to a maximum of 90.6 dB (BMT Asia Pacific, 2005). Unconstrained point source noise in the atmosphere (such as helicopter noise) spreads spherically (Truax, 1978), with noise received at the sea surface decreasing with increasing distance from the aircraft (Nowacek et al., 2007). Based on spherical geometric spreading (and not considering transmission loss from atmospheric absorption), the sound level is expected to decrease by 6 dB for every doubling of the distance from the source (Truax, 1978). Using this model, a maximum sound level of about 90 dB at 150 m would be reduced to about 76 dB directly below a helicopter travelling at an altitude of 500 m.

Generation of Underwater Noise from Positioning Equipment

An array of LBL and/or USBL transponders may be installed on the seabed for metrology and positioning. Transponders typically emit pulses of medium frequency sound, generally within the range 21 to 31 kHz. The estimated SPL would be 180 to 206 dB re 1 µPa at 1 m (Jiménez-Arranz et al., 2017).

Transmissions are not continuous but consist of short ‘chirps’ with a duration that ranges from 3 to 40 milliseconds. Transponders will not emit any sound when on standby. When required for general positioning they will emit one chirp every five seconds (estimated to be required for four hours at a time). When required for precise positioning they will emit one chirp every second (estimated to be required for two hours at a time). For moored drilling transponders are expected to be only active at the commencement of the drilling where positioning is required, while for subsea installation the LBL arrays will be deployed for a total period of approximately 12 months and be recovered at the end of the installation program. Similarly, for DP MODU positioning an array of transponder will be active whilst the drill rig is on location.

Generation of Underwater Noise from Flaring

Received levels from airborne propagation modelling were used to ascertain the underwater received levels during flaring activities. Only a very small fraction of the acoustic energy produced from flaring will transmit through the air/ water boundary due to the surface of water acting as a reflective plane and a significant component of acoustic energy reflecting back into the air. This is due to the principles of wave propagation between two mediums. When the two mediums have the same density and elasticity, then the ratio of incidental wave (noise from source) to transmitted wave (noise in the secondary medium) is 1/1. This ratio will significantly reduce when the density of the initial medium (air) for the incidental wave (flare noise) is significantly less than the density of the transmitted medium (sea water). Additionally, the angle at which the sound path meets the surface (angle of incidence) influences the transmission of noise energy from the atmosphere through the sea surface; with angles ±>13° from vertical being almost entirely reflected (Richardson et al. 1995).

The transmission of sound from air to water was conservatively calculated assuming worst case vertical incidence. Results indicate the underwater received sound pressure level during flaring is estimated to be 136 dB re 1µPa at 1m below the sea surface.

Impact Assessment

Potential Impacts to Protected Species

The Operational Area is located in waters about 170–990 m deep. The fauna associated with this area will be predominantly pelagic species of fish, with migratory species such as turtles, whale sharks and cetaceans present in the area seasonally. The Operational Area overlaps a small area of the Continental Slope Demersal Fish Communities KEF (**Figure 4-21**). The continental slope between North West Cape and the Montebello Trough has been identified as one of the most diverse slope assemblages in Australian waters, with over 508 fish species and the highest number of endemic species (76) of any Australian slope habitat (DEWHA, 2008). The Continental Slope Demersal Fish Communities KEF is described in **Section 4.7.3.1**.

Impacts to marine fauna from underwater noise relevant to this petroleum activities program are typically categorised as follows:

- Permanent Threshold Shift (PTS) – PTS is considered a reduction in hearing sensitivity from which marine fauna do not recover (permanent hair cell or receptor damage).
- Temporary Threshold Shift (TTS) or Auditory Fatigue – a temporary reduction in the ability of an individual to perceive sound associated with auditory fatigue. TTS is temporary, and full recovery has been demonstrated in a relatively short timeframes (minutes to hours) (Finneran et al., 2017).
- Masking – no change in the ability of an individual to perceive sound, but biologically meaningful sounds (vocal communication, echolocation, signals and sounds produced by predators or prey) may be drowned out by anthropogenic noise.
- Behavioural disturbance – typically short-term behavioural responses such as avoidance, displacement, or increased surfacing etc. Occurrence and intensity of behavioural disturbance can be highly variable and depends on a range of factors relating to the individual and situation. Behaviour will return to normal following cessation of the anthropogenic noise.

Impact thresholds have been derived from scientific literature and published guidelines, including:

- sound exposure guidelines for fishes and sea turtles: a technical report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI (Popper et al. 2014) **(Table 6-2**); and
- marine mammal noise exposure criteria: updated scientific recommendations for residual hearing effects (Southall et al. 2019) (**Table 6-3**).

Table 6-2: Continuous sources – fish and turtle impact threshold for environmental receptors modified from Popper et al. (2014)

Receptor	PTS	TTS	Masking	Behaviour
Fish: no swim bladder† (Whale Shark)	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder not involved in hearing†	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder involved in hearing†	170 dB rms SPL for 48 hrs	158 dB rms SPL for 12 hrs	(N) High (I) High (F) High	(N) High (I) Moderate (F) Low
Sea turtles†	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) High (I) Moderate (F) Low

Note: a range of sound units are provided in the table above, reflecting the range of studies from which this data has been derived. The difference in units presents difficulty in reliably comparing threshold values. Where practicable, the threshold values have been compared with indicative sound sources levels of the same sound unit types to facilitate comparison. The sound units provided in the table above include:

- *Root mean square (rms) sound pressure level (SPL): root mean square of time-series pressure level, useful for quantifying continuous noise sources (as per SEL point above).*

- *Relative risk (high, medium and low) is given for fish (all types), turtles and eggs and larvae at three distances from the source defined in relative terms as near (N), intermediate (I) and far (F) (after Popper et al. 2014).*

Table 6-3: Acoustic effects of continuous noise on marine mammals: Unweighted SPL and SEL_{24h} thresholds

Hearing group	NMFS (2013)	Southall et al. (2019)	
	Behaviour	PTS (injury) onset thresholds (received level)	TTS onset thresholds (received level)
	SPL (L_p; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^2·s)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^2·s)
Low-frequency cetaceans	120	199	179
High-frequency cetaceans		198	178
Very high frequency cetaceans		173	153

The adopted thresholds that could result in behavioural response for cetaceans are 120 dB re 1 µPa (SPL) for continuous noise sources, and 160 dB re 1 µPa (SPL) for impulsive noise sources (NMFS, 2014), these thresholds represents the most commonly applied behavioural response criterion by Regulators. These thresholds are adopted by the United States National Oceanic and Atmospheric Administration (NOAA) and are consistent with the levels presented by Southall et al. (2007).

Listed threatened and listed migratory species that could be potentially impacted by noise and vibration may be present within the Operational Area and primarily include cetaceans as well as whale sharks, rays and turtles. The Operational Area overlaps the migration corridor BIA for pygmy blue whales (**Figure 4-10**). Pygmy blue whale individuals may occasionally transit the Operational Area, with a higher likelihood of occurrence during April–August and October–January during their seasonal migrations. While not overlapping any BIA, the Protected Matters Search Tool results identified that humpback whales have the potential to occur in proximity of the Operational Area, in particular during the migration period (July (northbound) and late August/September (southbound)). Additional cetaceans likely to occur include the sei whale and fin whale. The Operational Area also overlaps with the whale shark foraging BIA, with peak numbers expected March to July, and the flatback turtle internesting buffer around the Montebello Islands and Dampier Archipelago during their summer nesting period. Satellite tracking of flatback turtle nesting populations (Barrow Island and mainland sites) indicates that this species travels to the east of Barrow Island between nesting events, within WA mainland coastal waters <70 m deep (Chevron Australia Pty Ltd, 2015).

MODU, Installation Vessel and Support Vessels

Underwater noise modelling was undertaken for behavioural response thresholds using the dBSea software to predict underwater noise levels. Model parameters included noise level spectra, source depths, local bathymetry, sound speed profile and seabed properties. The assessment of close range impacts such as hearing threshold shifts are precautionary estimates adopted from modelling from an existing petroleum activities program (McPherson et al. (2019) which is considered a representative analogue to this activity, given the depth of the modelling undertaken and the fact close range propagation radii are significantly less influenced by local bathymetry, sound speed profile and seabed properties.

Cetaceans

Cetaceans use sound for communication, to navigate, to find food, and avoid predators. Current research shows that cetaceans differ in their hearing capabilities, in both absolute hearing, and as well as the frequency band of hearing (Richardson et al., 1995; Southall et al., 2007; Wartzok and Ketten, n.d.). Southall et al. (2019) defines cetacean into three functional hearing groups based on their frequency hearing ranges:

- Low-Frequency (LF) cetaceans - all of the mysticetes, i.e. humpback and pygmy blue whale etc
- High-frequency (HF) cetaceans - most delphinid species, beaked whales, sperm whales, and killer whales
- Very-high frequency (VHF) cetaceans - porpoises, most river species, pygmy/dwarf sperm whales as well a number of oceanic dolphins.

The modelled range to the defined threshold for cetacean behavioural response from continuous noise produced from a DP MODU is calculated on average, approximately within 10.7 km, with maximum range of 31 km which is predominantly propagating parallel to the continental shelf in the north-east and south-west orientation. From the closest well location (Xena-2) received levels at the Montebello AMP boundary were calculated to be 123 dB re 1 µPa.

The DP MODU is estimated to exceed the 24 hour cumulative sound exposure level threshold criteria for PTS and TTS for low frequency cetaceans at maximum distances of approximately 110 m and 1000 m, respectively, however given these values do not incorporate animal movement, it is highly unlikely an animal would be exposed within these ranges over a continuous 24hr period. Instead whales would be expected to be transient through the area and move away from the sound source.

For high frequency cetaceans the 24 hour cumulative sound exposure Levels from the DP MODU are estimated to not exceed threshold criteria for PTS, whereas TTS is estimated to be exceed within 120 m. The cumulative sound exposure Levels from the DP MODU are estimated to exceed threshold criteria for PTS and TTS for very high frequency cetaceans at maximum distances of approximately 150 m and 2.78 km, respectively. However, given these values do not incorporate animal movement, it is highly unlikely an animal would be exposed within these ranges over a continuous 24hr period. Instead whales would be expected to be transient through the area and move away from the sound source.

Considering the overlap or proximity of the BIAs to the Permit Area (**Section 4.5.2**), it is likely that there may be increased numbers of individuals of pygmy blue whales (and other whale species such as humpback, sei and fin whales), whale sharks and turtles within the Operational Area during migratory/foraging periods. It is likely that there may be increased numbers of individuals of pygmy blue whales and humpback whales within the Operational Area during the seasonal periods described above. However, the potential impacts are considered to be not significant given the noise levels associated with routine operations of vessels and the MODU. It is reasonable to expect that fauna may demonstrate avoidance or attraction behaviour to the noise generated by the Petroleum Activities Program. Note that the Operational Area is surrounded by open water, with no restrictions (e.g. shallow waters, embayments) to an animal's ability to avoid the activities. Additionally, only one well will be drilled at a time; therefore, multiple petroleum activities which may impede migration routes further, will not occur. Potential impacts from predicted noise levels from the MODU, installation vessels and support vessels are not considered to be ecologically significant at a population level.

Fish, Sharks, Rays and Turtles

Other fauna associated with the Operational Area will be predominantly pelagic species of fish with migratory species such as whale sharks, rays and marine turtles transiting through the Operational Area.

Fish sensitivity and resilience varies greatly depending on the species, hearing capability, habits, proximity to the activity and if the noise occurs during a critical part of the fish lifecycle (McCauley and Salgado Kent, 2008). Fish vary widely in their vocalisations and hearing abilities, but generally hear best at low frequencies below 1 kHz (Ladich, 2013). Majority of fish species are hearing generalists (Amoser and Ladich, 2005) with relatively poor hearing. Hearing generalists are not as sensitive to noise and vibration as hearing specialists, which have developed hearing specialisations and can be particularly vulnerable to noise and particle motion as they possess an air-filled swim bladder (Gordon et al., 2003). 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 role of the swim bladder in hearing (Popper et al., 2014). Therefore, different thresholds are proposed for fish without a swim bladder, fish with a swim bladder not used for hearing, and fish that use their swim bladders for hearing.

Elasmobranches or cartilaginous fish (such as sharks and rays) lack a swim bladder and are considered less sensitive to sound than bony fish. The hearing capabilities of the whale shark have not been studied, but it has been suggested that they are likely to be most responsive to low frequency sounds (Myrberg, 2001). Accordingly, for the purposes of this impact assessment as outlined in **Table 6-2**, fish without a swim bladder are considered an appropriate analogue for whale sharks.

Potential PTS and TTS impacts to the most sensitive fish type (fish with swim bladder involved in hearing) is estimated to occur within less than 60m from the DP MODU and only relevant if the fish is continuously within this range for 48 and 12 hours, for PTS and TTS, respectively. Potential impacts associated with masking and behaviour to fish types and marine turtles are expressed qualitatively in **Table 6-2**, with near, intermediate and far defined as; tens of meters, hundreds of metres and thousands of metres, respectively. Therefore, potential impacts from MODU and vessel noise are likely to be restricted to temporary and localised avoidance behaviour of individuals transiting through the Operational Area, and are therefore considered localised with no lasting effect. As the wells will not be drilled concurrently, there is no potential for cumulative impacts from drilling concurrent wells.

Helicopter Noise

Water has a very high acoustic impedance contrast compared to air, and the sea surface is a strong reflector of noise energy (i.e. very little noise energy generated above the sea surface crosses into and propagates below the sea surface (and vice versa) – the majority of the noise energy is reflected). The angle at which the sound path meets the surface influences the transmission of noise energy from the atmosphere through the sea surface; angles ±>13° from vertical being almost entirely reflected (Richardson et al., 1995). Given this, and the typical characteristics of helicopter flights within the Operational Area (duration, frequency, altitude and air speed), the opportunity for underwater noise levels that may result in behavioural disturbance are not considered to be credible. Note that helicopter noise during approach, landing and take-off is more likely to propagate through the sea surface due to the reduced air speed and lower altitude. However, helicopter noise during approach, landing and take-off will be mingled with underwater noise generated by the facility hosting the helipad (e.g. thruster noise from vessels, machinery noise from MODU, etc.). Additionally, approach, landing and take-off are relatively short phases of the flight, resulting in little opportunity for underwater noise to be generated.

Given the standard flight profile of a helicopter transfer, maintenance of a >500 m horizontal separation from cetaceans (as per the EPBC Regulations), and the predominantly seasonal presence of whales within the Operational Area, interactions between helicopters and cetaceans resulting in behavioural impacts are considered to be highly unlikely. In the highly unlikely event that cetaceans are disturbed by helicopters, responses are expected to consist of short-term behavioural responses, such as increased swimming speed; the consequence of such disturbance is considered to have no lasting effect and of no significance.

Turtles may be present in low numbers within the Operational Area, particularly during internesting periods, and may be exposed to helicopter noise when on the sea surface (e.g. when basking or breathing). Typical startle responses occur at relatively short ranges (tens of metres) (Hazel et al., 2007) and as such, startle responses during typical helicopter flight profiles are considered to be remote. In the event of a behavioural response to the presence of a helicopter, turtles are expected to exhibit diving behaviour, which is of no lasting effect.

The Permit Area may be occasionally visited by migratory and oceanic birds but does not contain any emergent land that could be used as roosting or nesting habitat. The closest emergent facility is the Pluto platform located about 15 km from the Permit Area. One BIA, a breeding area for wedge-tailed shearwaters, overlaps the Permit Area (August–April) and foraging BIAs. However, there are no nesting sites such as islands within the Operational Area. Seabirds within the Operational Area may avoid helicopter flights. Given the expected low density of seabirds within the Operational Area due to a lack of roosting or nesting habitat, the relative infrequency of helicopter flights and lack of lasting effect of potential behavioural responses to helicopter noise, impacts would be minor and result in no lasting effect.

Positioning Equipment Noise

Transponders used for positioning have the potential to cause some temporary behavioural disturbance to marine fauna, however noise levels will be well below injury thresholds. Due to the short duration chirps, the temporary and intermittent use and the mid frequencies used by positioning equipment, the acoustic noise from the transponders is unlikely to have a substantive effect on the behavioural patterns of marine fauna. The Operational Area overlaps with seasonal BIAs for pygmy blue whales and whale sharks (as described above). Should the short period during which transponders are in use (intermittent over a period of drilling and 12 months subsea installation) overlap with the seasonal timing of these BIAs, individual animals at most may deviate slightly from their migration route, but continue on their migration pathway. The Operational Area is surrounded by open water, with no restrictions (e.g. shallow waters, embayments) to an animal's ability to avoid the activities.

Underwater Noise from Flaring

Underwater received sound pressure level during flaring is estimated to be 136 dB re 1μPa at 1m below the sea surface and is estimated to attenuate below the marine mammal behavioural response threshold of 120 dB re 1μPa within only 7 m from the sea surface. Accordingly, the potential impacts associated with noise produced during flaring is considered highly localised and not expected to result in any significant impacts to marine fauna.

Summary of Potential Impacts to Environmental Value(s)

It is considered that noise generated by the installation vessel, support vessels, MODU drilling activities, helicopters and positioning transponders will be limited to localised impacts with no lasting effect, not significant to marine fauna (i.e. Environmental Impact-F)

Any localised impacts to marine fish is not expected to impact on any commercial fishers in the area.

Demonstration of ALARP

Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
No additional controls identified.				
Good Practice				
The use of dedicated Marine Fauna Observers (MFOs) on support vessels for the duration of the Petroleum Activities Program to watch for whales and provide direction on and monitor compliance with Part 8 of the EPBC Regulations.	F: Yes. However, support vessel bridge crews already maintain a constant watch during operations. CS: Additional cost of MFOs.	Given that support vessel bridge crews already maintain a constant watch during operations, additional MFOs would not further reduce the likelihood of an individual being within close proximity of the acoustic source during start-up or during operations.	Disproportionate. The cost/sacrifice outweighs the benefit gained.	No

The well unload acceptance criteria that defines the well objectives will be established.	F: Yes. CS: Standard practice	Eliminates unnecessary flared volumes and corresponding emissions	Benefits outweigh the cost/sacrifice	Yes **C.3.1**
Professional Judgement – Eliminate				
Remove support vessel on standby at the Petroleum Activities Program location.	F: No. Activity support vessel required for safety reasons, particularly for maintaining the 500 m petroleum safety zone around the MODU/installation vessels. CS: Introduces unacceptable safety risk.	Not considered, control not feasible.	Not considered, control not feasible.	No
Eliminate generation of noise from the MODU, installation vessels, support vessels or survey positioning equipment.	F: No. The generation of noise from these sources cannot be eliminated due to operating requirements. Note that vessels operating on DP may be a safety critical requirement. CS: Inability to conduct the Petroleum Activities Program. Loss of project.	Not considered, control not feasible.	Not considered, control not feasible.	No
Do not flare	F: No. Flaring is the only feasible way mange the reservoir fluids and achieve the well objectives. CS: Not considered – Control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No
Professional Judgement – Substitute				
Management of vessel noise by varying the timing of the Petroleum Activities Program to avoid migration periods.	F: Not feasible. Variation of timing of specific activities is not feasible as activity is subject to schedule constraints and vessel availability. CS: Significant cost and schedule impacts deeming the project unviable if activities avoid specific timeframes.	Not considered, control not feasible.	Not considered, control not feasible.	No
Professional Judgement – Engineered Solution				
No additional controls 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, **Section 2.6.1**), Woodside considers the potential impacts from routine support vessel, installation vessel, MODU, helicopter and positioning transponder noise emissions to be ALARP in its current risk state. 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 support vessel, installation vessel, MODU drilling, helicopters and positioning transponder noise disturbance may result in localised impacts not significant to marine fauna, with no lasting effect. Further opportunities to reduce the impacts have been investigated above. The potential impacts are considered broadly acceptable. Therefore, Woodside considers standard operations appropriate to manage the impacts of support vessel, installation vessel, MODU drilling, helicopters and positioning transponder noise emissions to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 4 Flaring during emissions during the Petroleum Activities Program are restricted to those necessary to perform the activity to limit impacts to the environment from noise.	**C 4.1** The well unload acceptance criteria that defines the well objectives will be established.	**PS 4.1** Flaring restricted to a duration necessary to achieve the well objectives.	**MC 4.1.1** Records demonstrate flaring was restricted to a duration necessary to achieve the well objectives.

6.6.4 Routine and Non-routine Discharges to the Marine Environment: MODU and Project Vessels

Context		
Project vessels **– Section 3.5**	Physical environment – **Section 4.4** Biological environment – **Section 4.5**	

Impacts 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***	***Impact***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Routine discharge of sewage, grey water and putrescible wastes to marine environment from MODU, installation vessel and support vessels			X			X	X	A	F	-	-	LCS PJ	Broadly Acceptable	EPO 3
Routine discharge of deck and bilge water to marine environment from MODU, installation vessel and support vessels			X			X	X	A	F	-	-	LCS PJ		
Routine discharge of cooling water or brine to the marine environment from MODU, installation vessel and support vessels			X			X	X	A	F	-	-	LCS PJ		

Description of Source of Impact
The MODU, installation vessels and support 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/MODU per day), using an average volume of 75 L/person/day and a maximum of 200 persons on board. However, it is noted that vessels such as support vessels will have considerably less persons on board. • Routine/periodic discharge of relatively small volumes of bilge water. Bilge tanks receive fluids from many parts of the support vessels, installation vessel or MODU. Bilge water can contain water, oil, detergents, solvents, chemicals, particles and other liquids, solids or chemicals. • Variable water discharge from MODU/vessel decks directly overboard or via deck drainage systems. Sources could include rainfall events and/or deck activities such as cleaning/wash-down of equipment/decks. • Cooling water from machinery engines or mud cooling units and brine water produced during the desalination process of reverse osmosis to produce potable water on board the support vessels, installation vessel and MODU. Environmental risks relating to the unplanned disposal/discharges are addressed in **Section 6.7.7**.

Impact Assessment
Potential Impacts to Water Quality and Marine Fauna
The principal 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 conducted monitoring of sewage discharges at their Torosa-4 Appraisal Drilling campaign which demonstrated that a 10 m^3 sewage discharge reduced to about 1% of its original concentration within 50 m of the discharge location. In addition to this, monitoring at distances 50, 100 and 200 m downstream of the platform and at five different water depths confirmed that discharges were rapidly diluted and 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, 2011). Mixing and dispersion would be further facilitated in deep offshore waters, consistent with the location of the Permit 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 other receptors such as fish, reptiles, birds and cetaceans in significant numbers, and in close proximity to 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. Additional discharges outlined, which may include other non-organic contaminants (e.g. bilge water, deck drainage and cooling water), will be rapidly diluted through the same mechanisms as above and are expected to be intermittent and 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 (routine and non-routine) 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 located more than 12 nm from land, which exceeds the exclusion zones required by Marine Order 96 (Marine pollution prevention – sewage) 2018 and Marine Order 95 (Marine pollution prevention – garbage) 2013. While the Petroleum Activities Program may extend for several years, vessels will not be continuously in the Operational Area during this time. Vessels will also be moving (i.e. not in a single location for an extended period of time). Rather, these routine and non-routine discharges are expected to be intermittent in nature for the duration of the Petroleum Activities Program. Therefore, cumulative impacts to water quality within the Operational Area are expected to be localised and short-term with no lasting effect. It is possible that marine fauna transiting the localised area may come into contact with these discharges (e.g. marine turtles, pygmy blue whales, whale sharks as they traverse the Operational Area, **Section 4.5.2**). However, given the localised extent of cumulative impacts from multiple vessel discharges within the Operational Area, significant impacts to marine fauna are not expected.
Summary of Potential Impacts to Environmental Value(s)
Given the adopted controls, it is considered that routine or non-routine discharges described will be limited to localised contamination not significant to environmental receptors, with no lasting effect. (i.e. Environment Impact – F). Any localised (non significant) impacts to marine fish is not expected to impact on any commercial fishers in the area.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Marine Order 95 – Pollution prevention – garbage (as appropriate to vessel class) which requires putrescible waste and food scraps are passed through a macerator so that 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 likelihood or consequence would result.	Controls based on legislative requirements – must be adopted.	Yes **C 5.1**
Marine Order 96 – Pollution prevention – sewage (as appropriate to vessel class) which includes the following requirements: • a valid International Sewage Pollution Prevention Certificate, as required by vessel class • an AMSA approved sewage treatment plant; • a sewage comminuting 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 support vessel is proceeding (>4 knots), to avoid discharges in environmentally sensitive areas.	F: Yes. CS: Minimal cost. Standard practice.	No reduction in likelihood or consequence would result.	Controls based on legislative requirements – must be adopted.	Yes **C 5.2**

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
Where there is potential for loss of primary containment of oil and chemicals on the MODU, deck drainage must be collected via a closed drainage system. E.g. drill floor.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of contaminated deck drainage water being discharged to the marine environment. No change in consequence would occur.	Benefits outweigh cost/ sacrifice.	Yes **C 5.3**
Marine Order 91 – oil (as relevant to vessel class) requirements, which includes mandatory measures for the processing of oily water prior to discharge: • Machinery space bilge/oily water shall have 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 capable 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	F: Yes. CS: Minimal cost. Standard practice.	No reduction in likelihood or consequence would result.	Controls based on legislative requirements – must be adopted.	Yes **C 5.4**

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
and disposed of onshore. • Valid International Oil Pollution Prevention Certificate.				
Good Practice				
No additional controls identified.				
Professional Judgement – Eliminate				
No additional controls identified.				
Professional Judgement – Substitute				
Storage, transport & treatment/ disposal onshore of sewage, greywater, putrescible & bilge wastes.	F: Not feasible. Would present additional safety & hygiene hazards resulting from the storage, loading & transport of the waste material. Distance of activity offshore also makes the implementation of this control not feasible. CS: Not considered, control not feasible.	Not considered, control not feasible.	Not considered, control not feasible.	No
Professional Judgement – Engineered Solution				
No additional controls 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, **Section 2.6.1**), Woodside considers the adopted controls appropriate to manage the impacts of planned (routine and non-routine) discharges form MODU/vessels. 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, planned discharges (routine and non-routine) from the MODU/vessels is unlikely to result in a potential impact greater than localised impacts, not significant to environmental receptors and with no lasting effect. Further opportunities to reduce the impacts 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. The potential impacts are considered broadly acceptable if the adopted controls are implemented. 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 5 No impact to water quality greater than a consequence level of F from discharge of sewage, greywater, putrescible wastes, bilge and deck drainage to the marine environment during the Petroleum Activities Program.	**C 5.1** Marine Order 95 – Pollution prevention – garbage (as appropriate to vessel class) which requires putrescible waste and food scraps are passed through a macerator so that it is capable of passing through a screen with no opening wider than 25 mm.	**PS 5.1** MODU and project vessels compliant with Marine Order 95 – Pollution prevention – garbage.	**MC 5.1.1** Records demonstrate MODU and project vessels are compliant with Marine Order 95 – Pollution prevention (as appropriate to vessel class).
	C 5.2 Marine Order 96 – Pollution prevention – sewage (as appropriate to vessel class) which includes the following requirements: • a valid International Sewage Pollution Prevention Certificate, as required by vessel class • an AMSA approved sewage treatment plant • a sewage comminuting 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 support vessel is proceeding (>4 knots), to avoid discharges in environmentally sensitive areas.	**PS 5.2** MODU and project vessels compliant with Marine Order 96 – Pollution prevention – sewage (as appropriate to vessel class).	**MC 5.2.1** Records demonstrate MODU and project vessels are compliant with Marine Order 96 – Pollution prevention – sewage (as appropriate to vessel class).
	C 5.3	**PS 5.3**	**MC 5.3.1**

	Where there is potential for loss of primary containment of oil and chemicals on the MODU, deck drainage must be collected via a closed drainage system. E.g. drill floor.	Contaminated drainage contained, treated and/or separated prior to discharge.	Records demonstrate MODU has a functioning bilge/oily water management system.
	C 5.4 Marine Order 91 – oil (as relevant to vessel class) requirements, which includes mandatory measures for the processing of oily water prior to discharge: • Machinery space bilge/oily water shall have 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 capable 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. • Valid International Oil Pollution Prevention Certificate.	**PS 5.4** Discharge of machinery space bilge/oily water will meet oil content standard of <15 ppm without dilution.	**MC 5.4.1** Records demonstrate discharge specification met for MODU and project vessels.

6.6.5 Routine and Non-routine Discharges to the Marine Environment: Drill Cuttings and Drilling Fluids (WBM and NWBM)

Context	
Drilling activities **– Section 3.8** Project fluids **– Section 3.10**	Physical environment – **Section 4.4** Biological environment – **Section 4.5**

Impacts 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***	***Impact***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Routine discharge of WBM drill cuttings to the seabed and the marine environment		X	X		X		X	A	D	-	-	LCS GP PJ	Broadly Acceptable	EPO 4
Routine discharge of NWBM drill cuttings to the seabed and the marine environment		X	X		X		X	A	D	-	-			
Routine discharge of drilling fluids to the seabed and the marine environment		X	X		X		X	A	E	-	-			
Non-routine discharge of wash water from mud pits and vessel tank wash fluids		X	X		X		X	A	E	-	-			
Routine discharge of well clean-out fluids		X	X		X		X	A	E	-	-			
Discharge of well annular fluids from temporarily abandoned well		X	X		X		X	A	F	-	-			

Description of Source of Impact

Drilling Program

The proposed Petroleum Activities Program includes the drilling of one Pyxis production well, one Pluto infill production well and two Xena infill production wells, and may also include re-drilling of up to eight existing production wells or any of the proposed production wells within Permit Area WA-34-L, all within a seabed depth range of 170–990 m.

Drilling activities are described in **Section 3.8**. Wells will be drilled as a series of sections, as detailed in **Table 6-2**. The top hole sections of each well will be drilled without a riser in place (i.e. riserless drilling). Upon drilling of the top hole sections, casings will be cemented in place, a BOP installed and a riser put in place between the BOP and the MODU. The riser remains in place during drilling of the bottom hole sections and facilitates the circulation of drilling fluids and cuttings between the well bore and the MODU.

The following describes the source of impact with respect to discharge of drill cuttings, mud and clean-up fluids only (see **Section 6.6.6** for cement, cementing fluids and subsea control fluids). The base case (e.g. typical drilling operations) for the management of cuttings is to discharge into the marine environment along with WBM drilling muds which are used to transport the cuttings out of the well.

For the purposes of this impact assessment, the indicative dimensions, discharge locations and approximate cuttings volumes provided in **Table 6-2** represent the worst case for a single section, taking into account each well to be drilled during the Petroleum Activities Program.

Table 6-2: Estimated discharges of cuttings and volumes of drilling fluids used for the Petroleum Activities Program*

Section Description	Discharge Point	Drilling Fluid Type	Approx. Cuttings Discharged (m³)	Approx. Fluid Discharged (m³)
42" (Top)	Seabed	Sea Water + Sweeps**	90	510
26" (Top)	Seabed	Sea Water + Sweeps**	255	1210
17.5" (Top)	Below Sea Level	WBM	170	1115
12.25" (Bottom)	Below Sea Level	NWBM	65	80
9 7/8" (Bottom)	Below Sea Level	WBM	10	715
Total per well			**590**	**3630**
Contingent Activity Sidetrack				
12.25" (Bottom) (indicative)	Below Sea Level	NWBM	**65**	**80**

** Volumes described are approximate and may be subject to change due to well design and operational requirements.*
*** Seawater with pre-hydrated bentonite sweeps/XC Polymer sweeps (seawater volume not included in the estimated 'Drilling Fluid Volume').*

Drill Cuttings

Indicative drill cuttings generated from each well have been estimated to comprise a total of about 590 m³. Drilling is expected to generate drill cuttings ranging in size from very fine to very coarse (>1 cm) (**Section 3.10.3**). Cutting size is determined by TD, lithology, drill bit employed and solid control equipment specifications. Indicative volumes of drill cuttings for the well are outlined in **Table 6-2**.

Cuttings resulting from drilling the top hole section are drilled using seawater, pre-hydrated bentonite sweeps drilling fluid (WBM) system, discharging the cuttings to the seabed at the well site where they will accumulate near the wellhead.

The bottom hole sections will be drilled with a marine riser that enables cuttings and drilling fluid to be circulated back to the MODU, where the cuttings are separated from the drilling fluids by the SCE. The SCE uses shale shakers to remove coarse cuttings from the drilling fluids. After processing by the shale shakers, the recovered fluids from the cuttings may be directed to centrifuges, which are used to remove fine solids (~4.5 to 6 µm). The cuttings with retained fluids are discharged below the water line and the mud is recirculated into the fluid system (**Section 3.8.4**). Cuttings will typically drop out of suspension in the vicinity of the well site (as coarser materials), while the fluids if not flocculated with the cuttings may disperse further, temporarily elevating total suspended solids (TSS).

Where NWBM is needed to drill a well section, the cuttings from the NWBM drilling fluid system will also pass through a cuttings dryer to reduce the average residual oil on cuttings (OOC). In the event of SCE failures, cuttings may be discharged without having passed through the dryer; however, this will only occur for a short duration while the drill string is being moved to a safe location in the well and existing cuttings are circulated out of hole. A decision will then be made on the case for drilling ahead without the failed SCE, while still meeting residual OOC discharge limits. Drilling ahead while SCE breakdown assessment and repairs occur is a contingent activity subject to additional controls (**C 6.8**); however, the standard mode of operation to ensure management of cuttings to ALARP is to treat cuttings through a dryer.

An OOC discharge limit of <6.9% on wet cuttings will be averaged over well sections drilled with NWBM for the well. The estimated volume of cuttings discharged with residual NWBM is shown in **Table 6-2** for a hypothetical worst case well. Typical NWBM cuttings volumes may be around 65 m³ (per well). An additional 65 m³ of NWBM cuttings may also be discharged should a sidetrack be required.

Completion and Well Bore Clean-Out Fluids

Prior to installing the upper completion activities, wells will generally be displaced from the drilling fluid system to brine. A chemical clean-out fluids train will be circulated between the two fluids, then seawater or brine circulated until operational cleanliness specifications are met. This will be in line with Woodside's internal guideline. Brine is typically a filtered brine with <70 nephelometric turbidity units and/or <0.05% TSS. This results in a brine and seawater discharge after this operation.

Should there be clean-up brine contaminated with base oil or NWBM, it will be captured and stored on the MODU for discharge if oil concentration is <1% by volume, or returned to shore if discharge requirements cannot be met. Initial clean-up fluids (usually returned to the rig within the first few hours of circulation) which are predominantly drilling mud (concentration of mud compared to brine is a higher percentage of mud) will be discharged as per requirements in this EP, or returned to shore if requirements are not met.

Drilling Fluids

WBM will be operationally discharged to the marine environment at the location of the well being drilled during the Petroleum Activities Program under the following scenarios:

1. at the seabed when drilling the top hole (riser less) sections (bentonite and guar gum)
2. below sea surface as fluid remaining on drill cuttings, after passing through the SCE (bottom hole sections, drilled with riser in place)
3. from the mud pits from a pipe below the sea surface, if the WBM cannot be re-circulated/ re-used through the drilling fluid system (due to deterioration/contamination), re-used on the well or on another well; or stored.

NWBM may be used in the drilling of wells should the offset history, geohazards assessment and borehole stability studies indicate that NWBM is required to manage well stability to safe levels.

Drilling fluids are contained within the drilling fluids circulation system. Mud pits (tanks) within this system provide capacity for the storage of drilling fluids. The mud pits are cleaned out at the completion of drilling operations. Should NWBM be used, mud pit residue may be discharged to the sea where the residue contains <1% oil volume. Where the mud pit residue exceeds 1% by volume, the residue will be retained and disposed of onshore.

Base oil and chemicals used in WBM and NWBM are assessed in accordance with the Chemical Selection and Assessment Environment Guideline (**Section 3.10.1**).

Contingent Activities

Respud

It is unlikely that a well would be required to be respud. If required, the most likely scenario is that the decision to respud is made during drilling of the top hole section of a well; therefore, the incremental increase in cuttings and fluids discharges is associated with the repeat drilling of the same top hole sections for the respudded well with the same associated discharges. A respud once drilling of the bottom hole sections has commenced is far less likely, given the time and effort already committed to the well. However, if this was to occur, the associated discharges would also be a repeat of the discharges as per **Table 6-2** to re-drill the same sections of the respudded well.

Sidetrack

The option of a sidetrack instead of a respud may be determined, if operational issues are encountered. Should a sidetrack be required, it will result in an increase in the volume of cuttings generated and a potential increase in the use of NWBM. Additional drill cuttings volumes are estimated in **Table 6-2**.

Well Annular Fluids

Following completion of drilling, some wellbore fluids will remain in the annular spaces between casing. Upon wellhead removal, small volumes (~1.5 m³) of fluid exchange between the annular spaces and the ocean may occur. The exchange will not be instantaneous as the annular spaces are small and the fluids are typically heavier than seawater. In the unlikely event routine wellhead removal techniques are unsuccessful, this fluid exchange is expected to occur over time following sufficient corrosion of the wellhead.

Impact Assessment

Potential Impacts to Water Quality, Marine Sediment Quality and Habitats and Communities

The identified potential impacts associated with the discharge of drill cuttings and fluids include a localised and temporary reduction in water quality and localised change in seabed sediment quality, as well as localised burial of benthic biota (species; sparse epifauna individuals and infauna communities) and change to habitats and communities.

A number of direct and indirect impact pathways are identified for drill cuttings and drilling fluids, including:

- temporary increase in TSS in the water column
- attenuation of light penetration as an indirect consequence of the elevation of TSS and the rate of sedimentation
- sediment deposition to the seabed leading to the alteration of the physio-chemical composition of sediments, and burial and potential smothering effects to sessile benthic biota
- potential contamination and toxicity effects to benthic and in-water biota.

The Operational Area is situated in offshore waters (~50 km from the nearest shoreline of the Montebello Islands) in water depths of 170–990 m. The Montebello Australian Marine Park is the closest MPA to the Operational Area and its boundary is approximately 3.5 km from the closest potential Xena well location.

The top hole sections drilled (riser-less) have drill cuttings and unrecoverable fluids discharged at the seabed at the well site, and typically result in a localised area of sediment deposition (known as a cuttings pile) in close proximity to the well site. Depending on seabed current regimes, a greater spread of cuttings and muds may occur downstream from the well site. The spread of cuttings and WBMs is expected to be up to about 150 m from the discharge location based on a review of seven studies summarised by International Association of Oil and Gas Producers (IOGP) (2016).

The bottom hole sections are drilled after the riser is fitted. Cuttings with unrecoverable fluids are discharged below the water line at the MODU site, resulting in drill cuttings and drilling fluids (WBMs or NWBMs) rapidly diluting, which disperse through the water column. The dispersion and fate of the cuttings is determined by particle size and density of the unrecoverable fluids; the larger cuttings particles will drop out of suspension and deposit in proximity to the well site (tens of metres) with potential for localised spreading downstream, while the finer fluid particles will remain in suspension and will be transported away from the well site, rapidly diluting and eventually depositing over a larger area (hundreds of metres) downstream of the well site. Predicted impacts for bottom hole cuttings are generally confined to a maximum of 500 m of the discharge point (IOGP, 2016), with NWBM cuttings discharges to water less than about 300–400 m depth typically deposited in sediments within about 100 to 200 m of the discharge (IOGP, 2016).

Modelling studies

For the Greater Enfield Project, Woodside commissioned a modelling study to predict the fate of drill cuttings and drilling fluids discharged. The study was completed by RPS APAPSA (2016) and included numerical modelling techniques to predict total suspended sediments (TSS), sedimentation rate (concentration, g/m^2) and sediment deposition on the seabed (thickness, mm). Particle size distributions and associated settling velocities were calculated for each well section based on cuttings data from previous offshore wells and empirical data, respectively. A regional hydrodynamic model that considered mesoscale, tidal and wind generated currents was created for the dispersion model. A worst-case scenario approach to the modelling study was adopted to represent the extremes of potential transportation of sediment particles using a 10 year modelled data set as the basis for the cuttings discharge study.

In review of the data inputs, this study is considered a suitable (albeit conservative) surrogate to further inform the dispersion and fate of drill cuttings associated with drilling the Xena infill wells in proximity to the Montebello Marine Park. This is considered appropriate as the modelled drill cuttings and unrecoverable drilling fluids volume is greater than those described in Table 6-2. Additionally, the modelled currents are similar and the modelled water depth, while deeper (~560 m vs ~180 m) means that the modelled dispersion would consequently be greater and therefore conservative when assessing spatial extent of the potential impact.

Water Quality

The discharge of drill cuttings and unrecoverable fluids from the MODU is expected to increase turbidity and TSS levels in the water column, leading to an increased sedimentation rate above ambient levels associated with the settlement of suspended sediment particles in close proximity to the seabed or below the sea surface, depending on the location of discharge.

Drill cuttings discharge is generally intermittent and of short duration during the drilling of a well. Cuttings with retained (unrecoverable) drilling fluids are discharged below the water line at the MODU location, resulting in drill cuttings and drilling fluids rapidly diluting, as they disperse and settle through the water column. The dispersion and fate of the cuttings is determined by particle size and density of the retained (unrecoverable) drilling fluids, therefore, the sediment particles will primarily settle in proximity to the well locations with potential for localised spread downstream (depending on the speed of currents throughout the water column and seabed). The finer particles will remain in suspension and will be transported further before settling on the seabed.

Modelling results indicated that the TSS plume of suspended cuttings will typically disperse along the prevailing current while oscillating with the tide and diminish rapidly with increasing distance from the well locations. Maximum TSS concentrations predicted for 100 m, 250 m and 1 km distances from the well site were 7 mg/L, 5 mg/L and 1 mg/L respectively. Outside of the well location, TSS concentration did not exceed 10 mg/l. Nelson et al. (2016) identified <10 mg/L as a no effect or sub-lethal minimal effect concentration.

Based on these modelled results and prevailing currents, the discharge of drill cuttings and unrecoverable drilling fluids are not expected to reach the Montebello AMP boundary at concentrations that would result in ecological impacts (e.g. impacts to habitats or ecosystems). The Montebello AMP is a designated Multiple Use Zone, allowing for the sustainable use (including oil and gas activities), while conserving ecosystems and habitats. Therefore, in the event that drill cuttings and unrecoverable drilling fluids reach the Montebello AMP it would not impact on the Marine Park values.

Furthermore, there are no likely impacts expected for pelagic fauna. While very high concentrations of suspended sediments have been shown to result in mortality of pelagic animals (>1830 mg/L), such concentrations do not occur as a result of drill cuttings discharges (IOGP, 2016). In addition, most visual orientated fish/fauna species would likely relocate to an unaffected area to avoid the plume or simply pass unaffected through turbid waters. Megafauna such as cetaceans and turtles are not expected to be in direct contact with the TSS plume, given its proximity to the MODU. Any potential contact would be of a short duration given the rapid dispersion of the plume, intermittent nature of the discharge and the expected transient movement of megafauna in this offshore area. Light-dependent benthic primary producer habitats are not located within the Operational Area. The closest coral reef habitat is Rankin Bank, about 25 km from the Permit Area and therefore impacts are not expected.

Given the intermittent and short duration of drill cuttings and drilling fluids discharged, the offshore open ocean environment and rapid dispersion of sediment, any impacts to water quality would be highly localised and not significant to environmental receptors.

Habitats and Communities (physical impact of cuttings)

Cuttings discharged at the seabed during drilling of the top hole sections of the wells will result in localised cuttings piles on the seabed surrounding the wellhead, with a greater spread of cuttings expected to occur downstream from the well site. The cuttings pile will vary in particle size distribution from the surrounding seabed.

Potential impacts are expected to be confined to sessile biota such as sediment burrowing infauna and epifauna where present in or on the seabed in immediate proximity to the well location. Ecological impacts to such biota are predicted when sediment deposition is equal to or greater than 6.5 mm (in thickness) (IOGP, 2016). Modelling indicated that such deposition to a distance of within 170 m from the well locations (along the prevailing current) would potentially occur. This aligns with IOGP (2016), which based on a review of seven studies indicated that the spread of cuttings and WBMs is expected to be up to about 150 m from the discharge location.

The habitat expected in proximity to the wells is likely comprised of deep, soft, unconsolidated sediment. The rock pinnacles described in **Section 4.5.1.4**, are located at least 5 km from any of the proposed or existing wells and therefore will not be impacted. Benthic communities, associated with soft sediment, are expected to be infauna dominated by polychaetes, with other fauna including nemerteans and sipunculids and crustaceans (Section 4.5.1) and expected to recolonise cuttings piles over time. Mobile benthic fauna, such as demersal fish, may be temporarily displaced from areas where cuttings discharges accumulate.

Low levels of sediment deposition away from the immediate area of the well site may occur mostly as a result of bottom hole sections and would represent a thin layer of settled drill cuttings, which will likely be naturally reworked into surface sediment layers through bioturbation (US Environmental Protection Agency, 2000) and will not be more than a minor impact. This is supported by modelling results which indicated that maximum deposition at 250 m from the well locations would be less than 2 mm reduced to less than 0.1 mm at 1 km distance from the modelled wells. This aligns with IOGP (2016), where predicted impacts for bottom hole cuttings are generally confined to a maximum of 500 m of the discharge point, with NWBM cuttings discharges to water less than about 300–400 m depth typically deposited in sediments within about 100 to 200 m of the discharge (IOGP, 2016). Ecological impacts are not expected for mobile benthic fauna such as crabs and shrimps or pelagic and demersal fish, given their mobility (IOGP, 2016).

Balcom et al. (2012) concluded that impacts associated with the discharge of cuttings and base fluids (including synthetic based muds (NWBMs)) are minimal, with impacts highly localised to the area of the discharge. Changes to benthic communities are normally not severe. Organic enrichment can occur leading to anoxic conditions in the surface sediments and a loss of infauna species that have a low tolerance to low oxygen concentrations, and to a lesser extent chemical toxicity near the well location. These impacts are highly localised with short-term recovery that may include changes in community composition with the replacement of infauna species that are hypoxia-tolerant (IOGP, 2016). Recovery of affected benthic infauna, epifauna and demersal communities is expected to occur shortly after drilling finishes (Gates and Jones 2012) and in context of IOGP (2016) studies typically in the order of 2 years, given the short duration of the discharge and associated sediment deposition.

No hard coral habitat or other photo-sensitive benthic communities are present within WA-34-L and the closest coral reef habitat is Rankin Bank, about 25 km from the Permit Area. Therefore, impacts from drill cutting discharges and drilling fluids are not expected.

Drill cuttings discharged at the seabed and settlement of cuttings will likely occur on the Continental Slope Demersal Fish Communities KEF. Given no hard substrate was identified in proximity to the drilling locations and the wider representation of the KEF outside of the Operational Area, any potential ecological impacts are expected to be localised and any impacts to the values of the KEF are not considered significant. Further, based on these modelled results and prevailing currents, the discharge of drill cuttings and unrecoverable drilling fluids, even at the closest Xena well potential location (~3.5 km north west) are not expected to reach the Montebello AMP boundary at concentrations that would result in ecological impacts (e.g. impacts to habitats or ecosystems).

Sediment Quality and Habitats and Communities (contamination from and toxicological effects of drilling muds)

Indicative components of the WBM system outlined in **Section 3.8** have a low toxicity. Bentonite and a chemical from the family of XC Polymers (Xanthan Gum or similar) are listed as 'E' category fluids under the OCNS and considered to 'pose little or no risk to the environment' (PLONOR). These metals are present primarily as insoluble mineralised salts and consequently are not released in significant amounts to the pore water of marine sediments and have low bioavailability to those benthic fauna which may come into contact with the discharged barite (Crecelius et al., 2007; Neff, 2008).

The XC Polymer and bentonite sweeps have very low toxicities and are considered by OSPAR to be PLONOR to the environment. They may; however, cause physical damage to benthic organisms by abrasion or clogging, or through changes in sediment texture that can inhibit the settlement of planktonic polychaete and mollusc larvae (Swan et al., 1994). However, these impacts are not expected to be significant due to the rapid biodegradation and dispersion of WBM drilling fluids (Terrens et al., 1998) and no significant habitats/biota are considered to be present in the Permit Area. The dilution of solid elements of the WBM into substrate largely depends on the energy level of the local environment and the 'mixing' that takes place, but is expected to occur rapidly following release (especially with WBM). The low sensitivity of the benthic communities/habitats combined with the low toxicity of WBM and low physical impacts affirm that any significant impact is considered unlikely.

Base fluids for NWBM are designed to be biodegradable in offshore marine sediments. Biodegradation can result in a low oxygen (anoxic) environment resulting in changes in benthic community structure. However, this is dependent on the bioavailability of the base fluid. Species sensitive to anoxic environments are eliminated and replaced by tolerant and opportunistic species, resulting in decreased species diversity, but the number of individuals often increases (Neff et al., 2000). NWBMs are designed to be low in toxicity and are not readily bioavailable, based on their physical/chemical properties, for bioaccumulation to infauna and epifauna.

Furthermore, the combination of low toxicity and rapid dilution of unrecoverable NWBMs discharged in association with drill cuttings are of little risk of direct toxicity to water-column biota (Neff et al., 2000). A small quantity of WBM and

NWBM residue may be discharged at the sea surface during cleaning of mud pit (<1%), typically at the conclusion of drilling activities or when changing between mud types. Nedwed et al. (2006) found that depth is an important factor for concentrations of NWBM on cuttings, where cuttings which had a great distance to reach the seabed (950 m) had significantly lower concentrations of OOC, suggesting that loss of base fluid during settling acted to significantly reduce chemical effects from discharges. The study concluded that NWBM discharged in deep water posed very limited environmental impacts (from analysis of difference in benthic fauna between pre- and post-drilling samples (Nedwed et al., 2006)). This discharge is expected to dilute rapidly, with potential impacts to the environment considered to be a local, temporary decrease in water quality.

The low sensitivity of the benthic communities/habitats within and in the vicinity of the Operational Area, combined with the low toxicity of WBMs and NWBMs, no bulk discharges of NWBM and the highly localised nature and scale of predicted physical impacts to seabed biota affirm that any significant impact is considered likely but of a slight environmental consequence.

Cumulative Impacts

Given the Petroleum Activities Program includes the drilling of four new wells and the field includes eight existing wells, there is the potential for cumulative disturbance to marine sediment quality and benthic communities to occur. The cuttings and drilling fluids discharged from each of the wells will accumulate within the receiving environment. The existing Pluto subsea hydrocarbon gathering system has been in production since 2012; therefore, it is expected that the benthic habitat communities have fully recovered since then, posing no risk for significant cumulative impacts from historical wells. Therefore, cumulative impacts are expected to be limited to the Petroleum Activities Program.

Given that the distances between some existing and/or proposed wells are within 100 m, it is possible that overlap of Operational Areas will occur. When considering deposition of sediments from each drilling activity, deposition at a thickness of greater than 6.5 mm is limited to within a distance of a few hundred metres, although this is dependent on the nature of the cuttings, and the water depth and currents of the receiving environment (IOGP, 2016). Impacts from wells that overlap Operational Areas/cuttings discharges are anticipated to be minimal, considering the observed limited benthic biota within the Permit Area (**Section 4.5.1.2**).

No cumulative impacts to water quality are expected to occur since discharged sediments are predicted to settle in between the drilling activities for each well and no concurrent drilling will occur.

<u>*Well Annular Fluids*</u>

The non-instantaneous nature of the release of the well annular fluids is expected to result in rapid dilution to a no-effect concentration within metres of the release location.

Summary of Potential Impacts to Environmental Value(s)

Given the adopted controls, it is considered that the drill cuttings and drilling muds discharges described will not result in a potential impact greater than localised burial and smothering of benthic habitats and slight/short term effects to water quality (e.g. turbidity increase) (i.e. Environment Impact – E). Any localised impacts to water quality and marine fish is not expected to impact on any commercial fishers in the area.

Demonstration of ALARP

Control Considered	*Control Feasibility (F) and Cost/Sacrifice (CS)*	*Benefit in Impact/ Risk Reduction*	*Proportionality*	*Control Adopted*
Legislation, Codes and Standards				
No additional controls identified.				
Good Practice				
Drilling, completions, cementing, flowline pre-commissioning and subsea control fluids and additives will have an environmental assessment completed prior to use.	F: Yes. CS: Minimal cost. Standard practice.	Environmental assessment of chemicals will reduce the consequence of impacts resulting from discharges to the marine environment by ensuring chemicals have been assessed for environmental acceptability. Planned discharges are required for the safe execution of activities	Benefits outweigh cost/sacrifice.	Yes **C 6.1**

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
		and therefore no reduction in likelihood can occur.		
For drilling and completion fluids, six-monthly chemical reviews are performed.	F: Yes. CS: Minimal cost. Standard practice.	Regular reviews will ensure chemicals selected for drilling and completions fluids remain ALARP.	Benefits outweigh cost/sacrifice.	Yes **C 6.2**
Written NWBM justification process followed.	F: Yes. CS: Minimal cost. Standard practice.	The written justification considers the technical need for NWBM use, receiving environment, cost and additional controls that may be required. By performing formal assessment, the potential impacts are well understood, allowing for development of control measures to reduce the consequence of NWBM use. This provides an overall environmental benefit.	Benefits outweigh cost/sacrifice.	Yes **C 6.3**
NWBM base oils selected based on expected toxicity	F: Yes CS: Minimal cost.	By selecting a base oil with lower toxicity, the consequence of the release on the environment is reduced.	Benefits outweigh cost/sacrifice.	Yes **6.4**
Backload of NWBM.	F: Yes. CS: Minimal cost. Standard practice.	By restricting the volume of NWBM for overboard discharge, the consequence of the release on the environment is reduced. Although no change in likelihood is provided, the decrease in consequence results in an environmental benefit.	Benefits outweigh cost/sacrifice.	Yes **C 6.5**
Bulk operational discharges conducted under MODU’s Permit to Work (PTW) system (to operate discharge valves/pumps).	F: Yes. CS: Minimal cost. Standard practice.	The MODU’s PTW may slightly reduce the likelihood of bulk discharges occurring, but it is unlikely to be significant given bulk discharges are often operationally required and cannot be eliminated.	Benefits outweigh cost/sacrifice.	Yes **C 6.6**

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
SCE used to treat NWBM cuttings prior to discharge.	F: Yes. CS: Minimal – more frequent cuttings sampling and testing.	Achieving average oil on cuttings (sections using NWBM only) discharge limit of 6.9% or less oil on wet cuttings will have a small reduction in consequence.	Benefits outweigh cost/sacrifice.	Yes **C 6.7**
In event of SCE failure (where no redundancy is available) while drilling with NWBM, the initial action will be to cease drilling and determine whether to repair SCE or drill ahead until next practicable opportunity to trip out of the hole. If cuttings are discharged during dryer or auger failure, measurement of OOC to occur more frequently from shakers.	F: Yes. CS: Cost and schedule implications due to cessation of drilling.	Ceasing drilling in the event of equipment failure will allow for time to assess feasibility of drilling ahead while still meeting residual OOC discharge requirements.	Benefits outweigh cost/sacrifice.	Yes **C 6.8**
Professional Judgement – Eliminate				
None identified.				
Professional Judgement – Substitute				
None identified.				
Professional Judgement – Engineered Solution				
Mud pit wash residue will be measured for oil content prior to discharge.	F: Yes. CS: Minimal cost. Standard practice.	Ensuring <1% oil content will provide a small reduction in consequence when residue is discharged to the environment.	Benefits outweigh cost/sacrifice.	Yes **C 6.9**
Drill cuttings returned to the MODU will be discharged below the water line.	F: Yes. CS: Minimal cost. Standard practice.	Discharge of drill cuttings below the water line will reduce carriage and dispersion of cuttings thereby reducing the consequence of cuttings discharges during the Petroleum Activities Program.	Benefits outweigh cost/sacrifice.	Yes **C 6.10**
Cuttings reinjection into formation. Cuttings are to be crushed, slurrified and pumped to a desired geological structure with a suitable seal, below the seabed through an annulus or tubing.	F: No. No concurrent drilling or direct sequential drilling planned which would require cuttings to be stored prior to reinjection. CS: Not considered – control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
Riserless mud recovery (RMR) system to return top hole cuttings/mud from the riserless section of the well to the MODU prior to treatment onboard and discharge from the MODU (below the water line) for all wells. Note: RMR may be used for technical reasons if a weighted fluid is required to successfully drill a top hole section (such as mitigating against shallow hazards or unstable formations).	F: Yes. RMR in the water depth where this Petroleum Activities Program will take place (145–174 m) is technically feasible with a specially designed/ engineered solution. RMR may be required for technical reasons during the Petroleum Activities Program. CS: Primary cost/ sacrifice of this option is the installation of RMR equipment including the footprint of equipment onboard the rig, POB for operation/ maintenance and risks associated with operational reliability of the installed system (particularly in the deeper waters of the Petroleum Activities Program).	Potential environmental benefit from disposing top hole cuttings/fluid from the MODU below the surface, instead of directly to seafloor, includes a reduction in the consequence of environmental impacts from smothering surrounding benthic fauna (due to a greater spread of cuttings on the seafloor). The magnitude of this reduction in smothering potential could depend upon metocean factors such as tide at the time of discharge (which impact dispersion efficacy and patterns). Because RMR allows for fluid recovery, mud is able to be reused down-hole, reducing the total volume of mud used for that section. The net environmental benefit for this option is reduced or neutral due to the introduction of suspended sediment impact potential for in-water fauna, which doesn't exist to the same extent for disposal of top hole cuttings/fluids at seafloor. The transfer of environmental consequence from reducing cuttings/mud discharged at each well location (i.e. less potential for smothering benthic fauna at seafloor) to reductions in water quality for in-water fauna by suspended sediment and final sedimentation levels,	Disproportionate to implement RMR for environmental reasons. Although use of the RMR system to bring mud/fluids back to the MODU (rather than discharging at seabed) includes a reduction in the likelihood of environmental impacts from smothering of proximate benthic fauna, environmental impact potential is then transferred to in-water fauna from suspended sediment, rather than reduced by applying this control. Considering the already low level of impact from cuttings/fluid discharge predicted, the outcomes of the impact assessment described above which determined no sensitive benthic receptors in the vicinity of the Petroleum Activity Program, and transfer of environmental impacts to another receptor, any minor environmental benefits gained from implementing this control are considered disproportionate to the costs and risks associated with RMR system installation and use.	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
		means the consequence of discharging cuttings to the marine environment during the Petroleum Activities Program is not reduced.		
RMR system to return top hole cuttings from the riserless section of the well to the MODU prior to transport to an alternative discharge location or back to shore for disposal.	F: Yes. RMR in the water depth where some of this Petroleum Activities Program will take place (Xena wells less than 200 m deep) is technically feasible with a specially designed/ engineered solution. CS: Primary cost/sacrifice of this option is the additional handling required in transporting mud/cuttings to alternative disposal location. Particularly the health and safety risks associated with high frequency of support vessel activity alongside the rig and the amount of lifting operations required if a cuttings skip/drilling waste container system were employed. The installation of RMR equipment including the footprint of equipment onboard the rig, persons on board for operation/ maintenance and risks associated with operational reliability of the installed system (particularly in the deeper waters of the Petroleum Activities Program) was considered. Other cost/sacrifice elements which are considered include: • Further treatment of cuttings onshore is required to ensure a standard suitable for	As described above with additional environmental benefits of discharge at an alternative location or transported back to shore. With cuttings removed from location, potential environment benefit comes from reduced smothering/burial potential for local benthic habitat in the direct vicinity of the well, where cuttings would normally be discharged on the seafloor. Fluids are still discharged on location (from the MODU) in accordance with requirements in this EP. The net environmental benefit for this option is reduced due to the introduction of suspended sediment impact potential for in-water fauna with the sub-surface discharge of fluids from the top hole, which doesn't exist to the same extent for disposal of top hole fluids at seafloor. Discharging at a different location reduces the consequence to environmental sensitivities in the Operational Area. However, the small risk of impact is	Disproportionate. The cost/sacrifice outweighs the benefit gained over the duration of the Petroleum Activities Program. The potential environmental benefits derived from the use of RMR to bring cuttings/fluids back to the MODU (rather than discharging at seabed) are limited. The potential reduction in likelihood of burial/smothering due to removal of cuttings for one hole section is offset by cuttings/fluids discharged on location through drilling the rest of the well (i.e. discharges from the other well sections). There is also a transfer of risk and new risks introduced; bringing fluids back to the MODU and disposal at surface has an impact potential for in-water fauna compared to discharge at seabed. Considering the already low level of impact from cuttings/ fluid discharge predicted and the outcomes of the impact assessment described above, which determined no sensitive benthic receptors in the	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
	landfill: Class II disposed locally (e.g. Karratha); Class III landfill requires transport to Geraldton or Perth. • Increased risk of unplanned vessel collision or loss of cuttings during transfer activities. • Environmental impact (suspended sediment/ sedimentation) of discharging cuttings at new location and other regulatory approvals may also be required (e.g. sea dumping permit). • Potential halt to drilling activity if transfer operations are delayed due to weather or operational issues. • Additional environmental impact incurred (air emissions) from vessel use and onshore trucking for transportation of cuttings.	transferred to an alternate site. Given the relatively low biological significance of sensitivities in the Operational Area, no environmental benefit is gained overall. Transportation of cuttings for onshore disposal eliminates any consequence of discharge of cuttings. This only provides a small environmental benefit, given the low consequence of discharge cuttings on location.	vicinity of the Petroleum Activities Program, any environmental benefits gained from the implementation of this control are considered disproportionate to the costs and risks introduced by onshore cuttings relocation or disposal at alternative offshore location.	
Return riser-in-place cuttings for disposal at another marine location or onshore for processing and land disposal (skip and ship) for whole well to reduce risk of benthic disturbance. OR Return riser-in-place cuttings for all sections drilled with NWBM for disposal onshore (to reduce potential residual OOC to environment).	F: Yes. CS: Primary cost/ sacrifice of this option is the additional handling required to transport cuttings to an alternative disposal location. Particularly the health and safety risks associated with high frequency of support vessel activity alongside the rig and the amount of crane lifting required if a	Compared to adopted control, return riser-in-place cuttings would reduce cuttings/ mud discharged (although discharge would still occur during riserless drilling on the basis that this control is not adopted) at each well location; however, given current impact assessment and controls adopted, this	Disproportionate. Given the adopted controls and low current risk rating, the high cost/ sacrifice outweighs the benefit gained over the duration of the Petroleum Activities Program. Impact assessment has determined no sensitive benthic receptors in the	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
	cuttings skip/drilling waste container system were employed. Other cost/sacrifice elements which are considered include: • further treatment of cuttings onshore is required to ensure a standard suitable for landfill: Class II disposed locally (e.g. Karratha); Class III landfill requires transport to Geraldton or Perth • increased risk of unplanned vessel collision or loss of cuttings during transfer activities • environmental impact (suspended sediment/ sedimentation) of discharging cuttings at new location and other regulatory approvals may also be required (e.g. sea dumping permit) • potential halt to drilling activity if transfer operations are delayed due to weather or operational issues • additional environmental impact incurred (air emissions) from vessel use and onshore trucking for transporting cuttings • disposal via landfill and/or	would not result in a significant reduction of consequence.	vicinity and a low level of impact potential from overall cuttings/mud discharge; therefore, benefit to be gained from cuttings/mud recovery is disproportionate to the risks introduced by relocating cuttings (including if an alternative system which doesn't use transport containers was implemented).	

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
	treatment does not eliminate an environmental impact. These options have their own impacts and therefore disadvantages if implemented.			
Reduce total drill cuttings by implementing slim well design.	F: No. Slim well design is not considered feasible based on the following factors: • The wells to be drilled in the Petroleum Activities Program are expected to be deep. Designs have been optimised to minimise the size of hole drilled while still being able to reach the targets and meet development objectives. CS: Not considered, control not feasible.	Not considered, control not feasible.	Not considered, control not feasible.	No
Water quality and/or sediment monitoring of drill cuttings or drilling fluids to verify impact during activity.	F: Yes. CS: • For in-water sampling using ROV – Time and logistics for tool change-out from operational tools to specialised scientific sampling tools. • Additional personnel on board to operate ROV and coordinate sampling program. • Low ROV availability due to operations can limit time to carry out environment monitoring.	No environmental benefit would be gained by implementation of monitoring during the activity. Monitoring could be used to inform additional control measures in future drilling activities; however, there is a considerable body of existing scientific literature on potential impacts of drill cuttings and impacts are generally well understood. Furthermore, it is not guaranteed that additional controls would be feasible, or if they would provide any environmental benefit.	Disproportionate. Cost/sacrifice outweigh benefit to be gained in the context of existing environment (deep water, open ocean communities with no proximity to sensitive benthic communities or receptors). Although adoption of this control could be used to verify EPOs associated with drilling mud and cutting discharge, alternative controls identified achieve an appropriate outcome.	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
	• If additional ROV is required on the MODU, deck space and resources to run/ store/service ROV. • Resources for sample processing (space/equipment/ personnel).			

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
Use SCE with secondary treatment for NWBM: Thermomechanical systems (to achieve <1% average oil on cuttings).	F: Yes – with associated infrastructure including vessels for offline storage and delivery to thermomechanical dryer. CS: The primary cost/sacrifice of this option is the monetary outlay for acquisition and implementation which is estimated at $800,000 to mobilise, install and demobilise, along with a running cost of ~$32,000/day. Other factors considered include: • It is estimated that it would take a minimum of seven months to mobilise, install and commission the system on to the MODU. • Complex and unfamiliar system to integrate with the rig systems. • Increased Health & Safety exposure due to: – crew of nine engineers and technicians required to run the plant – multiple crane lifting operations, during installation, operations and demobilisation – rotating machinery – heat illness – deck congestion due to large footprint of the plant.	A reduction in consequence would be achieved by reducing the average oil on cuttings discharged.	Disproportionate. Cost/sacrifice outweighs benefit to be gained in the context of existing environment and drilling campaign.	No
WBM drill cuttings returned to the MODU will be processed using SCE equipment	F: Yes CS: Minimal cost. Standard practice	L: No reduction C: Reduced from D to E CRR: Reduced from Moderate to Low	Benefits outweigh cost/sacrifice.	Yes **C 6.11**

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
Time restricted discharge of WBM and/or cuttings to align with tide/current or other oceanographic events.	F: Yes. CS: Disruption to drilling operations in having to stop drilling at a time when discharge of WBM and/or cuttings might not be permitted. Additional mud storage volume required.	Given the offshore location, oceanographic changes are unlikely to significantly affect the dispersion of cuttings and therefore no environmental benefit would be gained.	Disproportionate. The cost/sacrifice outweighs the benefit gained – No hard coral or other photo-sensitive benthic communities in the vicinity of wells to rationalise phased/ timed discharge.	No

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, **Section 2.6.1**), Woodside considers the adopted, standard 'good practice' controls appropriate to manage the impacts of drill cuttings and drilling fluids discharges.

A range of engineered solutions and other elimination options were considered to further reduce the impact of planned discharge of drill cuttings and drilling fluids to ALARP; however, technical and operational challenges, safety and environmental risk and additional financial costs resulted in these options being rejected on the basis that they were grossly disproportionate to the potential environmental benefit gained. As no reasonable additional/alternative controls were identified that would further reduce the impacts, which due to the low sensitivity of the environment are already low, without grossly disproportionate sacrifice, the impacts are considered ALARP.

Demonstration of Acceptability

Acceptability Statement

The impact assessment has determined that, given the adopted controls, cuttings and fluid discharges may result in a potential minor, short-term impact on habitat (but not affecting ecosystem function), biological and physical attributes. Further opportunities to reduce the impacts have been investigated above.

The adopted controls are considered good oil-field practice/industry best practice to prevent the generation of significant volumes of drill cuttings. Other engineered solutions to manage drill cuttings and fluids were considered; however, these represented costly 'end of pipe' solutions rather than a preventative approach, with additional safety and environmental risks. The potential impacts are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts, which due to the low sensitivity of the environment are low, of these discharges to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 6 No impact to water quality, sediment quality or marine biota greater than a consequence level of D [12] from discharge of drilling cuttings or fluids during the Petroleum Activities Program.	**C 6.1** Drilling, completions, cementing, flowline pre-commissioning and subsea control fluids and additives will have an environmental assessment completed prior to use.	**PS 6.1** All chemicals intended or likely to be discharged into the marine environment reduced to ALARP using the chemical assessment process.	**MC 6.1.1** Records demonstrate chemical selection, assessment and approval process for selected chemicals is followed.
	C 6.2 For drilling and completion fluids, six-monthly chemical reviews are performed.	**PS 6.2** Acceptability of previously approved chemicals are re-evaluated to ensure ALARP and alternatives are considered.	**MC 6.2.1** Records confirm six-monthly reviews have taken place, and any actions/changes are being tracked to closure.

[12] Defined as 'Minor and short term impact on species or habitat but not affecting ecosystem function'.

	C 6.3 Written NWBM justification process followed.	**PS 6.3** The use of NWBM is consistently challenged using written justification.	**MC 6.3.1** Records demonstrate a formal justification has been completed prior to the use of NWBM.
	C 6.4 NWBM base oils selected based on expected toxicity	**PS 6.4** Group III base oils used in NWBM	**MC 6.4.1** Records demonstrate that only Group III base oils used in NWBM.
	C 6.5 Backload of NWBM	**PS 6.5** No overboard disposal of bulk NWBM.	**MC 6.5.1** Incident reports of any unplanned discharges of NWBM.
	C 6.6 Bulk operational discharges conducted under MODU's Permit to Work (PTW) system (to operate discharge valves/pumps).	**PS 6.6** Increased level of assurance and verification on bulk operational discharges.	**MC 6.6.1** Records demonstrate that bulk discharges are conducted under the MODU PTW system.
	C 6.7 SCE used to treat NWBM cuttings prior to discharge.	**PS 6.7** Average OOC (sections using NWBM only) discharge limit of 6.9% or less oil on wet cuttings is achieved.	**MC 6.7.1** Records confirm the average OOC for the entire well (sections using NWBM only) do not exceed limit.
	C 6.8 In event of SCE failure (where no redundancy is available) while drilling with NWBM, the initial action will be to cease drilling and determine whether to repair SCE or drill ahead until the next practicable opportunity to trip out of the hole. If cuttings are discharged during dryer or auger failure, measurement of OOC to occur more frequently from shakers.	**PS 6.8** The decision whether to repair SCE or drill ahead has considered the estimated time for repairs and the amount of drilling until next planned trip out of hole, to ensure the OOC limit is not exceeded.	**MC 6.8.1** Records demonstrate that in the event of auger or cuttings dryer failure (where no redundancy is available), active drilling is initially stopped as soon as safe to do so. Evidence of the decision to drill ahead with failed SCE can be produced. Records confirm the average OOC for the entire well (sections using NWBM only) do not exceed limit.
	C 6.9 Mud pit wash residue will be measured for oil content before discharge.	**PS 6.9** Less than 1% by volume oil content achieved before discharge.	**MC 6.9.1** Records after pit clean-out (for pits potentially contaminated with base oil) demonstrate mud pit wash residue was less than 1% by volume oil content before discharge.
	C 6.10 Drill cuttings returned to the MODU will be discharged below the water line.	**PS 6.10** Dispersion of cuttings increased by discharge below the water line.	**MC 6.10.1** Records confirm cuttings discharge chute/line is below the water line.
	C 6.11 WBM drill cuttings returned to the MODU will be processed (using SCE equipment)	**PS 6.11** WBM drill cuttings returned to the MODU processed using SCE equipment allowing reuse of mud prior to discharge.	**MC 6.11.1** Records demonstrate that operational SCE is in use.

6.6.6 Routine and Non-routine Discharges to the Marine Environment: Cement, Cementing Fluids, Grout, Subsea Well Fluids and Unused Bulk Products

Context	
BOP and marine riser installation – **Section 3.8.3** Well abandonment – **Section 3.11.7** Span/scouring rectification and stabilisation **– Section 3.9.10** Cement unit test **– Section 3.8.1**	Physical environment – **Section 4.4** Biological environment – **Section 4.5**

Impacts 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***	***Impact***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Routine and non-routine discharge of cement, cement cuttings, cementing fluids, grout, subsea fluids (e.g. BOP control fluids and well suspension fluids) and other down-well products to the seabed and the marine environment		X	X		X		X	A	E	-	-	LCS GP PJ	Broadly Acceptable	EPO 5

Description of Source of Impact

Cementing Fluids, Cement and Grout

Cementing fluids, including cementing mix water, may require discharge to the marine environment under various scenarios. When cementing the conductor and surface casings after top hole sections of the well have been drilled, cement must be circulated to the seabed to ensure structural integrity of the well. Excess cement is pumped to ensure structural integrity is achieved.

If the hole is completely in-gauge and there are no downhole losses while pumping the cement, a maximum volume of 110 m^3 per well is estimated to be circulated to the seafloor at the well location, which forms a thin concrete film on the seabed in close proximity to the well.

After each cement job, leftover cement slurry in the cement pump unit and the surface lines is flushed and discharged to the sea to prevent clogging of the lines and equipment. This is estimated at about 40 m^3 per well (based on up to four cement jobs per well x 10 m^3 discharged per job). In the unlikely event a respud event is required it would result in additional cement jobs.

Cement spacers can be used as part of the cementing process, within the well casing, to assist with cleaning of the casing sections prior to cement flow through. The spacers may consist of either seawater or a mixture of seawater and dye. The dye is used to provide a pre-indicator of cement overflow to the seabed surface, to ensure adequate cement height.

Excess cement (dry bulk, after well operations are completed) will either be: used for subsequent wells; provided to the next operator at the end of the drilling program (as it remains on the rig); or if these options aren't practicable, discharged to the marine environment as dry bulk or as a slurry.

Upon arrival on location at the Operational Area, the rig may be required to perform a cement unit test, or 'dummy cement job'. Discharges from the test are made through the usual cement unit discharge line, which may be up to 10 m above the sea level, and occur as a cement slurry. The slurry is usually a mix of cement and water (~10 m^3); however, may sometimes contain stabilisers or chemical additives.

Post-lay span rectification may also be required following flowline installation. This process typically involves the placement of grout bags under the span section. The empty bag is filled with grout on the seabed supplied from a mixing and pumping spread on the vessel via a downline. Typical grout volumes depend on the size of the span and may vary from about 200 kg to 2000 kg per span. If grout bags are used, the downline recovery time risks exceeding the grout curing time and if grout cures within the downline and pum1p, the equipment is likely to be rendered unserviceable, as well as the downline not being safely recoverable in the normal way. Therefore, following grouting activities at each span site, the downline and pump will need to be purged using seawater. This results in an amount of grout, approximately equivalent to the downline volume (5 m³), being discharged to the ocean. This flushing is required once per grout site. The actual number is not known until the line is laid and need for span rectification determined, if any.

Subsea Fluids (BOP and Well Construction Activity Control Fluids)

Subsea fluids likely to be released during drilling, completions and xmas tree installation, including BOP controls fluids. The BOP is required to be regularly function tested when subsea, as defined by legislative requirements. The BOP is function tested during assembly and maintenance and during operation on the seabed. As part of this testing, small volumes of BOP control fluid (generally consisting of water mixed with a glycol based detergent or equivalent water based anti-corrosive additive) is released to the marine environment. The BOP will be function tested about every seven days (when a pressure test is not occurring) and pressure tested approximately every 21 days as per API 53 (an American Petroleum Institute standard for Well Control Equipment Systems for Drilling Wells). The maximum volume of BOP control fluid per well is up to about 90 L.

Functioning and testing of the subsea xmas trees and subsea landing strings will result in the discharge of small volumes of water and glycol based control fluid.

Subsea Fluids – Well Intervention and Workover Fluids

A workover or intervention may be performed on any of the wells in the Petroleum Activities Program. If the well has been flowed previously, or if down-hole hydrocarbons remain in the well (e.g. reservoir fluid or if base oil has been left in the well), there is potential the intervention/workover fluids will be contaminated with hydrocarbons. If hydrocarbon contamination of the intervention/workover fluids has occurred, treatment of the fluid will occur on the MODU, to ensure hydrocarbon content prior to discharge is 1% by volume or less.

During IMR or workover activities, it may be necessary to remove marine growth from subsea infrastructure using acid (typically sulphamic acid) to aid visual inspection and operation of valves and other mechanisms.

Subsea Fluids – Displacement, Completion and Well Bore Clean-Out Fluids

As required throughout activities with the riser connected, wells will be displaced from one drilling fluid system to another, or from the drilling fluid system to completion brine. A chemical clean-out pill or fluids train will be circulated between the two fluids. Clean-out fluids and completion brine will be captured and stored on the MODU and discharged if oil concentration is <1% by volume, or returned to shore if discharge requirements cannot be met.

During well unloading, base oil will be sent to the flare. Refer to **Section 6.6.8** for an assessment of risk associated with planned flaring during well unloading.

Produced Water

During well unloading and completion activities, completion fluids and produced water will be discharged to the marine environment via the well test water treatment package. The well test water treatment package will be used to treat produced water that cannot be flared before discharge. Prior to discharge, the fluids are cycled through a water filtration system consistent with solids and polishing. About 100 bbls (16 m^3) of produced water is yielded per well, which may be discharged via the well test water treatment package.

Other Down-Well Products

Additional products such as barite and bentonite may be discharged in bulk during or at the end of the activity if they cannot be reused or taken back to shore. Use and discharge of all chemicals will be done in line with Woodside's internal guidelines (**Section 3.10.1**). Discharge may be in the form of dry bulk or as a slurry; however, discharges will not be contaminated with hydrocarbons.

Impact Assessment

Potential Impacts to Water Quality, Sediment Quality and Other Habitats and Communities

Pelagic and benthic habitats in the Permit Area are considered to be of low sensitivity (no known significant benthic habitat or infauna habitat). Although the Continental Slope Demersal Fish Communities KEF overlaps with the Permit Area, the values and sensitivities of this KEF occur on a broad scale outside of the Permit Area (**Section 4.7.3**). Coupled with the low toxicity of the fluids to be used for the Petroleum Activities Program, the likelihood of any significant impact to marine biota is considered to be low.

Cement and Grout

Impacts of cement on the marine environment are associated mainly with smothering of surrounding benthic and/or infauna communities. Cement is the most common material currently used in artificial reefs around the world (OSPAR, 2010) and is not expected to pose any toxicological impacts to receptors from leaching or direct contact. A minimum cement volume is required to be stored on the MODU for use in well control and plug and abandon activities. While cement volumes are calculated prior to use to minimise excess, the requirement for additional volumes on the MODU means some cement may require discharge if options for reuse on other wells is not possible. Discharge of excess cement may occur as dry bulk or as a slurry. Dry bulk has the potential to disperse across a wider area, but at lower concentration, compared to slurry which would have a greater tendency to settle on the seafloor closer to the well location. In either case, discharges are not expected to widely disperse before settling on the seabed.

The impact of cement discharge and grout (if required) at the seabed will therefore be limited to any surrounding benthic and/or infauna communities, in a small localised area immediately around the well and likely within the area previously impacted by drill cuttings (see **Section 6.6.5**).

Cementing Fluids, Subsea Well Fluids (BOP and Well Construction Activity Control Fluids, Completion Fluids and Well Intervention/Workover Fluids) and Other Down-Well Products

All chemicals that may be operationally released or discharged to the marine environment are required to be selected and approved as per the Chemical Selection and Assessment Environment Guideline (**Section 3.10.1**). Therefore, any chemicals selected and potentially released are expected to be of low toxicity and biodegradable. Additionally, where cements have been mixed in excess and cannot be reused or returned to shore, these will be turned into a slurry. As chemicals have initially been chosen based on the environmental performance and based on an ALARP assessment, additional dilution prior to discharge further reduces the environment impact to water quality, sediment quality and marine benthic and/or infauna communities. Given the minor quantities of routine and non-routine planned discharges, short discharge durations and the low toxicity and high dispersion in the open, offshore environment, any impacts on the marine environment are expected to be slight and localised.

Given the highly localised nature of these discharges and potential impacts, cumulative impacts to marine biota, water quality and sediments are not expected.

Summary of Potential Impacts to Environmental Value(s)

Given the adopted controls, it is considered that the routine discharge of cement, cementing fluid, grout, subsea fluids and other down-well products described will not result in a potential impact greater than localised, slight and short term impacts to infauna and benthic communities, water quality and marine sediment (but not affecting ecosystems function) (i.e. Environment Impact – E). Any localised impacts to marine fish is not expected to impact on any commercial fishers in the area.

Demonstration of ALARP

Control Considered	*Control Feasibility (F) and Cost/Sacrifice (CS)*	*Benefit in Impact/Risk Reduction*	*Proportionality*	*Control Adopted*
Legislation, Codes and Standards				
No additional controls identified.				
Good Practice				
Drilling, completions, cementing, flowline pre-commissioning and subsea control fluids and additives will have an environmental assessment completed prior to use.	F: Yes. CS: Minimal cost. Standard practice.	Environmental assessment of chemicals will reduce the consequence of impacts resulting from discharges to the marine environment by ensuring chemicals have been assessed for environmental acceptability. Planned discharges are required for the safe execution of activities and therefore no reduction in likelihood can occur.	Benefits outweigh cost/sacrifice.	Yes **C 6.1**
For Drilling and Completions fluids, six-monthly chemical review performed to confirm potential chemical impacts are reduced to ALARP.	F: Yes. CS: Minimal cost. Standard practice.	Regular reviews will ensure chemicals selected for Drilling and Completions fluids remain ALARP.	Benefits outweigh cost/sacrifice.	Yes **C 6.2**
Bulk operational discharges conducted under MODU's Permit to Work (PTW)	F: Yes. CS: Minimal cost. Standard practice.	The MODU's PTW may slightly reduce the likelihood of bulk discharges occurring, but it	Benefits outweigh cost/sacrifice.	Yes **C 7.1**

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
system (to operate discharge valves/ pumps).		is unlikely to be significant given that bulk discharges are often operationally required and cannot be eliminated.		
Displacement, brine, workover or intervention fluids contaminated with hydrocarbons will be treated prior to discharge or contained. If discharge specification not met the fluid will be returned to shore.	F: Yes. CS: Minimal cost. Standard practice.	Ensuring <1% oil content will provide a small reduction in consequence when fluids are discharged to the environment.	Benefits outweigh cost/sacrifice.	Yes **C 7.2**
During well unloading and completion activities, if produced water is not flared, it will be processed through the well test water treatment package prior to discharge to the environment.	F: Yes. CS: Minimal cost. Standard practice.	Reduced toxicity to the marine environment when discharged.	Benefits outweigh cost/sacrifice.	Yes **C 7.3**
Professional Judgement – Eliminate				
Do not use BOP control fluids.	F: No. BOP control fluids are critical to the operation of the BOP. CS: Not considered, control not feasible.	Not considered, control not feasible.	Not considered, control not feasible.	No
Return cement and other down-well products onshore for treatment/disposal.	F: Yes. However, cement slurry may harden during transport, introducing difficulty in handling and transportation. CS: The cost involved in transporting cement for shore-based disposal is significant.	No discharge of cement to the marine environment would eliminate the likelihood and consequence of impacts from such activities.	Disproportionate. Given the non-toxic nature of cement, the cost/sacrifice outweighs the benefit gained.	No
Options for use of excess bulk cement, bentonite and barite will be assessed prior to discharge to the marine environment	F: Yes. However, the cement may not meet the required technical specifications, and hence not be usable. CS: Minor.	Using excess bulk cement for subsequent wells would eliminate the bulk discharge of cement to the marine environment and eliminate the consequence of impacts from such activities.	Benefits outweigh cost/sacrifice.	Yes **C 7.4**
Professional Judgement – Substitute				
No additional controls identified.				

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Professional Judgement – Engineered Solution				
No additional controls 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, **Section 2.6.1**), Woodside considers the adopted controls appropriate to manage the impacts of cement, cementing fluids, grout and subsea fluids (BOP control fluids). 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, routine cement, cementing fluids, grout and subsea fluids (BOP control fluids) may result in localised, slight and short term impacts to infauna and benthic communities, water quality and marine sediment (but not affecting ecosystems function). Further opportunities to reduce the impacts have been investigated above. The adopted controls are considered good oil-field practice/industry best practice. The potential impacts are considered broadly acceptable if the adopted controls are implemented. 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 7 No impact to water quality or marine biota greater than a consequence level of E [13] from discharge of cement, cementing fluids, subsea well fluids and unused bulk products during the Petroleum Activities Program.	**C 6.1** Drilling, completions, cementing, flowline pre-commissioning and subsea control fluids and additives will have an environmental assessment completed prior to use.	**PS 6.1** All chemicals intended or likely to be discharged into the marine environment reduced to ALARP using the chemical assessment process.	**MC 6.1.1** Records demonstrate chemical selection, assessment and approval process for selected chemicals is followed.
	C 6.2 For drilling and completion fluids, six-monthly chemical reviews are undertaken.	**PS 6.2** Acceptability of previously approved chemicals are re-evaluated to ensure ALARP and alternatives are considered.	**MC 6.2.1** Records confirm six-monthly reviews have taken place, and any actions/changes are being tracked to closure.
	C 7.1 Bulk operational discharges conducted under MODU's Permit to Work (PTW) system (to operate discharge valves/pumps).	**PS 7.1** To ensure an increased level of assurance and verification on bulk operational discharges.	**MC 7.1.1** Records demonstrate that bulk discharges are conducted under the MODU PTW system.
	C 7.2 Displacement, brine, workover or intervention fluids contaminated with	**PS 7.2** Achieve oil concentration <1% by volume prior to discharge.	**MC 7.2.1** Records demonstrate that discharge criteria was met

[13] Defined as ‘ Slight and short term impact on species or habitat but not affecting ecosystem function’ as in **Figure 2-6**/**Section 2.6.3**.

	hydrocarbons will be treated prior to discharge or contained. If discharge specification not met the fluid will be returned to shore.		prior to discharge or contained.
	C 7.3 During well unloading and completion activities, if produced water is not flared, it will be processed through the well test water treatment package prior to discharge to the environment.	**PS 7.3** Produced water discharged to the marine environment achieves discharge specification of <30 ppm	**MC 7.3.1** Records demonstrate that formation water met discharge specification.
	C 7.4 Options for use of excess bulk cement, bentonite or barite will be assessed prior to discharge to the marine environment.	**P.S 7.4** No bulk cement, bentonite or barite discharged without documented ALARP assessment.	**MC 7.4.1** Records demonstrate that, prior to discharge of excess bulk cement, bentonite or barite options for use were assessed.

6.6.7 Routine and Non-routine Discharges to the Marine Environment: Flowline and Subsea Installation Fluids

Context		
Project fluids – **Section 3.10**	Physical environment – **Section 4.4** Biological environment – **Section 4.5**	Stakeholder consultation – **Section 5**

Impacts 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***	***Impact***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Discharge of flowline and subsea installation fluids to the marine environment		X	X		X			A	E	-	-	GP PJ	Broadly Acceptable	EPO 6

Description of Source of Impact

The following activities will result in the discharge of flowline and subsea installation preservation and pre-commissioning fluids:

- flood, clean and gauge testing (FCGT) to clean and preserve the flowline (**Section 3.9.11**)
- dewatering of flexible flowline (**Section 3.9.11.3**)
- hydrotesting subsea infrastructure (**Section 3.9.11.2**)
- tie in of MEG line and hydrocarbon line (**Section 3.9.9)**

Flowline Fluids

All production flexible flowlines will be installed filled with chemically treated 50 wt% MEG/water. All flexible jumpers will be installed filled with chemically treated 90 wt% MEG/water. The MEG concentration will be Fibre-grade (99.9 wt%) prior to mixing with water. All production flexible flowlines will not require further flooding post installation. Production flexible flowlines and jumpers will not be dewatered and inerted following installation, except for the main 12" production flexible flowline. As it is pre-flooded with chemically treated 50 wt% MEG pre-lay, a single bi-directional pig will be used, propelled by N2 gas to displace the fluid. The pig train may consist of bi-directional pigs if required (**Section 3.9.11**). The estimated discharge volumes including chemical additives are shown in **Table 6-3**. There is also potential that some debris remaining from flowline installation activities within the line may be discharged with this water.

Table 6-3: Estimated worst case discharges from FCGT and subsea commissioning activities (including contingency)

Action Description	Flowline internal diameter	Flowline length	Total volume	+20% contingency	MEG volume	Water volume	Fluorescein volume (50 ppm)	Chemical treatment volume (650 ppm)
Pyxis Subsea System Discharge	inches	m³	m³	m³	m³	m³	litres	litres
	12	14,000	1089	1306	588	718	65	849
Xena Phase 2 and Phase 3 Subsea System Discharge	No planned discharge							

The direction of pig run and associated discharge locations will be determined through detailed engineering. All subsea chemicals will be selected, assessed and approved in accordance with a defined framework and set of tools to ensure the potential impacts are acceptable, ALARP and meet Woodside's expectation for environmental performance (**Section 3.10.1**). This procedure is used to demonstrate that the potential impacts of the chemicals selected are acceptable and ALARP (subject to technical and economic constraints). ***Subsea Installation Fluids*** Small leak tests result in discharges of MEG and hydrotest fluid in very small quantities. The total leak test discharge volume for the Petroleum Activities Program is expected to be about 5 m^3, discharged at the locality of the subsea infrastructure, e.g. each of the well centres, manifolds and umbilicals. Tie in of a new MEG Line may result a non-routine MEG discharge. Discharge of MEG would only occur in the unlikely event of an isolation valve failure at the tie-in point, which if occurred is expected to result in a release of approximately 35 m^3 MEG over a 12 hour period discharged at the tie in location. Similarly, the hydrocarbon line contains three isolation valves. Discharge of condensate would only occur in the unlikely event of values failure, which if occurred is expected to result in a release of a maximum discharge volume of approximately 2m^3 of condensate over a 48 hour period.
Impact Assessment
Potential Impacts to Water Quality, Marine Sediment Quality, Other Habitats and Communities and Protected Species
Flowline Fluids The worst case dewatering discharge of 1306 m^3 (Pyxis subsea discharge – refer **Table 6-3**) associated with FCGT activities for the main 12" flexible flowline will contain approximately 588 m^3 of MEG and up to 650 ppm of treatment chemicals (e.g. biocide, oxygen scavenger and fluorescein dye), with a discharge rate ranging between ~2.4 m^3/min to ~4.8 m^3/min, subject to further detailed engineering. Woodside has previously performed modelling for a pipeline installation campaign with a comparable discharge volume (1449 m^3) and rate (4.8 m^3/min) to assess the near-field dispersion of a dewatering discharge of treated seawater (APASA 2012). The nearfield dispersion modelling indicated that under median current scenarios (50th percentile exceedance – median currents, average dilution and advection using 0.21 m/s), about 900 dilutions are achieved within about 50 m of the release site, while under worst-case mixing (95% exceedance case – slow currents, low dilution and slow advection using 0.04 m/s) about 280 dilutions are achieved within about 25 m of the release site. This indicates that based on an in-pipe chemical concentration of 650 ppm, the plume would dilute to below 1 ppm (based on LC_{50} over 96 hours) in proximity to the discharge location. Approximately 588 m^3 of MEG will be released once during FCGT activities. MEG is considered to pose little or no risk to the environment by OSPAR (2012). However, very high concentrations of MEG (>50%) may cause irritation to sensitive areas of larger marine fauna (e.g. eyes, gills). MEG is biodegradable and water-soluble and will dilute rapidly in the marine environment to low concentrations. Impacts may occur if marine fauna is within the mixing zone when the MEG is released. However, given MEG's low toxicity impacts, it is unlikely there would be any measurable effects on marine species resident in the vicinity of the release. The MEG discharge is expected to mix rapidly with the local receiving environment with short term environmental impact. As such potential impacts from the dewatering activity to benthic communities, fish or pelagic invertebrates would be limited to within the low sensitivity Operational Area around subsea installation. Furthermore, it is expected that motile fish and other marine fauna will adapt their behaviour and move away from the discharge, if exposed. The habitats in the vicinity of the proposed release location are mostly composed of benthic communities typical of the NWMR (**Section 4.5.1.4**) and the seabed is expected to be flat and featureless and no hard substrate habitat is expected at the release location at either end of the flowline (rock pinnacles are at least 5 km away). Impacts on benthic communities are predicted to be negligible due to the relatively low biological abundance and wide distribution of similar community types throughout the region. In the event of lethal/sub-lethal stress to infauna, the ecological consequences may include temporary and localised impact to infauna populations with a temporary decline in abundance in the immediate area of the discharge; however, populations would recover rapidly by recolonisation by surrounding populations (Neff, 2005). Potential impacts to marine fauna such as pelagic fish species and marine mammals are expected to be limited to avoidance of the plume in a localised area. Plankton populations may be affected in the immediate discharge plume; however, given the fast population turnover of open water plankton populations, the potential ecological impacts are considered very minor. Therefore, localised, short term and negligible impacts are predicted. Potential impacts to the Continental Slope Demersal Fish Communities KEF are expected to be negligible, with no overall impact on the environmental values and sensitivities associated with the KEF.

Subsea Installation Fluids

Subsea leak testing and tie in of the MEG and hydrocarbons lines may result in discharge of relatively small amounts of MEG, condensate and hydrotest fluid. Impacts from routine and non-routine discharges of chemicals will be localised to the immediate vicinity of the release location with short-lasting impacts. This is based on:

- the low potential for toxicity and bioaccumulation (MEG is considered PLONAR)
- the relatively small volumes/rates of discharges
- the rapid dilution of the release
- the low sensitivity of the receiving environment.

Given the low volume of MEG and hydrotest fluids likely to be discharged during testing, any impact on the marine environment is expected to be highly localised and negligible. Potential impacts to benthic habitats and pelagic fauna are discussed above.

Cumulative Impacts

Given that only localised, short term and negligible impacts are predicted to water quality and marine biota, cumulative impacts affecting marine biota from the discharge of dewatering and small volumes of subsea installation fluids are considered unlikely. However, due to the short duration of the discharge, full dispersion between discharge events is expected and potential impacts will remain localised, short-term and negligible with no cumulative impacts expected.

Summary of Potential Impacts to Environmental Value(s)

Given the adopted controls, it is considered that the routine discharge of flowline fluids and subsea installation fluids described will not result in a potential impact greater than localised, slight and short term impacts to infauna and benthic communities, marine sediment, water quality and pelagic marine fauna (but not affecting ecosystems function) (i.e. Environment Impact – E).

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)*** [14]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
No additional controls identified.				
Good Practice				
Drilling, completions, cementing, flowline pre-commissioning and subsea control fluids and additives will have an environmental assessment completed prior to use.	F: Yes. CS: Minimal cost. Standard practice.	Environmental assessment of chemicals will reduce the consequence of impacts resulting from discharges to the marine environment by ensuring chemicals have been assessed for environmental acceptability. Planned discharges are required for the safe execution of activities and therefore no reduction in likelihood can occur.	Benefits outweigh cost/sacrifice.	Yes **C 6.1**
Chemical concentration will be confirmed during flooding of the 12“flowline	F: Yes. CS: Minimal cost. Standard practice.	Confirmation of the chemical concentration during flooding will reduce the consequence of impacts resulting from discharges to the marine environment by ensuring chemicals concentration is acceptable. Planned discharges are required for the safe execution of activities and therefore no reduction in likelihood can occur.	Benefits outweigh cost/sacrifice.	Yes **C 8.1**

[14] Qualitative measure.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)*** [14]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
ROV inspection during hydrotest test.	F: Yes. CS: Minimal cost. Standard practice.	A procedure for hydrotesting work that includes inspection (including by ROV) during testing to identify leakage and trigger activity to stop will reduce the likelihood of impacts.	Benefits outweigh cost/sacrifice.	Yes **C 8.2**
Professional Judgement – Eliminate				
Reduce volume or not use preservation and pre-commissioning chemicals.	F: No. Preservation and pre-commissioning fluids are required to verify the structural integrity of the subsea infrastructure. The volumes selected are required to achieve verification. CS: Potential loss of production due to loss of integrity possibly leading to a larger environmental incident.	Not considered, control not feasible.	Disproportionate. The cost/ sacrifice outweighs the benefit gained.	No
Do not conduct FCGT activities.	F: No. FCGT activities are required to control the potential for corrosion of the flowlines and to determine if any unacceptable restrictions and/or obstructions exist in the line. CS: Potential loss of production due to loss of integrity possibly leading to a larger environmental incident.	This would eliminate any potential impacts from the FCGT activities but increases likelihood of loss of integrity during operation and potentially greater environmental impacts.	Disproportionate. The cost/ sacrifice outweighs the benefit gained.	No
Professional Judgement – Substitute				
No additional controls identified.				
Professional Judgement – Engineered Solution				
No additional controls 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 flowline and subsea installation fluid discharges. 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, flowline and subsea installation fluid discharges represent a low current risk rating that may result in localised, slight and short term impacts to infauna and benthic communities, marine sediment, water quality and pelagic marine fauna (but not affecting ecosystems function). Further opportunities to reduce the impacts have been investigated above. The adopted controls are considered good oil-field practice/industry best practice. The potential impacts are considered broadly acceptable if the adopted controls are implemented. 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 8 No impact to water quality or marine biota greater than a consequence level of E [15] from discharges of flowline and subsea installation fluids during the Petroleum Activities Program.	**C 6.1** Drilling, completions, cementing, flowline pre-commissioning and subsea control fluids and additives will have an environmental assessment completed prior to use.	**PS 6.1** All chemicals intended or likely to be discharged into the marine environment reduced to ALARP using the chemical assessment process.	**MC 6.1.1** Records demonstrate chemical selection, assessment and approval process for selected chemicals is followed.
	C 8.1 Chemical concentration will be confirmed during flooding of the 12“flowline.	**PS 8.1** Chemical concentration confirmed to be equal to or less than 650 ppm during flooding of the 12“flowline.	**MC 8.1.1** Records demonstrate compliance with maximum chemical concentration.
	C 8.2 ROV inspection during hydrotest test.	**PS 8.2** ROV inspection during hydrotest to identify leakage and trigger activity to stop.	**MC 8.2.1** Records demonstrate ROV inspection during hydrotest and record any instances of activity required to stop due to identified leak(s).

[15] Defined as ‘ Slight and short term impact on species or habitat but not affecting ecosystem function’.

6.6.8 Routine Atmospheric Emissions: Fuel Combustion, Flaring, Incineration and Venting

Context														
Project vessels – **Section 3.5**							Physical environment – **Section 4.4**							
Impacts Evaluation Summary														
Source of Risk	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Impact***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Internal combustion engines and incinerators on MODU, installation vessel and support vessels				X				A	F	-	-	LCS GP PJ	Broadly Acceptable	EPO 7
Flaring during well unloading				X				A	F	-	-	LCS GP PJ		EPO 8
Contingent venting of gas (in the event of well kick)				X				A	F	-	-	LCS GP PJ		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).

During well unloading and testing it is expected that gas condensate, diesel or base oil and methanol in the wellbore will be flared. The volumes of hydrocarbons flared are unknown and subject to operational requirements. To inform the impact assessment, Woodside has estimated that well unloading may require intermittent flaring for up to 20 days, up to 900 million standard cubic feet of hydrocarbons flared per well. These estimates are based on Woodside's operational experience and are considered applicable for the Petroleum Activities Program.

During drilling of the well, a kick may occur. A kick is an undesirable influx of formation fluid into the wellbore. The resultant effect would be a release of a small volume of greenhouse gases via the degasser to the atmosphere during well control operations, known as 'venting'. Venting is required to ensure well integrity is maintained in the event of a kick, thereby avoiding an emergency condition.

Impact Assessment
Potential Impacts to Air Quality
Fuel combustion, flaring and incineration have the potential to result in localised, temporary reduction in air quality. Potential impacts include a localised reduction in air quality, generation of dark smoke and contribution to greenhouse gas emissions. Given the short duration and exposed location of the MODU, installation vessels and support vessels (which will lead to the rapid dispersion of the low volumes of atmospheric emissions), the potential impacts are expected to have no lasting effect, with no cumulative impacts when considered in the context of existing or future oil and gas operations in the region. Venting may result in localised and temporary reduction in air quality as the gas vents to the atmosphere, and localised and temporary contribution to greenhouse gas emissions. There is potential for human health effects for workers in the immediate vicinity of atmospheric emissions. However, the closest sensitive residential receptor is on Barrow Island, about 127 km south-south-east of the Permit Area; therefore, any risks associated with off-site human health effects are negligible beyond the immediate zone of release and dispersion. Given the short duration and isolated location of the Petroleum Activities Program (which will lead to the rapid dispersion of the low volumes of atmospheric emissions), the potential impacts are expected to be minor.
Summary of Potential Impacts to Environmental Value(s)
Given the adopted controls, it is considered that fuel combustion, flaring, incineration and venting emissions will not result in a potential impact greater than a temporary decrease in local air quality and/or water quality standards with no lasting effect and no significant impact to environmental receptors (i.e. Environment Impact – F).

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)*** [16]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Marine Order 97 (Marine pollution prevention – air pollution).	F: Yes. CS: Minimal cost. Standard practice.	Legislative requirements to be followed may slightly reduce the likelihood of air pollution.	Control based on legislative requirements – must be adopted.	Yes **C 9.1**
Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011: Accepted Well Operations Management Plan (WOMP) and application to drill.	F: Yes. CS: Minimal cost. Standard practice.	The accepted WOMP will manage the risk of well kicks, reducing the likelihood of occurrence. No reduction in consequence will occur.	Benefits outweigh cost/sacrifice.	Yes **C 11.1**
As-built checks that shall be completed during well operations to establish a minimum acceptable standard of well integrity is achieved.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of occurrence. No reduction in consequence will occur.	Benefits outweigh cost/sacrifice.	Yes **C 11.2**

[16] Qualitative measure.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)*** [16]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Good Practice				
Burning and flaring during well unloading activities will be conducted using Woodside and Vendor approved TPS (Well Test) Package.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of atmospheric emissions impacting air quality. Consequence remains unchanged.	Benefits outweigh cost/sacrifice.	Yes **C 10.1**
Oil burner will have an independent certified emissions testing certificate.	F: Yes. CS: Minimal cost. Standard practice.	This control results in a reduction on likelihood of atmospheric emissions impacting air quality, consequence remains unchanged.	Benefits outweigh cost/sacrifice.	Yes **C 10.2**
Subsea BOP installed and function tested during drilling operations.	F: Yes. CS: Standard practice. Required by Woodside standards.	BOP testing reduces the volume of gas vented in the event of a well kick.	Benefits outweigh cost/sacrifice.	Yes **C 11.3**
Process conducted to calculate, update and monitor kick tolerance for use in well design and while drilling.	F: Yes. CS: Minimal cost. Standard practice for Woodside activities.	Processes will reduce the volume of gas vented in the event of a well kick.	Benefits outweigh cost/sacrifice.	Yes **C 11.4**
Well control bridging document for alignment of Woodside and the MODU contractor in order to manage the equipment and procedures for preventing and handling a well kick.	F: Yes. CS: Minimal cost. Standard practice for Woodside activities.	Implementing equipment and procedures in the well control bridging document will reduce the volume of gas vented in the event of a well kick.	Benefits outweigh cost/sacrifice.	Yes **C 11.5**
Professional Judgement – Eliminate				
Do not combust fuel.	F: No. There are no MODUs or 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
Do not vent during well kick.	F: No. Venting is a critical safety activity required in the event	Not considered – control not feasible.	Not considered – control not feasible.	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)***[16]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
	of a kick to reduce pressure build up. CS: Not considered – control not feasible.			
Professional Judgement – Substitute				
No additional controls identified.				
Professional Judgement – Engineered Solution				
No additional controls 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, **Section 2.6.1**), Woodside considers the adopted controls are considered good oil-field practice/industry best practice, and appropriate to manage the impacts of fuel combustion, flaring, incineration and venting. 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, fuel combustion, flaring, incineration and venting may result in a temporary decrease in local air quality standards, with no lasting effect. Further opportunities to reduce the impacts have been investigated above. The controls adopted are considered good oil-field practice/industry best practice and meet the legislative requirements within Marine Order 97. The potential impacts are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the impacts of the described emissions to a level that is broadly acceptable**.**

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 9 Fuel combustion emissions during the Petroleum Activities Program are restricted 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 Certificate, required by vessel class • use of low sulphur fuel when available • Ship Energy Efficiency Management Plan, where required by vessel class • onboard incinerator complies with Marine Order 97.	**PS 9.1** MODU and 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 conducted prior to contracting vessels, to ensure suitability and compliance with vessel combustion certification/ Marine Order requirements.	**MC 9.1.1** Marine Assurance inspection records demonstrate compliance with Marine Order 97.
EPO 10 Maximise efficiency of combustion during flaring and oil-burning.	**C 10.1** Burning and flaring during well unloading activities will be conducted using Woodside and Vendor approved TPS (Well Test) Package.	**PS 10.1** Maintain gas flare and oil burner to maximise efficiency of combustion and minimise venting.	**MC 10.1.1** Records demonstrate that a Woodside approved Well Test package is in use during well unloading/testing.

	C 10.2 Oil burner will have an independent certified emissions testing certificate.		**MC 10.2.1** Records demonstrate that oil burner is certified and emissions tested.
EPO 11 Emissions to air as a result of venting from well kick are restricted to those necessary to maintain well integrity.	**C 11.1** *Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011*: accepted Well Operations Management Plan (WOMP), which describes the well design and barriers to be used to prevent a loss of well integrity, specifically: • all permeable zones penetrated by the well bore, containing hydrocarbons or over-pressured water, shall be isolated from the surface environment by a minimum of two barriers (primary and secondary) (a single fluid barrier may be implemented during the initial stages of well construction if appropriateness is confirmed by a shallow hazard study) • discrete hydrocarbon zones shall be isolated from each other (to prevent cross flow) by a minimum of one barrier where deemed required • all normally pressured permeable water-bearing formations shall be isolated from the surface by a minimum of one barrier. The barriers shall: • be effective over the lifetime of well construction. • Fluid barriers shall remain monitored and provide sufficient pressure to counter pore pressure during well construction. • Cementing barriers (including conductor, casing and liners) shall conform to the relevant minimum standards set out in the Woodside Engineering Standard – Well Cementation. Verification: • Effectiveness of primary and secondary barriers	**PS 11.1** Wells drilled in compliance with the accepted WOMP, including implementation of barriers to prevent a loss of well integrity.	**MC 11.1.1** Acceptance letter from NOPSEMA demonstrates the WOMP and application to drill were accepted by NOPSEMA prior to the drilling activity commencing. **MC 11.1.2** Records demonstrate minimum of two verified barriers (a single fluid barrier may be implemented during the initial stages of well construction if appropriateness is confirmed by a shallow hazard study) were in place for all permeable zones penetrated by the wellbore. **MC 11.1.3** Records demonstrate composition and weight of drilling fluids were applicable to down hole conditions.

	shall be verified (physical evidence of the correct placement and performance) during the drilling of the well.		
	C 11.2 As-built checks shall be completed during well operations.	**PS 11.2** A minimum acceptable well integrity standard is achieved and verified through as-built checks completed during well operations.	**MC 11.2.1** Records show Well Acceptance Criteria are developed for each well. **MC 11.2.2** Records demonstrate Well Acceptance Criteria have been met.
	C 11.3 Subsea BOP installed and function tested during drilling operations. The BOP shall include: • one annular preventer • two pipe rams (excluding the test rams) • a minimum of two sets of shear rams, one of which must be capable of sealing • deadman functionality • the capability of ROV intervention • independent power systems.	**PS 11.3** Subsea BOP specification, installation and function testing compliant with internal Woodside Standards and international requirements (API Standard 53 4th Edition) as agreed by Woodside and MODU contractor.	**MC 11.3.1** Records demonstrate that BOP and BOP control system specifications and function testing were in accordance with minimum standards for the expected drilling conditions as agreed by Woodside and MODU contractor.
	C 11.4 Process conducted to calculate, update and monitor kick tolerance for use in well design and while drilling, including: • Closing the BOP upon detecting a positive well influx. • The shut in procedure shall be according to the rig contractor procedures or as the well conditions dictate. • Kick tolerance calculations will be made for drilling all hole sections based on the weakest known point in the well. Kick detection techniques will be adjusted based on the level of kick tolerance through management of change (MOC). • The manual also includes requirements for kick tolerance management in the event of down-hole losses.	**PS 11.4** Kick tolerance is calculated, managed, monitored and updated while drilling.	**MC 11.4.1** Records demonstrates well kick tolerance is calculated, managed, monitored and updated while drilling. **MC 11.4.2** Records demonstrate shut-in procedures followed in the event of a potential well kick.
	C 11.5	**PS 11.5**	**MC 11.5.1**

	Well Control Bridging Document (WCBD) for alignment of Woodside and the MODU contractor in order to manage the equipment and procedures for preventing and handling a well kick.	Well is drilled in accordance with the contractor WCBD to ensure no unplanned emissions to air from a well kick, drilling operations.	Records demonstrate well drilled in accordance with WCBD.

6.6.9 Routine Light Emissions: External Lighting on MODU and Project Vessels

Context	
Project vessels – **Section 3.5**	Physical environment – **Section 4.4**

Source of Impact	Soil and Groundwater	Marine Sediment	Water Quality	Air Quality (incl Odour)	Ecosystems/Habitat	Species	Socio-Economic	Decision Type	Impact	Likelihood	Current Risk Rating	ALARP Tools	Acceptability	Outcome[17]
External light emissions on-board MODU, installation vessels and other project vessels						X		A	F	-	**-**	PJ	Broadly Acceptable	N/A

Impacts Evaluation Summary: Environmental Value Potentially Impacted (Soil and Groundwater to Socio-Economic); Evaluation (Decision Type to Outcome).

Description of Source of Impact

The MODU, installation vessels and support vessels will have external lighting to facilitate navigation and safe operations at night throughout the Petroleum Activities Program. External light emissions from the MODU, installation vessels and support vessels are typically managed to maintain good night vision for crew members.

Lighting on the MODU is used to allow safe operations during night hours, as well as to communicate the MODU's presence and activities to other marine users (i.e. navigation lights). Lighting is required for the safe operation of the MODU and cannot reasonably be eliminated. Note that flaring, which is a relatively bright light source, may occur during well unloading.

External lighting is located over the entire MODU, with most external lighting directed towards working areas such as the main deck, pipe rack and drill floor. These areas are typically lower than 20 m above sea level when the MODU is on station. The highest point on the MODU is the top of the derrick, which is typically about 50 m above sea level. The flare will also be an intermittent and temporary source of light on the MODU. Flaring is expected to occur intermittently over a cumulative total of approximately 12 days.

The distance to the horizon at which components of the MODU will be directly visible can be estimated using the formula below:

$$\textit{horizon distance} = 3.57 \times \sqrt{\textit{height}}$$

where horizon distance is the distance to the horizon at sea level in kilometres and height is the height above sea level of the light source in metres. Using this formula, the approximate distances at which various MODU components (and associated light sources) will be visible at sea level are:

- main deck (~20 m above sea level): about 16 km from MODU.
- Derrick top (~50 m above sea level): about 25 km from MODU.
- Flare (~12 m above sea level): about 12 km from MODU.

[17] There are no specific controls and EPOs identified for external lighting on MODU and project vessels. However, minimum lighting aboard the MODU and project vessels will be maintained to facilitate safe operations and navigation.

Impact Assessment

Potential Impacts to Protected Species

Light emissions can affect fauna in two main ways:

- *Behaviour*: Many organisms are adapted to natural levels of lighting and the natural changes associated with the day and night cycle as well as the night time phase of the moon. 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. In instances where an artificial light source is brighter than a natural source, the artificial light may act to override natural cues leading to disorientation.

The fauna within the Permit Area are predominantly pelagic fish and zooplankton, with a low abundance of transient species such as marine turtles, whale sharks, whales and migratory sea birds. There is no known critical habitat within the Permit Area for EPBC listed species, although there is overlap with BIAs for flatback turtle internesting, whale shark foraging, pygmy blue whale migration and wedge-tailed shearwater breeding. Pygmy blue whales and whale sharks are not expected to be impacted by above-surface light emissions, except indirectly in the event of prey aggregations around the light source. Given the fauna expected to occur within the Permit Area, impacts from light emissions are considered to be highly unlikely.

Marine Turtles – Adults

Artificial lighting may affect the location that turtles emerge to the beach, the success of nest construction, whether nesting is abandoned, and even the seaward return of adults (Salmon et al., 1995a,b; Salmon and Witherington, 1995). Such lighting is typically from residential and industrial development overlapping the coastline, rather than offshore from nesting beaches. While the Permit Area overlaps with the north-west extent of a BIA for flatback turtle internesting (described in **Section 4.5.2.3**), the nearest landfall for this BIA occurs at the Montebello Islands, about 50 km south-east of the Operational Area. Impacts to nesting turtles is therefore not expected. Given the water depth of the Operational Area (at least ~170 m), turtle species are unlikely to be foraging. However, it is acknowledged that marine turtles may be present transiting the Operational Area in low densities.

Migratory Birds

The Operational Area may be occasionally visited by migratory and oceanic birds but does not contain any emergent land that could be used as roosting or nesting habitat and contains no known critical habitats (including feeding for any species). The closest emergent land is the Pluto facility located about 15 km east of the Permit Area. A BIA for Wedge-tailed Shearwater breeding overlaps with the Permit Area, with the breeding period occurring from August to April (**Section 4.5.2**). Seabird surveys over the North West Shelf Province have noted that seabird distributions in tropical waters were generally patchy, except near islands (Dunlop et al., 1988). Given the Operational Area lies offshore with the closest island 50 km away and the Pluto facility 15 km away, seabirds are likely to only transit over the Operational Area when travelling between emergent land and important habitats. Migratory shorebirds may be present in or fly through the region between July and December, and again between March and April as they complete migrations between Australia and offshore locations (Department of Environment, 2015). The risk associated with collision from seabirds attracted to the light is considered to be low, given the low numbers expected to transit the area and that there is no critical habitat for these species within the Operational Area, as well as the slow moving speeds associated with the MODU and project vessels.

Fish

Lighting from the presence of a vessel may result in the localised aggregation of fish below the vessel. These aggregations of fish are considered localised and temporary and any long term changes to fish species composition or abundance is considered highly unlikely. This localised increase in fish extends to those comprising the whale shark's diet. However, given that a large proportion of the diet comprises krill and other planktonic larvae, it is unlikely that a light source will lead to a significant increase in whale shark abundance in the vicinity of the MODU and vessels. Similarly, any localised impacts to marine fish is not expected to impact on any commercial fishers in the area.

Summary of Potential Impacts to Environmental Value(s)

Light emissions from the MODU (including flaring), installation vessel and support vessels will not result in an impact greater than localised and temporary disturbance to fauna in the vicinity of the Operational Area, with no lasting effect (i.e. Environment Impact – F).

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
No additional controls identified.				
Good Practice				
No additional controls identified.				
Professional Judgement – Eliminate				
Substitute external lighting with 'turtle friendly' light sources (reduced emissions in turtle visible spectrum).	F: Yes. Replacement of external lighting with turtle friendly lighting is technically feasible, although is not considered to be practicable. CS: Significant cost sacrifice. The retrofitting of all external lighting on the MODU, etc., would result in considerable cost and time expenditure. Considerable logistical effort to source sufficient inventory of the range of light types onboard the MODU.	Given the potential impacts to turtles during this activity is insignificant, implementation of this control would not result in a reduction in consequence.	Grossly disproportionate. Implementation of the control requires considerable cost sacrifice for minimal environmental benefit. The cost/sacrifice outweigh the benefit gained.	No
The well unload acceptance criteria that defines the well objectives will be established.	F: Yes. CS: Standard practice	Eliminates unnecessary flared volumes and corresponding emissions	Benefits outweigh the cost/sacrifice	Yes **C 4.1**
Variation of the timing of the Petroleum Activities Program to avoid peak turtle internesting periods (December to January).	F: No. The Operational Area has a minor overlap with the flatback turtle internesting BIA in an area not known to provide foraging habitat. Given the low potential for internesting turtles to be present within the Operational Area, the risk of potential impacts from vessel light emissions on adult turtles is considered to be low. CS: Significant cost and schedule impacts due to delays in securing vessels/ MODU for specific timeframes.	Not considered, control not feasible.	Not considered, control not feasible.	No
Do not flare.	F: No. Flaring is the only feasible way mange the reservoir fluids and achieve the well objectives. CS: Not considered – Control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No
Professional Judgement – Engineered Solution				
No additional controls identified.				

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
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, **Section 2.6.1**), Woodside considers the potential impacts from routine light emissions from the MODU, installation vessels and support vessels to be ALARP in its current risk state. 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, in its current state, routine light emissions from the MODU, installation vessels and support vessels may result in localised behavioural disturbance to fauna within the Operational Area, with no lasting effect. Further opportunities to reduce the impacts have been investigated above. The potential impacts are consistent with good oil-field practice/industry best practice and are considered to be broadly acceptable in its current state. Therefore, Woodside considers standard operations appropriate to manage the impacts of routine light emissions to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 12 Flaring emissions during the Petroleum Activities Program are restricted to those necessary to perform the activity to reduce impacts to the environment from light.	**C 4.1** The well unload acceptance criteria that defines the well objectives will be established.	**PS 4.1** Flaring restricted to a duration necessary to achieve the well objectives.	**MC 4.1.1** Records demonstrate flaring was restricted to a duration necessary to achieve the well objectives.

6.7 Unplanned Activities (Accidents, Incidents, Emergency Situations)

6.7.1 Quantitative Spill Risk Assessment Methodology

Quantitative hydrocarbon spill modelling was performed by RPS, on behalf of Woodside, using a three-dimensional hydrocarbon spill trajectory and weathering model, SIMAP (Spill Impact Mapping and Analysis Program). The model is designed to simulate the transport, spreading and weathering of specific hydrocarbon types under the influence of changing meteorological and oceanographic forces. Near-field subsurface discharge modelling was performed using OILMAP, which predicts the droplet sizes that are generated by the turbulence of the discharge as well as the centreline velocity, buoyancy, width and trapping depth (if any) of the rising gas and oil plumes. The OILMAP output parameters were used as input into SIMAP.

The algorithms in the SIMAP model are based on the best available scientific knowledge, and are updated when necessary in response to significant advances in knowledge. Recent improvements have been implemented to the entrainment algorithm, which have been adjusted to implement the findings of published data based on field research performed during the Macondo spill event in the Gulf of Mexico (Spaulding et al., 2017; Li et al., 2017; French-McCay et al., 2018).

Stochastic modelling was performed for this study, which compiled data from 100 hypothetical spills under different environmental conditions to determine the widest extent of possible oil dispersion. The environmental conditions for each hypothetical spill 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 representative 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. The model also calculates the accumulation of hydrocarbon mass that arrives on each section of shoreline over time, taking into account any mass that is lost to evaporation and/or subsequent removal by current and wind forces.

All hydrocarbons spill modelling assessments performed by RPS undergo initial sensitivity modelling to determine appropriate time to add to the simulation after the spill ceases. 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.

In addition to the stochastic modelling, single-trajectory modelling (deterministic) was performed to assess potential worst-case trajectories based on the stochastic modelling runs. The deterministic simulations are therefore representative of single spill events under certain wind and current conditions. The deterministic simulations were performed to represent the fastest time to shoreline contact and the largest volume ashore from a single model run.

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 (**Sections 6.7.2** to **6.7.4**). They include:

- a vessel collision scenario resulting in ~1000 m³ of diesel instantaneously released
- a bunkering incident scenario resulting in ~8 m³ of diesel instantaneously released
- a loss of well integrity scenario resulting in ~147,755 m³ of Pyxis condensate released for 67 days from the Pyxis PYA-01 production well location. This includes five days of surface release (2706 m³) and 62 days of subsea release (145,049 m³). This is considered the worst case scenario from a loss of well integrity. A loss of well integrity from other Pyxis and Xena wells, including during workover activities, would be of equal or lower extent.

The characteristics of the hydrocarbons, used as the basis for the modelling studies used to inform the assessment, are summarised in **Table 6-4**. The properties of Pyxis condensate[18] differ for the surface and seabed release to account for pressure and temperature differentials between the water surface and the seabed. For the surface blowout the composition of the fluid simulated by the reservoir model shows that a heavier fluid is expected to be released as a portion of the more volatile components, which would be lost to the atmosphere immediately at the release point. The subsea release fluid composition is expected to be lighter, as fewer liquid hydrocarbons are expected to escape with the gas flow at the initial release point.

[18] Adapted from Pluto condensate assay as an analogue

Table 6-4: Summary of hydrocarbon characteristics

Hydrocarbon Type	Scenarios	Location of release[19]	Initial Density (g/cm³)	Wax Content (% by Weight)	Asphaltene Content (% by weight)	Pour Point (°C)	Viscosity (cp)	Component boiling point percentage of total (°C)				Aromatic of whole product <380 °C BP
								Volatiles <180 °C	Semi-volatiles 180-264 °C	Low volatility 264-380 °C	Residual >380 °C	
								Non-persistent			Persistent	
Pyxis condensate[20]	Loss of well integrity	Surface release	0.822 @ 15 °C	<5 %	<0.05%	<-36	0.994 @ 20 °C	11.4	38.3	30.5	19.8	21.1
		Seabed release	0.733 @ 15 °C	<5 %	<0.05%	<-36	0.583 @ 20 °C	76.1	13.5	10.3	0.1	17.1
Marine diesel	Vessel collision Bunkering	Surface	0.829 @ 25 °C	-	-	-	4.0	6	34.6	54.4	5	3

6.7.1.1 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 hydrocarbon threshold concentrations. 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, which is driven by the worst-case credible hydrocarbon spill scenario, which in this instance is the loss of well integrity.

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 fates. The EMBA also includes areas that are predicted to experience shoreline contact with hydrocarbons above threshold concentrations.

The EMBA covers a larger area than the area that is likely to be affected during any one single spill event, as the model was run for a variety of weather and metocean conditions (100 simulations in total). The EMBA therefore represents the total extent of all locations where hydrocarbon thresholds could be exceeded, as determined from all modelling runs.

[19] Surface and seabed hydrocarbon characteristics adopted to account for pressure differential between water surface and the seabed.

[20] Adapted from Pluto condensate assay as an analogue

Surface and accumulated shoreline hydrocarbon concentrations are expressed as grams per square metre (g/m²), with entrained and dissolved aromatic hydrocarbon concentrations expressed as parts per billion (ppb). A conservative approach, adopting accepted contact thresholds that are documented as impacting the marine environment, are used to define the EMBA. These hydrocarbon thresholds are presented in **Table 6-5** and described in the following subsections.

Woodside recognises that hydrocarbons may be visible at low concentrations of approximately 1 g/m^2. The threshold for visible surface oil (1 g/m^2) has therefore been 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 6-5,** 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
- fisheries.

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

Table 6-5: Summary of environmental impact thresholds applied to the quantitative hydrocarbon spill risk modelling results

Hydrocarbon Type	Surface hydrocarbon (g/m²)	Entrained hydrocarbon (ppb)	Dissolved aromatic hydrocarbon (ppb)	Accumulated hydrocarbon (g/m²)
Condensate	10	100	50	100
Diesel	10	500	500	100

Surface Hydrocarbon Threshold Concentrations

The spill modelling outputs defined the EMBA for surface hydrocarbon spills (contact on surface waters) using the ≥10 g/m² for both condensate and diesel. This is equivalent to dull metallic colours based on the relationship between film thickness and appearance (Bonn Agreement, 2015) (**Table 6-6**). This threshold concentration, expressed in terms of g/m², 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. For example: 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 by surface slicks have been estimated by different researchers at about 10–25 g/m² (French et al., 1999; Koops et al., 2004; NOAA, 1996). 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/m² threshold is the reported level of oiling to instigate impacts to seabirds and is also applied to other wildlife, though 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 to the most vulnerable wildlife such as seabirds. Due to weathering processes, surface hydrocarbons will 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 contact. The 10 g/m² threshold is considered appropriate for both Pyxis condensate and diesel delineating potential chronic and acute effects to ecosystems.

A lower concentration of 1 g/m^2, which represents a rainbow sheen on the surface (**Table 6-6**), has also been used to define a wider area within which socio-cultural impacts to the visual amenity of the marine environment may occur. This wider area is referred to as the 'socio-cultural EMBA'.

Table 6-6: The Bonn Agreement oil appearance code

Appearance (following Bonn visibility descriptors)	Mass per area (g/m²)	Thickness (µm)	Volume per area (L/km²)
Discontinuous true oil colours	50 to 200	50 to 200	50,000 to 200,000
Dull metallic colours	5 to 50	5 to 50	5,000 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

6.7.1.2 Dissolved Aromatic Hydrocarbon Threshold Concentrations

Condensate

The condensate threshold concentration value for dissolved aromatic hydrocarbons (i.e. 50 ppb) is considered conservative and has been set with reference to the dissolved exposure values detailed in NOPSEMA Bulletin #1 Oil Spill Modelling (2019), and in context of ecotoxicity tests results from Pluto condensate. Pluto condensate is considered representative of the target reservoir fluids within the Pluto north, Pyxis and Xena fields.

The ecotoxicity tests were undertaken on a broad range of taxa of ecological relevance for which accepted standard test protocols are well established. These ecotoxicology tests are focused on the early life stages of test organisms, when organisms are typically at their most sensitive. The ecotoxicology tests were conducted on eight mainly tropical-subtropical species representatives from six major taxonomic groups.

The ecotoxicity testing focusses on the total petroleum hydrocarbons (TPH) concentration of the WAF of the hydrocarbon and includes the carbon chains C6 to C36. Typically, C4 to C10 compounds are volatile (BP < 180 °C), C11 to C15 compounds are semi-volatile (BP 180–265 °C), C16 to C20 compounds have low volatility (265–380 °C) and C21 compounds and above are residual (BP > 380 °C).

The laboratory-based ecotoxicity tests used a range of water accommodated fraction (WAF) concentrations to expose the different test organisms. For each ecotoxicity test, samples of the WAF were analysed to determine the TPH concentration of the solution. TPH concentration is representative of the sum of the hydrocarbons in each test solution for C6–C36. A sample solution was then further analysed to determine the relative dissolved aromatic content in the TPH concentration. From this additional analysis the aromatic concentration in solution was calculated for each test solution.

Table 6-7 presents the results of no observed effect aromatic concentrations (NOEC) and the EC, LC or IC 50 TPH concentrations for each of the condensate WAFs tested. Toxicity tests indicated NOECs ranged from 140 to 6,099 ppb. EC, LC and IC50 TPH concentrations ranged from 690 to 10,790 ppb (although it should be noted that the lowest value is outside 95% confidence intervals).

Based on these ecotoxicology tests, the selected dissolved aromatic hydrocarbon threshold of 50 ppb has been conservatively adopted for Pyxis condensate. This 50 ppb threshold is below the NOEC values for all eight sensitive organisms tested (**Table 6-7**) and is considered to be conservative.

Table 6-7: Summary of aromatic NOECs for key life-histories of different biota based on toxicity tests for WAF of Pluto condensate (ESA, 2013)

Biota and Life Stage	Exposure Duration	NOEC – Aromatic concentration of unweathered condensate showing no direct biological effect (ppb)	EC/LC/IC50 – TPH Concentration of unweathered condensate (ppb)
Sea urchin fertilisation	1 hours	442	2981 (EC50)
Sea urchin larval development	72 hours	2028	10,790 (EC50)
Milky oyster larval development	48 hours	3654	10,060 (EC50)
Micro-algal growth test	72 hours	140 [21]	3006 (IC50)
Macro-algal germination test	72 hours	1917	4801 (EC50)
Amphipod juvenile survival	96 hours	231	671 (EC50)
Copepod juvenile survival	48 hours	556	1273 (EC50)
Larval fish imbalance test	96 hours	6099	9000 (EC50)

Diesel

The dissolved aromatic threshold of 500 ppb for diesel has been selected as a conservative threshold to be consistent with the NERA Environment Plan Reference Case: Consequence analysis of an accidental release of diesel (2018:1003; NERA 2018). A threshold of 500 ppb is recommended in the reference case in accordance with a review by IRC (2011) of Group II (MGO) hydrocarbon toxicity to the marine environment (NERA 2018). A contact threshold of 500 ppb was found to be conservative for a range of species including crustaceans, molluscs, echinoderms and fish. Five out of six indicator species in ecotoxicology testing showed no observed effect from hydrocarbons below this concentration.

6.7.1.3 Entrained Hydrocarbon Threshold Concentrations

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).

Condensate

The condensate threshold concentration value for entrained hydrocarbons (i.e. 100 ppb) is considered conservative and has been set with reference to the entrained exposure values detailed in NOPSEMA Bulletin #1 Oil Spill Modelling (2019), and in context of ecotoxicity tests results from Pluto condensate, as a suitable surrogate for Pyxis condensate (see above).

The threshold concentration of entrained hydrocarbons that could result in a biological impact cannot be determined directly using available ecotoxicity data for WAF of oil hydrocarbons (**Table 6-7**). However, it is likely this data specific to dissolved oil hydrocarbon represents a worst-case scenario. This is owing to the fact that entrained oil hydrocarbons are less biologically available to organisms

[21] Value estimated due to TPH concentration measurement method limitations and 95% confidence limits not reliable

through absorption into their tissues than dissolved hydrocarbons. The selected threshold of 100 ppb is below the NOEC for the eight sensitive organisms tested in relation to dissolved hydrocarbons and is therefore considered to be conservative.

Diesel

The entrained threshold for diesel has been selected to be consistent with the NERA Environment Plan Reference Case: Consequence analysis of an accidental release of diesel (2018:1003; NERA 2018). As described above, entrained droplets may contain soluble compounds and hence have the potential for generating elevated concentrations of dissolved hydrocarbons. However, the potential for physical and chemical effects from direct contact with entrained oil droplets, which are less biologically available, is more applicable. An entrained threshold of 500 ppb, consistent with the threshold for toxicity from dissolved components, is therefore considered to be conservative.

6.7.1.4 Accumulated Hydrocarbon Threshold Concentrations

Owens and Sergy (1994) define accumulated hydrocarbon <100 g/m² to have an appearance of a stain on shorelines. French-McCay (2009) defines accumulated hydrocarbons ≥100 g/m² 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/m² has therefore been adopted to define the EMBA for both a condensate and diesel spill. Further, any ecological impacts at the accumulated thresholds concentration EMBA may also result in socio-cultural impacts.

6.7.1.5 Scientific Monitoring

A planning area for scientific monitoring is also described in Section 5.7 of the Oil Spill Preparedness and Response Mitigation Assessment (Appendix D). This planning area has been set with reference to the low exposure entrained value of 10 ppb detailed in NOPSEMA Bulletin #1 Oil Spill Modelling (2019).

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.

6.7.2 Accidental Hydrocarbon Release: Loss of Well Integrity

Context		
Drilling activities – **Section 3.8** Project vessels **–** **Section 3.5**	Physical environment – **Section 4.4** Biological environment – **Section 4.5** Socio-economic – **Section 4.6** Values and sensitivities – **Section 4.7**	Stakeholder consultation – **Section 5**

Risk Evaluation Summary														
Source of Risk	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Loss of hydrocarbons (condensate) to marine environment due to loss of well integrity		X	X	X	X	X	X	C	B	1	**M**	LCS GP PJ RBA CS SV	Acceptable if ALARP	EPO 10

Description of Source of Risk

Loss of Well Integrity – Background

Woodside has identified a well blowout as the scenario with the worst case credible environmental outcome as a result of loss of well integrity. A blowout is an incident where formation fluid flows out of the well or between formation layers after all the predefined technical well barriers (e.g. the BOP) or activation of the same have failed.

Likelihood Assessment

Woodside has a good history of implementing industry standard practice in well design and construction. In the Company's 60 year history, it has not experienced any well integrity events that have resulted in significant releases or significant environmental impacts.

The spill likelihood was evaluated using Blowout and Well release Frequencies based on SINTEF offshore blowout database 2012 (Scandpower, 2013). This uses data from 1991-2010 to determine likelihood for well blowouts and releases. For a gas well, the SINTEF calculated probability of blowout during drilling and completion is 2.93 X 10^{-4}.

Operation	Frequency, average well	Frequency, Gas well	Frequency Oil well
Development drilling, deep (normal wells)	2.24 E-05	1.33E-05	3.34 E-05
Completion	1.85 E-04	2.83 E-04	8.72E-05
Total Per well	2.07 E-04	2.93 E-04	1.26 E-04

The SINTEF data supports a likelihood of 'Highly unlikely' for a well blowout with potential to result in the worst case credible spill as the dataset does not account for Woodside and Industry Process Safety Improvements post the Gulf of Mexico Macondo event and is therefore likely to be conservative. The SINTEF data set is January 1991 – December 2010, whilst the Macondo blowout occurred in April 2010. Significant strengthening of barriers is now in place post the data set period, including, but not limited to:

- o Revised and more stringent API 53 Subsea BOP requirements in force.
- o Competency assessments of offshore personnel is now more stringent for both Woodside and drilling contractors, for example through implementation of improvements to well control training as recommended by IOGP and requirements

for Woodside personnel in safety critical roles to complete the Process Safety Management training requirements.
o Revision to Woodside barrier installation and verification process, including acceptance criteria and change control management.

The Pluto/Xena/Pyxis reservoirs are well appraised with a comprehensive set of measured pressure data from exploration, appraisal and producing wells. The likelihood of encountering significant overpressure in the overburden section is minimised through pre-drill geohazard evaluations including seismic surveys and multiple in-field and offset well data. This is believed another area of conservatism in the SINTEF likelihood data when applied to Pyxis and Xena.

When considering likelihood from an 'Experience' perspective a ranking of 'Has occurred many times in the industry' is considered too high when assessing the worst credible event of blowout with no pipe in hole, and no significant bridging or flow restriction through the BOP or other means. This is supported by SINTEF data, showing that none of the 17 blowouts analysed were open hole with no pipe in hole, whilst 28% had an annulus 'full flow' but the flow area is unknown (though it is unlikely to be as large as the open hole, no pipe in hole case).

When considering likelihood of the environmental consequence of the blowout event, historic blowouts that have had catastrophic impact to the environment ('A' consequence rating) have not occurred many times in the industry. This also further supports the likelihood ranking of 'Highly Unlikely."

Drilling Timeframe

Drilling is scheduled to occur throughout the year (all seasons), to provide operational flexibility for requirements and schedule changes and vessel/MODU availability.

Credible Scenario – Loss of Well Integrity

The Petroleum Activities Program consists of drilling up to four production wells. A loss of well integrity could result in a loss of containment at any of these four wells. The location of the proposed Pyxis PYA-01 production well was chosen as the release site in the modelling since this is a representative location resulting in the worst case flow rates, in terms of volume and EMBA, compared to the other proposed and existing wells.

For wells in the Permit Area, Woodside identified the duration of the credible spill scenarios for a well blowout to be an uncontrolled surface release for five days, when the MODU would provide a conduit to the surface for the uncontrolled flow, followed by a 62 day uncontrolled seabed release as the MODU would no longer be present to provide a conduit.

The MODU would no longer be present after five days for the following reasons:

- In a non-explosion scenario, the MODU is likely to be moved off location as soon as practicable to prevent escalation and further harm to personnel.
- In an explosion scenario, the MODU may sink after a period of time due to an anticipated compromise in structural integrity and stability after a period of time. The most recent example of a similar scenario is the *Deepwater Horizon* incident, when the semi-submersible MODU sank after 36 hours following the loss of well control in the Gulf of Mexico in April 2010.

For each EP well loss of integrity scenario, Woodside assesses whether the standard 77-day release usually modelled is most appropriate, based on the timeframes of:

- mobilisation of relief MODU: 21 days.
- relief well drill time: 42 days.
- intersect and kill: 14 days.

A number of Woodside procedures were followed to identify credible spill scenarios, including spill duration. For this scenario the estimated time to drill a relief well is 32 days, this assumed the maximum depth of the hydrocarbon reservoir would be open. The process followed is outlined in **Figure 6-1**, with a breakdown of timeframes and justification for the reduced relief well drill time provided in **Table 6-8**.

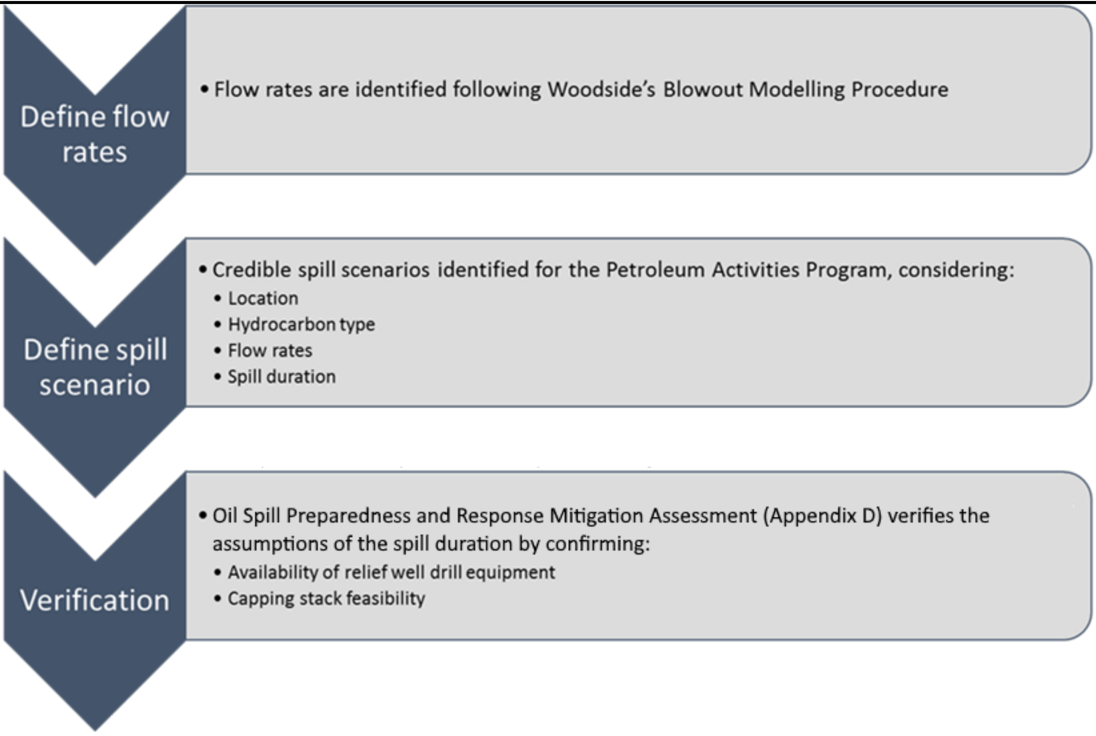


Figure 6-1:Credible hydrocarbon spill scenario identification process

Table 6-8: Relief well drill times

Phase	Description	Time for completion (days)
Mobilisation	Sourcing a MODU through APPEA MoU and mobilisation	21
Drill relief well	Mooring and drill well	32
Intersect and kill	Relief well intersects uncontrolled well, kills well, ceasing release of hydrocarbons	14
	Total days	**67 days**

Blowout Volume

Woodside has determined that the worst case credible total release for a loss of well control in the Permit Area was about 147,755 m³ of condensate. This volume is calculated based on estimated release rate and time to drill a relief well, taking into account well characteristics including total vertical depth and time to mobilise a relief MODU.

Quantitative Spill Risk Assessment

Spill modelling was undertaken by RPS, on behalf of Woodside, to determine the fate of hydrocarbon released for the 67 day blowout scenario at the Pyxis PYA-01 production well location, based on the assumptions in **Table 6-9**. RPS carried out the modelling based on a volume of ~147,755 m³.

Table 6-9: Summary of modelled credible scenario – well blowout

	Loss of well integrity	Fluid Type
Total discharge at surface	5 days 2706 m³	Pyxis condensate (surface)
Total discharge at seabed	62 days 145,049 m³	Pyxis condensate (subsea)
Water depth	985 m	N/A

**The discharge volumes in this table are predicted using reservoir modelling software packages that take into account a number of factors (well design, reservoir properties and environmental conditions (e.g. water depth, temperature and pressure)) to provide a production profile over the oil spill modelling period.*

<u>*Hydrocarbon Characteristics*</u>

Pyxis condensate [22] was selected as the representative hydrocarbon for wells proposed under this EP and is described in **Section 6.7.1** and **Table 6-4**. Characteristics of the Pyxis condensate based on whether it is a surface or subsea release are described below. The properties of Pyxis condensate differ for the surface and seabed release to account for the pressure and temperature differentials between the water surface and the seabed (**Section 6.7.1**).

Pyxis condensate (surface) contains a moderate percentage (19.8%) of hydrocarbon compounds that will not evaporate at atmospheric temperatures in comparison to Pyxis condensate (subsea; 0.1%). These compounds will persist in the marine environment.

The Pyxis condensate (surface and subsea) mixtures are composed of hydrocarbons that have a wide range of boiling points and volatilities at atmospheric temperatures, and which will begin to evaporate at different rates on exposure to the atmosphere. Evaporation rates will increase with temperature, but in general about 11.4% of the Pyxis condensate (surface) mass has the capacity to evaporate within the first 12 hours (BP <180 °C); a further 38.3% could evaporate within the first 24 hours (180 °C <BP <265 °C); and a further 30.5% could evaporate over several days (265 °C <BP <380 °C). For the Pyxis condensate (subsea) oil, 76.1% of the mass has the capacity to evaporate within the first 12 hours (BP <180 °C); a further 13.5% could evaporate within the first 24 hours (180 °C <BP <265 °C); and a further 10.3% could evaporate over several days (265 °C <BP <380 °C), once exposed to the atmosphere. The whole oils have low asphaltene contents (0.05%), indicating a low propensity for the mixtures to take up water to form water-in-oil emulsion over the weathering cycle.

A series of model weathering tests were conducted to illustrate the potential behaviour of Pyxis condensate (surface and subsea) when exposed to idealised calm constant wind conditions and more representative variable wind conditions. Weathering simulations are standardised tests that assess hydrocarbon behaviour once exposed to the atmosphere, therefore the weathering plots are based on surface releases of both types of Pyxis condensate (surface and subsea).

The results for the constant-wind case (**Figure 6-2**) for a discrete spill of 50 m^3 of Pyxis condensate (subsea) released at the surface, for the purposes of the weathering simulation, shows that a small percentage will tend to persist on the sea surface (1.5% after seven days), with negligible levels of entrainment (<0.5%) and about 94% of the oil predicted to evaporate within 24 hours. Under these calm conditions most 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 constant wind case for a discrete spill of 50 m^3 of Pyxis condensate (surface) weathering test results show approximately 49.7% is expected to evaporate within the first 24 hours, another 30.5% within a few days and the remaining 19.8% will expect to persist in the marine environment until decay due to photochemical and biological degradation (**Figure 6-4**).

Under the more realistic variable-wind case, where the winds are of greater strength, a higher percentage of Pyxis condensate (subsea) is predicted to entrain in the water column. Approximately 24 hours after the spill, about 12% of the oil mass is forecast to have entrained and a further 86% is forecast to have evaporated, leaving only a small percentage of the oil floating on the water surface (0.01%). The residual compounds will tend to remain entrained beneath the surface under conditions that generate wind waves. The increased level of entrainment in the variable-wind case will result in a higher percentage of biological and photochemical degradation. The slow degradation of this weathered condensate will extend the area of potential effect, requiring the break-up and dispersion of the slicks to reduce concentrations below the thresholds considered in this study. Under the variable wind case for a discrete spill of 50 m^3 of Pyxis condensate (surface) weathering test results show approximately 39% is expected to evaporate within the first 24 hours and approximately 57% is expected to entrain. Evaporation remains at approximately 40% of the next 6 days at the entrainment decreases to 40% by day 7 (**Figure 6-5**).

[22] Adapted from Pluto condensate assay as an analogue

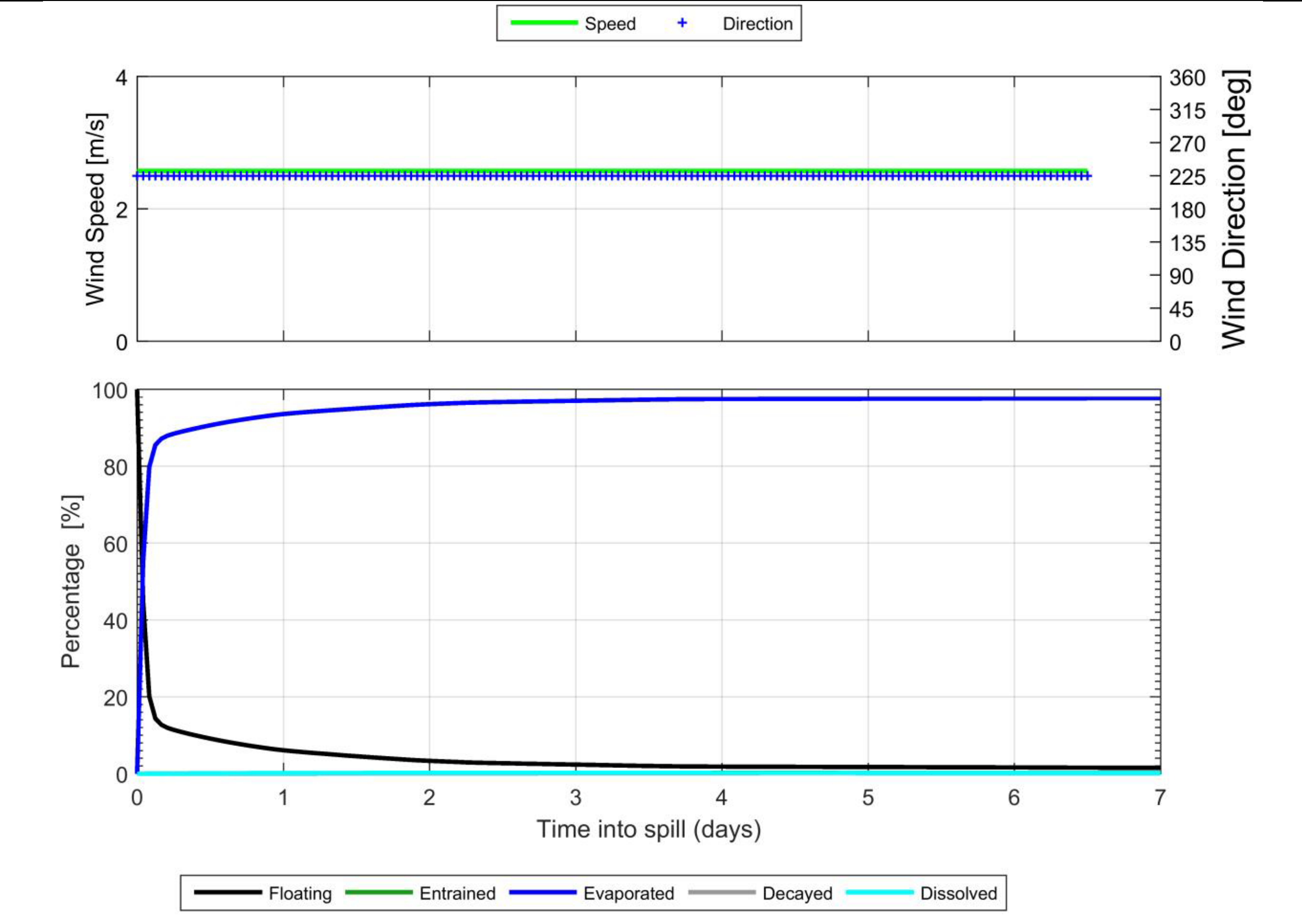


Figure 6-2: Time series wind speed and percentage mass balance plots for the weathering of Pyxis condensate (subsea) spilled into the water column as a one-off release and subject to a constant 5 kn (2.6 m/s) wind at 27 °C water temperature and 25 °C air temperature

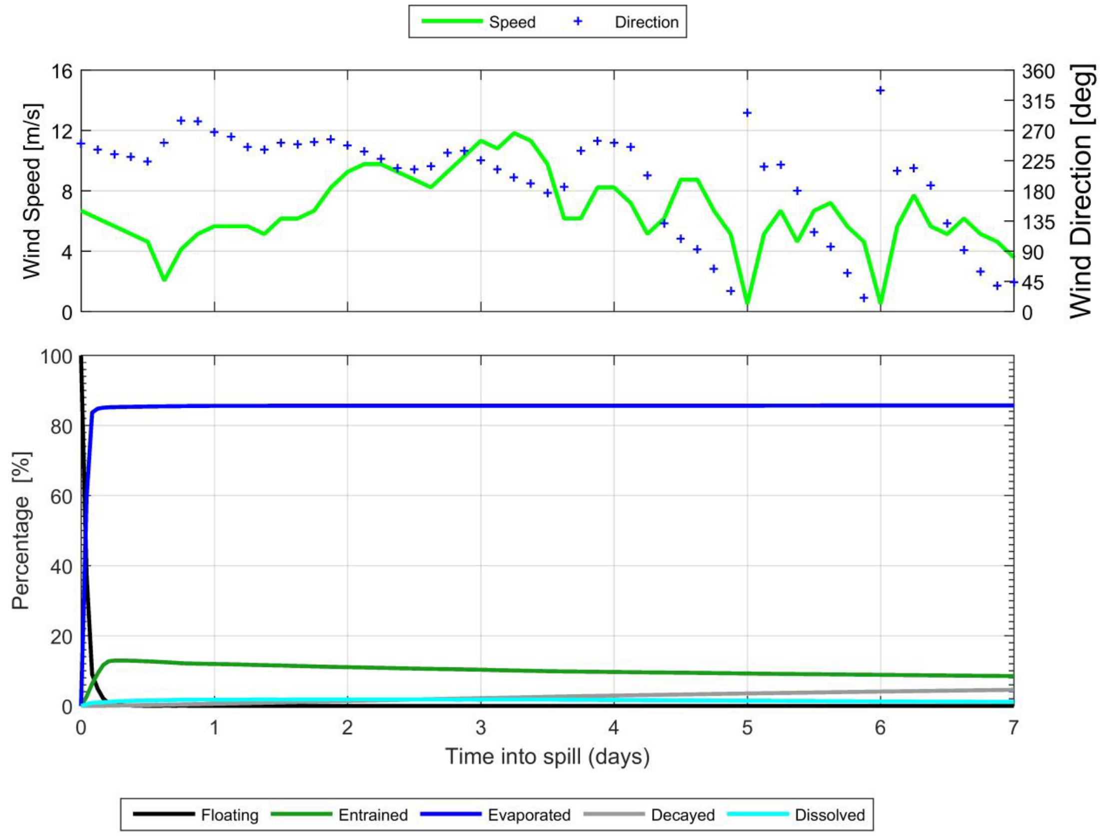


Figure 6-3: Time series wind speed and percentage mass balance plots for the weathering of Pyxis condensate (subsea) spilled onto the water column as a one-off release and subject to variable wind at 27 °C water temperature and 25 °C air temperature

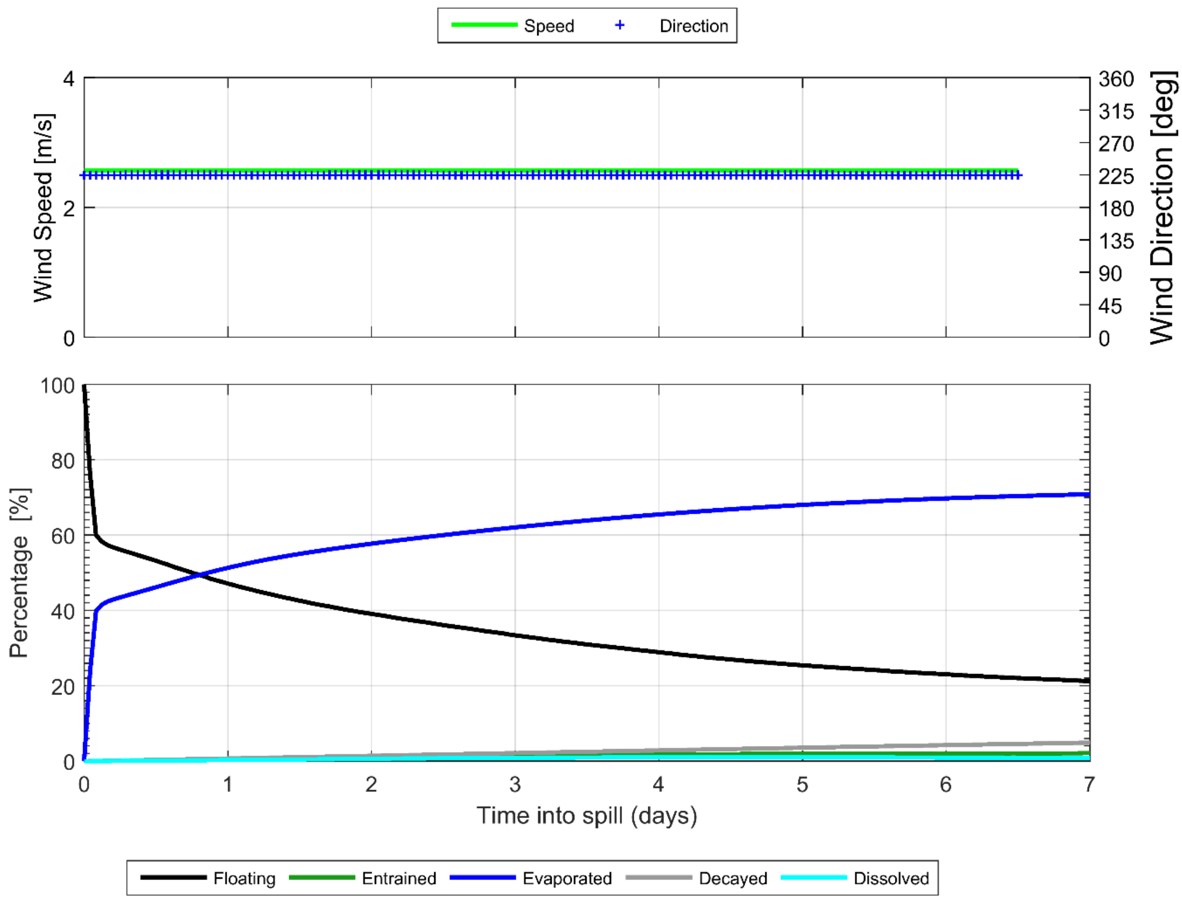


Figure 6-4: Time series wind speed and percentage mass balance plots for the weathering of Pyxis condensate (surface) spilled into the water column as a one-off release and subject to a constant 5 kn (2.6 m/s) wind at 27°C water temperature and 25 °C air temperature

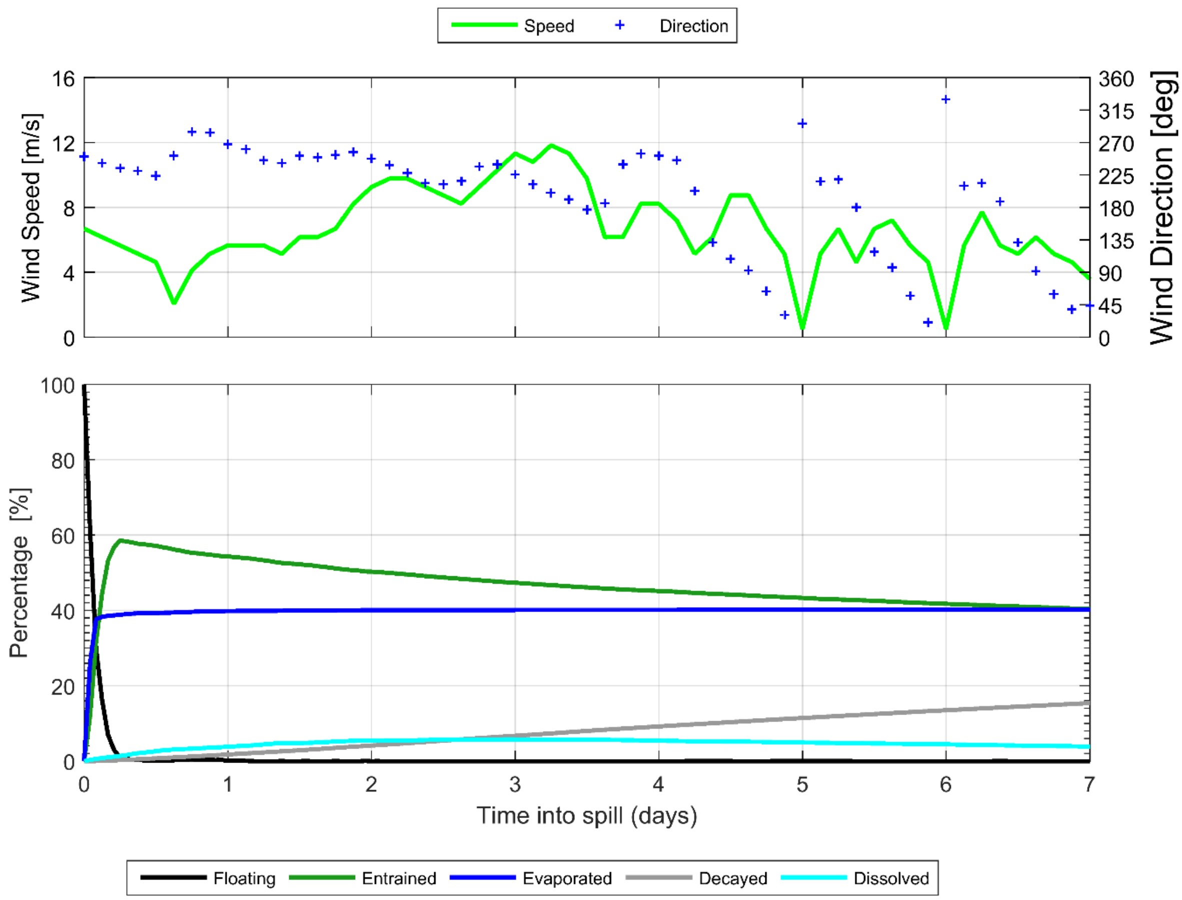


Figure 6-5: Time series wind speed and percentage mass balance plots for the weathering of Pyxis condensate (surface) spilled onto the water column as a one-off release and subject to variable wind at 27 °C water temperature and 25 °C air temperature

Subsea Plume Dynamics

The well blowout surface/subsea release that has been modelled forecasts the size of the hydrocarbon droplets that would be released from the well, as determined by the OILMAP model. **Table 6-10** shows a summary of the results of the OILMAP modelling for the well blowout.

Table 6-10: Range of assumed inputs and range of calculated outputs, by OILMAP model for the surface/subsea well loss of containment

	Variable	Pyxis condensate
Assumed discharge	Release depth (m)	Surface (initial) 985 m (seabed release phase)
	Hydrocarbon temp (C°)	62 °C
	Gas:Oil ratio (scf/bbl)	~90,900
	Hydrocarbon flow rate (bbl/day)	12,898–292,762
	Diameter of exit hole (m)	0.314 m
Calculated gas plume dynamics	Plume radius (m)	179 (Week 1)–149 (Week 9)
	Plume trapping height (metres above the seabed)	694 (Week 1)–660 (Week 9)
Calculated droplet size distribution	Droplet size (minimum – maximum; µm)	55–263

The results of the OILMAP simulation predict that the discharge will generate a cone of rising gas that will entrain the oil droplets and ambient sea water, up to a trapping depth (where the gas plume becomes neutrally buoyant and its vertical velocity drops to zero) ranging from 694 m above the seabed in Week 1 to 660 m above the seabed in Week 9. The mixed plume is forecast to initially jet towards the water surface with a vertical velocity of around 4.4–4.8 m/s, gradually slowing and increasing in plume diameter as more ambient water is entrained. The radius of the central cone of rising water and oil at the neutral buoyancy point is predicted to be about 179 m in Week 1 and 149 m by Week 9.

The discharge velocity and turbulence generated by the expanding gas plume is predicted to generate oil droplet sizes between 56–263 µm. These droplets will be subject to mixing due to turbulence generated by the lateral displacement of the rising plume, as well as vertical mixing induced by wind and breaking waves. The largest droplets have the potential to reach the surface a few hours after the release, in the absence of turbulence or strong stratification of the water column. Floating slicks are likely to be formed under typical wind conditions.

The ongoing nature of the release combined with the potential for the plume to breach the water surface may present other hazards, including conditions that may lead to high local concentrations of atmospheric volatiles. These issues should be considered when evaluating the practicality of the response operations at or near the blowout site.

Impact Assessment

Potential Consequence 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 6.7.1**). The EMBA therefore covers a larger area than the area that would be affected during any one single spill event, and therefore represents the total extent of all the locations where hydrocarbon thresholds could be exceeded from all modelling runs. The trajectory of a single spill would have a considerably smaller footprint.

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 discussed for each fate.

Surface Hydrocarbons

Modelling of floating oil indicates that concentrations equal to or greater than the 10 g/m² threshold could potentially be found in the form of slicks, up to 30 km from the spill site. No receptors are predicted to be contacted by floating oil concentrations at the 10 g/m² threshold (biological/ecological impact).

Entrained Hydrocarbons ppb

Entrained oil at concentrations equal to or greater than the 100 ppb threshold is predicted to be found up to 138 km from the spill site. The Montebello Marine Park is the only receptor predicted to be contacted by entrained oil concentrations above the 500 ppb threshold (946 ppb) with a probability of 2%.

Dissolved Hydrocarbons

Dissolved aromatic hydrocarbons at concentrations equal to or greater than the 50 ppb threshold are predicted to be found up to 135 km from the spill site. None of the key receptors examined are predicted to be contacted by dissolved aromatic hydrocarbon concentrations at the 500 ppb threshold. The maximum dissolved aromatic hydrocarbon concentrations forecast for any receptor is predicted as 441 ppb at Montebello Marine Park.

Accumulated Hydrocarbons

Potential for accumulation of oil on shorelines is predicted to be low, with a maximum accumulated volume of 2 m³ forecast at the shoreline receptors: Ningaloo Coast Middle, Ningaloo Coast North and Pilbara Islands – Southern Island Group located more than 150 km from the Permit Area. A maximum local accumulated concentration on shorelines of 55 g/m² was forecast at the Pilbara Islands – Southern Island Group.

Summary of Potential Impacts

Table 6-12 presents the full extent of the EMBA, i.e. the sensitive receptors and their locations that may be exposed to condensate (surface, entrained, dissolved and accumulated) at or above the set threshold concentrations in the unlikely event of a major hydrocarbon release from a loss of well integrity during the Petroleum Activities Program. Details of these receptors are outlined in **Section 4**. The potential biological and ecological impacts of an unplanned condensate release as a result of a loss of well integrity during the Petroleum Activities Program are presented in the following sections.

Table 6-11: Environment that May Be Affected – Key receptor locations and sensitivities with the summary hydrocarbon spill contact for a 67 day blowout of condensate

Environmental setting	Location/name	Condensate EMBA	Environmental, Social, Cultural, Heritage and Economic aspects presented as per the Environmental Risk Definitions (Woodside's Risk Management Procedure (WM0000PG10055394))																													Hydrocarbon contact and fate (>1% probability) (Condensate)				
			Physical		*Biological*																							*Socio-economic and Cultural*								
			Water Quality	*Sediment Quality*	*Marine Primary Producers*			*Other Communities/Habitats*								*Protected Species*									*Other Species*											
			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)*	*Seasnakes*	*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 & Gas Infrastructure (topside and subsea)*	*Surface hydrocarbon (≥10 g/m²)*	*Surface hydrocarbon (1 to 10 g/m²)*	*Entrained hydrocarbon (≥100 ppb)*	*Dissolved aromatic hydrocarbon (≥50 ppb)*	*Accumulated hydrocarbons (>100 g/m²)*
Offshore[23]	Commonwealth waters	✓	✓	✓					✓		✓					✓	✓				✓	✓	✓	✓	✓		✓		✓		✓	✓	✓	✓	✓	
	Ningaloo AMP	✓	✓						✓		✓					✓	✓			✓		✓	✓	✓	✓	✓	✓		✓	✓					✓	
	Montebello AMP	✓	✓	✓	✓			✓	✓							✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓*				✓	✓	
	Gascoyne AMP	✓	✓	✓												✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓			✓	✓	
Sub-merged Shoals	Glomar Shoal	✓	✓	✓				✓			✓												✓		✓	✓	✓								✓	
	Rankin Bank	✓	✓	✓	✓			✓	✓		✓						✓				✓		✓		✓	✓	✓		✓					✓	✓	

[23] Note: hydrocarbons cannot accumulate on open ocean, submerged receptors, or receptors not fully emergent.

Summary of Potential Impacts to Environmental Value(s)	
The following summary of potential impacts considers the impacts of surface, entrained and dissolved hydrocarbon phases of condensate on receptors identified in **Table 6-12**.	
Summary of Potential Impacts to Protected Species	
Setting	***Receptor Group***
Offshore, Oceanic Reefs and Islands	***Cetaceans*** Cetaceans 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 (Deepwater Horizon 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 (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016). In a review of cetacean observations in relation to large scale hydrocarbon spills, it was concluded that exposure to oil from the *Deepwater Horizon* resulted in increased mortality to cetaceans in the Gulf of Mexico (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016), and long-term population level impacts to killer whales have been linked to the *Exxon Valdez* tanker spill (Matkin et al., 2008). Geraci (1988) also identified behavioural disturbance (i.e. avoiding spilled hydrocarbons) observed in some instances for several species of cetacean, which suggests 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 *Deepwater Horizon* spill, cetaceans were routinely seen swimming in surface slicks offshore (and nearshore) (Aichinger Dias et al., 2017). A range of cetaceans were identified as potentially occurring within the Permit Area and wider EMBA (**Section 4.5.2**). In the event of a loss of well containment, surface, entrained and dissolved hydrocarbons exceeding environmental impact threshold concentrations may drift across habitat for oceanic cetacean species and the migratory routes and BIAs of cetaceans considered to be MNES (**Section 4.5.2**), including humpback whales and pygmy blue whales (northbound and southbound migrations). The BIAs for both these species overlap the EMBA and the pygmy blue whale BIA also overlaps the Permit Area. Cetacean populations that are resident within the EMBA may be susceptible to impacts from spilled hydrocarbons if they interact with an area affected by a spill. Such species are more likely to occupy coastal waters (refer to the Mainland and Islands section below for additional information). Suitable habitat for oceanic toothed whales (e.g. sperm whales) and dolphins (e.g. Indo-Pacific humpback dolphin and spotted bottlenose dolphin) is broadly distributed throughout the region, and as such, impacts are unlikely to affect an entire population. Other species identified in **Section 4.5.2.2** may also have possible transient interactions with the EMBA. Physical contact with hydrocarbons to these species is likely to have biological consequences; however, it is unlikely to affect an entire population and not predicted to impact on the overall population viability. Given the nature of the hydrocarbon, it is expected to weather rapidly and remain entrained in the water column; cetaceans that may interact with spilled hydrocarbons are most likely to be subject to physical impacts. Given cetaceans maintain thick skin and blubber, external exposure to hydrocarbons may result in irritation to skin and eyes. Entrained hydrocarbons may also be ingested, particularly by baleen whales which feed by filtering large volumes of water. Fresh hydrocarbons (i.e. typically in the vicinity of the release location) may have a higher potential to cause toxic effects when ingested, while weathered hydrocarbons are considered to be less likely to result in toxic effects. A major spill in July to December would coincide with humpback whale migration through the waters off the Pilbara, North West Cape and Shark Bay (**Figure 4-10**). A major spill in April to August or October to January would coincide with pygmy blue whale migration. Double et al. (2014) suggest that pygmy blue whales migrate in offshore waters in about 200–1000 m of water (**Figure 4-10**). Both pygmy blue and humpback whales are baleen whales, and hence, are most likely to be significantly impacted by toxic effects when feeding. However, feeding during migrations is low level and opportunistic, with most feeding for both species in the Southern Ocean. As such, the risk of ingestion of hydrocarbons is low. Migrations of both pygmy blue whales and humpback whales are protracted through time and space (i.e. the whole population will not be within the EMBA), and as such, a spill from the loss of well containment is unlikely to affect an entire population. The humpback whale resting area in Exmouth Gulf and the calving area in Camden Sound are not predicted to be contacted by surface, entrained or dissolved hydrocarbons above threshold concentrations. A loss of well containment resulting in a well blowout could result in a disruption to a significant portion of the humpback or pygmy blue whale populations, if the event occurred during the seasonal migration periods during which these species are present in 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, reproductive failure) and, in rare circumstances, death. However, such disruptions or impacts are not predicted to impact on the overall population viability.
	Marine Turtles Adult sea turtles exhibit no avoidance behaviour when they encounter hydrocarbon spills (NOAA, 2010). Contact with entrained (or floating) hydrocarbon can 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). Given the modelling results indicated concentrations of floating hydrocarbons are not expected to exceed impact thresholds except immediately surrounding the offshore waters around the well, the potential for contact with this hydrocarbon phase is very low. 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 vapour which is 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 (Gagnon and Rawson, 2010) causing irritation of mucous membranes in the nose, throat and eyes leading to inflammation and infection (Gagnon and Rawson, 2010). Given the hydrocarbon is expected to weather rapidly when released to the environment, relatively fresh entrained hydrocarbons (which are typically relatively close to the release location) are considered to have the greatest potential for impact. Due to the absence of potential nesting habitat and offshore location, the Permit Area is unlikely to represent important habitat for marine turtles. It is, however, acknowledged that marine turtles may be present foraging within the EMBA, and the EMBA would overlap with the internesting BIAs identified in **Section 4.5.2**, particularly the internesting BIA for flatback turtles around the Montebello Islands which extend for about 80 km from known nesting locations. It is noted that the Petroleum Activities Program will coincide with nesting season for marine turtles in the region. In the event of a loss of well containment, there is potential that surface, entrained and dissolved hydrocarbons exceeding environmental impact threshold concentrations will be present in offshore waters. Therefore, a hydrocarbon spill may disrupt a portion of the population, but is unlikely to reduce overall population viability.
	Seasnakes Impacts to seasnakes from direct contact with hydrocarbons are likely to result in similar physical effects to those recorded for marine turtles and may include potential damage to the dermis and irritation to mucus membranes of the eyes, nose and throat (International Tanker Owners Pollution Federation, 2011). They may also be impacted when they return to the surface to breathe and inhale the toxic vapours associated with the hydrocarbons, resulting in damage to their respiratory system. Given modelling indicated floating hydrocarbons are not expected to exceed impact thresholds, the potential for seasnakes to be exposed to floating hydrocarbons is considered to be very low. In general, seasnakes frequent the waters of the continental shelf area around offshore islands and potentially submerged shoals. It is acknowledged that seasnakes may be present in the wider EMBA, particularly in waters less than 100 m deep of the Montebello AMP and near submerged shoals; however, their abundance is not expected to be high in the deep water and offshore environment. Therefore, a hydrocarbon spill may have a minor disruption to a portion of the population but there is not considered to be a threat to overall population viability.
	Sharks and Rays Hydrocarbon contact may affect whale sharks through ingestion (entrained/dissolved hydrocarbons), particularly if feeding. Whale sharks may transit offshore open waters when migrating to and from Ningaloo Reef, where they aggregate for feeding from March to July. A whale shark foraging BIA overlaps the Permit Area and wider EMBA (**Section 4.5.2**). Whale sharks are versatile feeders, filtering large amounts of water over their gills, catching planktonic and nektonic organisms (Jarman and Wilson, 2004). Therefore, individual whale sharks that have direct contact with hydrocarbons within the spill affected area may be impacted. 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). As gill breathing organisms, sharks and rays may be vulnerable to toxic effects of dissolved hydrocarbons (entering the body via the gills) and entrained hydrocarbons (coating of the gills inhibiting gas

	exchange). Pelagic sharks are highly mobile and unlikely to be exposed to hydrocarbons for long periods of time. Therefore, any impact on sharks and rays is predicted to be minor and localised.
	Seabirds and Migratory Shorebirds Seabirds and migratory birds are particularly vulnerable to contact with floating hydrocarbons, which may mat feathers. This may lead to hypothermia from loss of insulation and ingestion of hydrocarbons when preening to remove hydrocarbons; both impacts may result in mortality (Hassan and Javed, 2011). The credible loss of well containment scenario results in highly localised floating hydrocarbons above impact thresholds only around the release location. Hence, considering the distance to any emergent features, the potential for seabird exposure to floating hydrocarbons is considered to be low. Migratory shorebirds are unlikely to interact with spilled hydrocarbons as there would be no accumulation on shorelines above impact thresholds. Offshore waters are potential foraging grounds for seabirds associated with the coastal roosting and nesting habitat, which includes the numerous islands along the Pilbara coast. There are four BIAs for seabirds and migratory shorebirds that overlap with the wider EMBA, as provided in **Section 4.5.2**. However, given the relatively low likelihood of encounters between seabirds and floating hydrocarbons, impacts to seabirds in offshore waters are expected to consist of ecosystem-scale effects, such as reduced prey abundance. Impacts from a loss of well containment to prey such as small pelagic fish (prey for the birds) are not expected to be significant; hence, subsequent impacts to a significant portion of seabirds are not expected. A hydrocarbon spill is unlikely to result in the disruption of a significant portion of the foraging habitat for seabirds.
Submerged Shoals	***Marine Turtles*** There is the potential for marine turtles to be present at submerged shoals such as Rankin Bank and Glomar Shoal. These shoals may be contacted by dissolved and entrained (Rankin Bank only) hydrocarbons above impact thresholds. However, it is noted that entrained hydrocarbons reaching these shoals will be highly weathered, with the volatile and water soluble (often the most toxic) components expected to have dissipated (minimum time to contact with entrained hydrocarbons is predicted to be three days for Rankin Bank). These shoals and banks may, at times, be a foraging habitat for marine turtles, given the coral and filter feeding biota associated with these areas. However, these areas are not known foraging locations and satellite tracking of individual green turtles in the nearshore environment of the NWS did not indicate any overlap of the tracked post-nesting migratory routes and the Permit Area. It is, however, acknowledged that individual marine turtles may be present at these shoals and surrounding areas. However, given the predicted minimum time to contact and the volatile and non-persistent nature of the hydrocarbons, a hydrocarbon spill is expected to result in sub-lethal effects with a minor disruption to a portion of the population (see Offshore section above). There is the potential for marine turtles to be present within the shallower waters of the Montebello AMP, including around Tryal Rocks located at the eastern end of the EMBA for entrained hydrocarbons (**Section 4.7.1.1**). The potential impacts of exposure are as discussed previously in Offshore – Marine Turtles.
	Seasnakes There is the potential for seasnakes to be present at submerged shoals such as Rankin Bank and Glomar Shoal, and within the shallower waters of the Montebello AMP, particularly around Tryal Rocks located at the eastern end of the EMBA for entrained hydrocarbons. The potential impacts of exposure are as discussed previously in Offshore – Seasnakes. A hydrocarbon spill may have a minor disruption to a portion of the population but there is no threat to overall population viability.
	Sharks and Rays There is the potential for resident shark and ray populations to be impacted directly from hydrocarbon contact or indirectly through contaminated prey or loss of habitat. Spill model results indicate potential impacts to shallow waters of the Montebello AMP, including around Tryal Rocks, and to the communities of Rankin Bank and Glomar Shoal, which may host shark and ray populations. Sharks and rays present at these reefs may be exposed to fresh, unweathered hydrocarbons, which may have greater potential for toxic impacts. Any direct impacts are expected to be sub-lethal; however, no impacts at the population level. Pelagic sharks and rays are expected to move away from areas affected by spilled hydrocarbons. Impacts to such species are expected to be limited to behavioural responses/displacement. Shark and ray species that have associations with submerged shoals and oceanic atolls may not move in response to such habitat being contacted by spilled hydrocarbons. Such species may be more susceptible to a reduction in habitat quality resulting from a hydrocarbon spill. Impacts to sharks and rays at Tryal Rocks, Rankin Bank and Glomar Shoal are likely to be localised as surface hydrocarbons above the 10 g/m^2

	threshold are not expected to reach these areas and entrained/dissolved hydrocarbons will have experienced considerable weathering (minimum time to contact with entrained hydrocarbons is predicted to be three days for Rankin Bank). It is expected that there will be no impacts at the population level.
Mainland and Islands (Nearshore Waters)	Based on the modelling, floating, shoreline accumulation, dissolved and entrained oil is unlikely to reach any nearshore receptors at the impact thresholds. The EMBA overlaps with the Montebello AMP, Ningaloo AMP and Gascoyne AMP. However, the EMBA boundary is over 4 km from the nearest island (Airlie Island), 8 km from the next nearest islands (Bessieres and Thevenard Islands) and 11 km away from the mainland (nearest to the North West Cape). Therefore, nearshore waters are unlikely to be affected above impact thresholds.

Summary of Potential Impacts to Other Species	
Setting	***Receptor Group***
All Settings	***Pelagic and Demersal Fish*** Fish mortalities are rarely observed to occur as a result of hydrocarbon spills (International Tanker Owners Pollution Federation, 2011). This has generally been attributed to the possibility that pelagic fish are able to detect and avoid surface waters underneath hydrocarbon spills by swimming into deeper water or away from the affected areas. Fish that have been exposed to dissolved aromatic hydrocarbons are capable of eliminating the toxicants once placed in clean water, hence individuals exposed to a spill are likely to recover (King et al., 1996). Where fish mortalities have been recorded, the spills (resulting from the groundings of the tankers *Amoco Cadiz* in 1978 and the *Florida* in 1969) have occurred in sheltered bays. Laboratory studies have shown that adult fish are able to detect hydrocarbons in water at very low concentrations, and large numbers of dead fish have rarely been reported after oil spills (Hjermann et al., 2007). This suggests that juvenile and adult fish are capable of avoiding water contaminated with high concentrations of hydrocarbons. However, sub-lethal impacts to adult and juvenile fish may be possible, given long-term exposure (days to weeks) to polycyclic aromatic hydrocarbons (PAH) concentrations (Hjermann et al., 2007). While modelling of the loss of well containment indicates the potential EMBA for dissolved hydrocarbons is extensive, no time-integrated exposure metrics were modelled; given the oceanographic environment within the wider EMBA, PAH exposures in the order of weeks for pelagic fish are not considered credible. The effects of exposure to oil on the metabolism of fish appears to vary according to the organs involved, exposure concentrations and route of exposure (waterborne or food intake). Oil reduces the aerobic capacity of fish exposed to aromatics in the water and to a lesser extent affects fish consuming contaminated food (Cohen et al., 2005). The liver, a major detoxification organ, appears to be the organ where anaerobic activity is most impacted, probably increasing anaerobic activity to facilitate the elimination of ingested oil from the fish (Cohen et al., 2005). Fish are perhaps most susceptible to the effects of spilled oil in their early life stages, particularly during egg and planktonic larval stages, which can become entrained in spilled oil. Contact with oil droplets can mechanically damage feeding and breathing apparatus of embryos and larvae (Fodrie and Heck, 2011). The toxic hydrocarbons in water can result in genetic damage, physical deformities and altered developmental timing for larvae and eggs exposed to even low concentrations over prolonged timeframes (days to weeks) (Fodrie and Heck, 2011). More subtle, chronic effects on the life history of fish as a result of exposure of early life stages to hydrocarbons include disruption to complex behaviour such as predator avoidance, reproductive and social behaviour (Hjermann et al., 2007). Prolonged exposure of eggs and larvae to weathered concentrations of hydrocarbons in water has also been shown to cause immunosuppression and allows expression of viral diseases (Hjermann et al., 2007). PAHs have also been linked to increased mortality and stunted growth rates of early life history (pre-settlement) of reef fishes, as well as behavioural impacts that may increase predation of post-settlement larvae (Johansen et al., 2017). However, the effect of a hydrocarbon spill on a population of fish in an area with fish larvae and/or eggs, and the extent to which any of the adverse impacts may occur, depends greatly on prevailing oceanographic and ecological conditions at the time of the spill and its contact with fish eggs or larvae. Demersal fish species are associated with the Continental Slope Demersal Fish Communities KEF, Ancient Coastline at 125 m Depth Contour KEF and the Montebello AMP which overlap the EMBA (the KEFs also overlap or are in immediate proximity to the Permit Area) and provide habitat for demersal fish species. Rankin Bank (about 25 km from the Operational Area) also hosts a diverse demersal fish assemblage. Fish associated with these features may be exposed to dissolved and entrained hydrocarbons above impact thresholds. Mortality and sub-lethal effects may impact populations located close to the well blowout and within the EMBA for entrained/dissolved aromatic hydrocarbons (≥100 ppb and 50 ppb respectively). Additionally, if prey (infauna and epifauna) surrounding the well location and within the EMBA is contaminated, this can result in the absorption of toxic components of the hydrocarbons (PAHs) potentially impacting fish populations that feed on these. These impacts may result in localised medium/long term impacts on demersal fish habitat, e.g. seafloor.

Summary of Potential Impacts to Marine Primary Producers	
Setting	***Receptor Group***
Oceanic Reef and Offshore Islands	The waters overlying the Montebello AMP have low potential (15% probability) to be exposed to entrained and dissolved hydrocarbons above threshold concentrations (>100 ppb) within a relatively short space of time after a loss of well containment (53 hours). This permanently submerged habitat represents sensitive oceanic reef benthic community receptors, extending from deep depths (150 m) to relatively shallow water (15 m). The EMBA would only extend to the deeper depths of the AMP with the exception of the areas around Tryal Rocks. Given the depth of the AMP, it is likely the potential for biological impact is reduced when compared to the upper water column layers. The waters overlying the Gascoyne AMP also have low potential (5% probability) to be exposed to entrained hydrocarbons above threshold concentrations (>100 ppb) within eight days. Contact at or above entrained and dissolved thresholds is predicted, based on modelling, resulting in potential biological impacts including sub-lethal stress and, in some instances, total or partial mortality of sensitive benthic organisms such as corals and the early life stages of resident fish and invertebrate species. No other submerged shoals or any offshore islands within the wider EMBA are predicted to be exposed to entrained or dissolved hydrocarbons above threshold concentrations.
Submerged Shoals	The waters overlying the submerged Rankin Bank and Glomar Shoals have the potential to be exposed to dissolved hydrocarbons above threshold concentrations (at or greater than 50 ppb) and Rankin Bank has the potential to be exposed to entrained hydrocarbons above threshold concentrations (at or greater than 100 ppb). Entrained hydrocarbons reaching these shoals will be highly weathered, with the volatile and water soluble (often the most toxic) components expected to have dissipated (minimum time to contact with entrained hydrocarbons is predicted to be 3 days for Rankin Bank). The permanently submerged habitats of Rankin Bank, Glomar Shoals and Rowley Shoals represent sensitive open water benthic community receptors, extending from deep depths to relatively shallow water. Given the depths of these habitats, it is likely the potential for biological impact is significantly reduced when compared to the upper water column layers. However, potential biological impacts could include sub-lethal stress and in some instances total or partial mortality of sensitive benthic organisms such as corals and the early life stages of resident fish and invertebrate species. The submerged shoals are areas associated with sporadic upwelling and associated primary productivity events. Impacts to plankton communities from exposure to entrained hydrocarbons above threshold concentrations may result in short-term changes in plankton community composition but recovery would occur. Hydrocarbon contact during the spawning seasons for resident shoal community benthos and fish (meroplankton), particularly exposure to in water toxicity effects to biota, may result in the loss of a discrete cohort population but would not affect the longer term viability of resident populations. Therefore, any impacts to resident shoal community benthos and fish (meroplankton) are likely to be localised at the shoals and temporary. Hydrocarbon exposure to offshore filter-feeding communities may occur depending on the depth of the entrained/dissolved hydrocarbons. Exposure to entrained (aromatic) hydrocarbons (≥50 ppb) has potential to result in lethal or sub-lethal toxic effects. Sub-lethal impacts, including mucus production and polyp retraction, have been recorded for gorgonians exposed to hydrocarbon (White et al., 2012). Shoals that are exposed to entrained and/or dissolved hydrocarbons are expected to result in localised long-term effects, depending on the exposure concentrations and degree of weathering. ***Filter Feeders*** Hydrocarbon exposure to offshore filter-feeding communities (e.g. communities within the Montebello AMP where depths range between 15 m and 150 m) may occur depending on the depth of the entrained/dissolved hydrocarbons. Exposure to entrained hydrocarbons/dissolved aromatic hydrocarbons (≥100 ppb and 50 ppb respectively) has potential to result in lethal or sub-lethal toxic effects. Sub-lethal impacts, including mucus production and polyp retraction, have been recorded for gorgonians exposed to hydrocarbon (White et al., 2012). Any impacts may result in localised long-term effects to community structure and habitat.
Mainland and Islands (Nearshore Waters)	Based on the modelling, floating, dissolved and entrained oil is unlikely to reach any nearshore receptors at the impact thresholds. The EMBA overlaps with the Montebello AMP, Ningaloo AMP and Gascoyne AMP. However, the EMBA boundary is over 4 km from the nearest island (Airlie Island), 8 km from the next nearest islands (Bessieres and Thevenard Islands) and 11 km away from the mainland (nearest to the North West Cape). Therefore, nearshore waters are unlikely to be affected above impact thresholds. Shoreline accumulation at any receptors above impact thresholds is also very unlikely.

Summary of Potential Impacts to Other Habitats and Communities	
Setting	***Receptor Group***
Offshore	***Benthic Fauna Communities*** In the event of a loss of well containment at the seabed, the stochastic spill model predicted hydrocarbons droplets would be entrained in a gas plume, transporting them to the water column and sea surface. As a result, the low sensitivity benthic communities associated with the unconsolidated, soft sediment habitat and any epifauna (filter feeders) within and outside the Permit Area are not expected to be exposed to released hydrocarbons. A localised area relating to the hydrocarbon plume at the point of release is predicted, which would result in a small area of seabed and associated epifauna and infauna exposed to hydrocarbons.
	Open Water – Productivity/Upwelling Primary production by plankton (supported by sporadic upwelling events in the offshore waters of the North West Shelf) is an important component of the primary marine food web. Planktonic communities are generally mixed including phytoplankton (cyanobacteria and other microalgae) and secondary consuming zooplankton, such as crustaceans (e.g. copepods), and the eggs and larvae of fish and invertebrates (meroplankton). Exposure to hydrocarbons in the water column can result in changes in species composition with declines or increases in one or more species or taxonomic groups (Batten et al., 1998). Phytoplankton may also experience decreased rates of photosynthesis (Tomajka, 1985). For zooplankton, direct effects of contamination may include toxicity, suffocation, changes in behaviour, or environmental changes that make them more susceptible to predation. Impacts on plankton communities are likely to occur in areas where entrained or dissolved aromatic hydrocarbon threshold concentrations are exceeded, but communities are expected to recover relatively quickly (within weeks or months). This is due to high population turnover with copious production within short generation times that also buffers the potential for long-term (i.e. years) population declines (International Tanker Owners Pollution Federation, 2011). Therefore, impacts on exposed planktonic communities present in the EMBA are likely to be short-term.
Islands and Mainland (Nearshore Waters)	Based on the modelling, floating, dissolved and entrained oil is unlikely to reach any nearshore receptors at the impact thresholds. The EMBA overlaps with the Montebello AMP, Ningaloo AMP and Gascoyne AMP. However, the EMBA boundary is over 4 km from the nearest island (Airlie Island), 8 km from the next nearest islands (Bessieres and Thevenard Islands) and 11 km away from the mainland (nearest to the North West Cape). Therefore, nearshore waters are unlikely to be affected above impact thresholds. Shoreline accumulation at any receptors above impact thresholds is also very unlikely.
Key Ecological Features	***Key Ecological Features*** Potentially impacted by the hydrocarbon spill above impact thresholds from a loss of well containment event are the following KEFs: • Ancient Coastline at 125 m Depth Contour • Continental Slope Demersal Fish Communities • Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula • Commonwealth waters adjacent to Ningaloo Reef • Exmouth Plateau • Glomar Shoals. Although these KEFs are primarily defined by seabed geomorphological features, they are described to identify the potential for increased biological productivity and, therefore, ecological significance. The consequences of a hydrocarbon spill from a loss of well containment may impact the values of the KEFs affected (for the values of each KEF see **Section 4.7**). Potential impacts include the contamination of sediments, impacts to benthic fauna/habitats and associated impacts to demersal fish populations and reduced biodiversity as described above and below. Most of the KEFs within the EMBA have relatively broad-scale distributions and are unlikely to be significantly impacted.
Summary of Potential Impacts to Water Quality	
Setting	***Aspect***
Offshore	***Open Water – 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 entrained and dissolved hydrocarbon fates and their predicted extent. 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.
Submerged Shoals	***Open Water – Water Quality*** Water quality would be reduced due to hydrocarbon contamination that is predicted to be at or above biological effect concentrations for the surrounding marine waters over the Montebello AMP (Tryal Rocks), Gascoyne AMP, Rankin back and Glomar Shoal, have the potential to be exposed to entrained hydrocarbons at or greater than 100 ppb and/or dissolved hydrocarbons at greater than 50 ppb. Entrained hydrocarbons reaching Rankin Bank will be highly weathered, with the volatile and water soluble (often the most toxic) components expected to have dissipated (minimum time to contact with entrained hydrocarbons is predicted to be three days). The waters surrounding these submerged habitats would show a reduction in quality due to hydrocarbon contamination above background and/or national/international quality standards.
Mainland and Islands (Nearshore Waters)	Based on the modelling, floating, dissolved and entrained oil is unlikely to reach any nearshore receptors at the impact thresholds. The EMBA overlaps with the Montebello AMP, Ningaloo AMP and Gascoyne AMP. However, the EMBA boundary is over 4 km from the nearest island (Airlie Island), 8 km from the next nearest islands (Bessieres and Thevenard Islands) and 11 km away from the mainland (nearest to the North West Cape). Therefore, nearshore waters are unlikely to be affected above impact thresholds. Shoreline accumulation at any receptors above impact thresholds is also very unlikely.
Summary of Potential Impacts to Marine Sediment Quality	
Setting	***Receptor Group***
Offshore	In the event of a major hydrocarbon release at the seabed, modelling indicates that a pressurised release of condensate would atomise into droplets that would be rapidly transported into the water column to the surface. As a result, the extent of potential impacts to the seabed area at and surrounding the release site would be confined to a localised footprint. Marine sediment quality would be reduced (contamination above national/international quality standards) as a consequence of hydrocarbon contamination for a small area within the immediate release site for a long to medium term.
Submerged Shoals	There is potential for the reduction of marine sediment quality due to contact and adherence of entrained hydrocarbons with seabed sediments of submerged shoals (Tryal Rocks of the Montebello AMP, Gasoyne AMP and Rankin Bank). If this was to occur, marine sediment quality would be reduced (contamination above national/international quality standards) as a consequence of hydrocarbon contamination for a small area within the immediate release site for a long to medium term. However, given the nature of the hydrocarbon, contact with submerged shoals is considered unlikely.
Mainland and Islands (Nearshore Waters)	Based on the modelling, floating, dissolved and entrained oil is unlikely to reach any nearshore receptors at the impact thresholds. The EMBA overlaps with the Montebello AMP, Ningaloo AMP and Gascoyne AMP. However, the EMBA boundary is over 4 km from the nearest island (Airlie Island), 8 km from the next nearest islands (Bessieres and Thevenard Islands) and 11 km away from the mainland (nearest to the North West Cape). Therefore, nearshore waters are unlikely to be affected above impact thresholds. Shoreline accumulation at any receptors above impact thresholds is also very unlikely.
Summary of Potential Impacts to Air Quality	
A hydrocarbon release during a loss of well containment event has the potential to result in localised, temporary reduction in air quality. Potential impacts are expected to be a slight and temporary localised effect to ecosystems, species and/or habitats in the area. There is potential for human health effects for workers in the immediate vicinity of atmospheric emissions. The ambient concentrations of methane and volatile organic carbons released from diffuse sources is difficult to accurately quantify, although their behaviour and fate is predictable in open offshore environments as it is dispersed rapidly by meteorological factors such as wind and temperature. Methane and VOC emissions from a hydrocarbon release in such environments are rapidly degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals. Due to the unlikely occurrence of a loss of well containment; the temporary nature of any methane or VOC emissions (from either gas surfacing or weathering of liquid hydrocarbons from a loss of well containment); the predicted behaviour and fate of methane and VOCs in open offshore environments; and the significant distance from the Permit Area to the nearest shore (50 km from Montebello Island), the potential impacts are expected to be minor and temporary.	
Summary of Potential Impacts to Protected Areas	
The quantitative spill risk assessment results indicate that the open water environment protected within the Montebello AMP and Gascoyne AMP, may be affected by the released hydrocarbons. In most cases, the hydrocarbons that are	

predicted to reach these protected areas will be in an advanced state of weathering and at concentrations typically associated with lethal and sub-lethal impacts to only the most sensitive marine organisms. Conservation values for these AMPs and other nearby State marine parks and reserves, which won't be impacted above impact thresholds, are provided in **Section 4.7.1**.

Impact on the protected areas is discussed in the sections above for the ecological values and sensitivities and below for socio-economic 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 biologically diverse environments.

Summary of Potential Impacts to Socio-economic Values	
Setting	***Receptor Group***
Offshore	***Fisheries – Commercial*** Spill scenarios modelled are unlikely to cause significant direct impacts on the target species of Commonwealth and offshore State fisheries within the defined EMBA. Further details are provided below with impact assessment relating to spawning discussed above under 'Summary of Potential Impacts to Other Habitats and Communities'. 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 major spill would result in the establishment of a Petroleum Safety 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. Additionally, hydrocarbons can foul fishing equipment such as traps and trawl nets, requiring cleaning or replacement. Of the four Commonwealth fisheries and nine State fisheries, the majority have either had no or limited fishing effort concentrated within the Permit Area (**Table 4-9**).
	Tourism including Recreational Activities Recreational fishers predominantly target tropical species, such as emperor, snapper, grouper, mackerel, trevally and other game fish. Recreational angling activities include shore-based fishing, private boat and charter boat fishing, with the peak in activity between April and October (Smallwood et al., 2011). Limited recreational fishing takes place in the offshore waters of the Permit Area due to the distance from shore; however, fishing may take place within the offshore waters of the Montebello AMP. Impacts on species that are recreationally fished are described above and under 'Summary of Potential Impacts to Other Species' above. A major loss of hydrocarbon from the Petroleum Activities Program may lead to exclusion of marine nature-based tourist activities, resulting in a loss of revenue for operators.
	Offshore Oil and Gas Infrastructure In the unlikely event of a major spill, surface hydrocarbons may affect production from existing petroleum facilities (platforms and FPSOs). For example, facility water intakes for cooling and fire hydrants could be shut off which could in turn lead to the temporary cessation of production activities. Spill exclusion zones established to manage the spill could also prohibit activity support vessel access as well as tankers approaching facilities on the North West Shelf. The impact on ongoing operations of regional production facilities would be determined by the nature and scale of the spill and metocean conditions. Furthermore, decisions on the operation of production facilities in the event of a spill would be based primarily on health and safety considerations. The closest oil and gas operations are the Pluto and Wheatstone platforms 15 km to the east of the Permit Area (**Section 4.6.7**). Operation of these facilities is likely to be affected in the event of a worst-case loss of well containment.
Submerged Shoals	***Tourism and Recreation*** In the unlikely event of a major spill, a temporary prohibition on charter boat recreational fishing trips and any other marine nature-based tourism trips to the Montebello AMP may be put into effect, depending on the trajectory of the plume, resulting in a loss of revenue for operators.
Mainland and Islands (Nearshore Waters)	Based on the modelling, floating, dissolved and entrained oil is unlikely to reach any nearshore receptors at the impact thresholds. The EMBA overlaps with the Montebello AMP, Ningaloo AMP, Ningaloo World Heritage Area and Gascoyne AMP. Less than 1% of the Ningaloo World Heritage Area overlaps the EMBA. In addition, the EMBA boundary is over 4 km from the nearest island (Airlie Island),

	8 km from the next nearest islands (Bessieres and Thevenard Islands) and 11 km away from the mainland (nearest to the North West Cape). Therefore, nearshore waters are unlikely to be affected above impact thresholds. Shoreline accumulation at any receptors above impact thresholds is also very unlikely.

Summary of Potential Impacts to Environmental Value(s)
In the unlikely event of a major hydrocarbon spill due to a loss of well integrity, the EMBA includes the areas listed in **Table 4-11**, including the sensitive offshore marine environments and associated receptors of the Montebello AMP, Gascoyne AMP, Rankin Bank and Glomar Shoals. In summary, long term impacts may occur at sensitive submerged shoals, Rankin Bank and Glomar Shoals, as a result of a major spill of hydrocarbon from drilling activities within the Permit Area. The overall environmental consequence is defined as B 'Major, long term impact (10–50 years) on highly valued ecosystem, species, habitat, physical or biological attributes' (**Table 2-3**). The likelihood of the event is defined as 2 'Unlikely' resulting in a risk ranking of high.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)*** [24]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011: accepted Well Operations Management Plan (WOMP), which describes the well design and barriers to be used to prevent a loss of well integrity, specifically: • all permeable zones penetrated by the well bore, containing hydrocarbons or over-pressured water, shall be isolated from the surface environment by a minimum of two barriers (primary and secondary) (a single fluid barrier may be implemented during the initial stages of well construction if appropriateness is confirmed by a shallow hazard study) • discrete hydrocarbon zones shall be isolated from each other (to prevent cross flow) by a minimum of one barrier where deemed required • all normally pressured permeable water-bearing formations shall be isolated from the surface	F: Yes. CS: Minimal cost. Standard practice.	Compliance with an accepted WOMP will ensure a number of barriers are in place and verified, reducing the likelihood of loss of well integrity event occurring. Although the consequence of a blowout would not be reduced, the reduction in likelihood reduces the overall risk.	Benefits outweigh cost/sacrifice.	Yes **C 11.1**

[24] Qualitative measure.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)*** [24]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
by a minimum of one barrier. The barriers shall: • be effective over the lifetime of well construction. • Fluid barriers shall remain monitored and provide sufficient pressure to counter pore pressure during well construction. • Cementing barriers (including conductor, casing and liners) shall conform to the relevant minimum standards set out in the Woodside Engineering Standard – Well Cementation. Verification: • Effectiveness of primary and secondary barriers shall be verified (physical evidence of the correct placement and performance) during the drilling of the well.				
Implement requirements for permanent well abandonment: • well barrier as per the internal Woodside Standard and Procedure • placement, length, material and verification of a permanent barrier.	F: Yes. CS: Minimal cost. Standard practice.	This procedure will reduce the likelihood of a spill occurring from a suspended well. Although changes in consequence would occur, the reduction in likelihood results in a reduction in overall risk.	Benefits outweigh cost/sacrifice.	Yes **C 13.1**
An approved Blowout Contingency Plan shall exist prior to drilling each well, including feasibility and any specific considerations for relief well kill.	F: Yes. CS: Minimal cost. Standard practice.	Assessment of the feasibility considerations for relief well kill and well capping will reduce the duration of a spill resulting in a reduction in consequence and overall risk.	Benefits outweigh cost/sacrifice.	Yes **C 13.2**
Good Practice				
Subsea BOP installed and function tested during drilling operations. The BOP shall include: • one annular preventer; • two pipe rams (excluding the test rams); • a minimum of two sets of shear rams, one of which	F: Yes. CS: Standard practice. Required by Woodside standards.	Testing of the BOP will reduce the likelihood of a blowout resulting in release of hydrocarbons to the marine environment. In the event of a blowout, this control would not reduce the consequence, although	Benefits outweigh cost/sacrifice.	Yes **C 13.3**

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)*** [24]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
must be capable of sealing; • deadman functionality; • the capability of ROV intervention independent power systems.		the reduction in likelihood reduces the overall risk ranking.		
Project-specific Mooring Design Analysis.	F: Yes. CS: Standard practice. Required by Woodside standards.	Ensure adequate MODU station holding capacity to prevent loss of station. This will reduce the likelihood of a blowout resulting in release of hydrocarbons to the marine environment.	Benefits outweigh cost/sacrifice.	**C 3.2**
Professional Judgement – Eliminate				
Do not drill well.	F: No. CS: Inability to produce hydrocarbons. Loss of the project.	All risk would be eliminated.	Disproportionate. Given the extremely low likelihood of a loss of well integrity due to the systematic implementation of Woodside's policies, standards, procedures and processes relating to drilling activities, the cost/sacrifice outweighs the benefit gained.	No
Professional Judgement – Substitute				
No additional controls identified.				
Professional Judgement – Engineered Solution				
Risk Based Analysis				
A quantitative spill risk assessment was undertaken (refer **Section 6.7.1**).				
Company Values				
Corporate values require all personnel at Woodside to comply with appropriate policies, standards, procedures and processes while being accountable for their actions and holding others to account in line with the Woodside Compass. As detailed above, the Petroleum Activities Program will be undertaken in line with these policies, standards and procedures that include suitable controls to prevent loss of well control, and response should a loss of well control occur. This EP has been internally reviewed and approved in line with the Woodside Manual of Authorities.				
Societal Values				
Due to the Petroleum Activities Program's potential extent of the wider EMBA, the loss of well control current risk rating presents a Decision Type C, in accordance with the decision support framework. Extensive consultation was undertaken for this program to identify the views and concerns of relevant stakeholders, as described in **Section 5**. This consultation conducted in 2019 has been reviewed. Woodside sent an Activity Factsheet				

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)*** [24]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
to all identified relevant stakeholders regarding the Petroleum Activities Program (**Section 5** and **Appendix F**). Woodside has consulted with AMSA and WA DoT on spill response strategies. In accordance with the Memorandum of Understanding between Woodside and AMSA, a copy of the Oil Pollution First Strike Plan was provided to AMSA and WA DoT.				
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 C), Woodside considers the adopted controls appropriate to manage the risks and consequences of an unlikely unplanned hydrocarbon release as a result of a loss of well integrity. As no reasonable additional/alternative controls were identified that would further reduce the risks and consequences without grossly disproportionate sacrifice, the risks and consequences are considered ALARP.				

Demonstration of Acceptability

Acceptability Statement

While unlikely, loss of containment has been evaluated as having a high level of current risk rating due to potential environmental consequence. Woodside considers high current risk ratings as acceptable if ALARP is demonstrated using good industry practice, consideration of company and societal values and risk based analysis, if legislative requirements are met and societal concerns are accounted for, and the alternative control measures are grossly disproportionate to the benefit gained.

Acceptability is demonstrated with regard to the following considerations:

Principles of Ecological Sustainable Development

Woodside is a proud Australian company that is here for the long term. Woodside has a strong history of exploration and development of oil and gas reserves in the North West of Western Australia with an excellent environmental record, while providing revenue to State and Commonwealth Governments, returns to shareholders, jobs and support to local communities. Titles for oil and gas exploration are released based on commitments to explore with the aim of uncovering and developing resources. It is under the lease agreement that Woodside has determined the potential to explore the hydrocarbon fields for which acceptance of this EP is sought under the Environment Regulations.

Woodside has established a number of research projects in order to understand the marine environments in which they operate, notably in the Exmouth Region, Dampier Archipelago and the Kimberley Region, including Rankin Bank and Scott Reef. Where scientific data does not exist, Woodside assumes that a pristine natural environment exists and therefore implements all practicable steps to prevent damage. Woodside's corporate values (**Appendix A**) require that we consider the environment and communities in which we operate when making decisions.

Woodside looks after the communities and environments in which it operates. Risks are inherent in petroleum activities; however, through sound management, systematic application of policies, standards, procedures and processes, Woodside considers that despite this risk, the extremely low likelihood of loss of well control is acceptable.

Internal Context

The Petroleum Activities Program is consistent with Woodside corporate policies, standards, procedures, processes and training requirements as outlined in the Demonstration of ALARP and Environmental Performance Outcomes, including:

- Health, Safety, Environment and Quality Policy (**Appendix A**)
- Risk Management Policy (**Appendix A**)
- Engineering Standards – Well Barriers
- Well Acceptance Criteria Procedure
- Drilling and Completions – Well Control Manual
- Woodside Engineering Standard – Rig Equipment.

Oil spill preparedness and response strategies are considered applicable to the nature and scale of the risk and associated impacts of the response are reduced to ALARP (**Appendix D**).

Woodside corporate values include working sustainably, with respect to the environment and communities in which we operate, listening to internal and external stakeholders and considering HSE when making decisions. Stakeholder consultation, outlined below, has been undertaken prior to the Petroleum Activities Program.

External Context – Societal Values (includes environmental consequence and stakeholder expectations)

Woodside recognises that its licence to operate from a regulator and societal perspective is based on historical performance, complying with appropriate policies, standards and procedures, and understanding the expectations of external stakeholders. External stakeholder consultation, outlined below, has been undertaken prior to the Petroleum Activities Program:

- Woodside has consulted with AMSA and WA DoT on spill response strategies. In accordance with the Memorandum of Understanding between Woodside and AMSA, a copy of the Oil Pollution First Strike Plan was provided to AMSA and WA DoT.
- Other stakeholders have been consulted (**Section 5**) and their feedback incorporated into this EP where appropriate.
- The impact assessment has determined that there is unlikely to be a major long-term environmental impact on the offshore environment or sensitive nearshore and shoreline habitats from a loss of well integrity.
- By providing additional measures to prevent loss of well containment, in addition to oil spill response measures that are commensurate with the current risk rating, location and sensitivity of the receiving environment (including social and aesthetic values), Woodside believes this addresses societal concerns to an acceptable level.

Other Requirements (includes laws, policies, standards and conventions)

The Petroleum Activities Program is consistent with laws, policies, standards and conventions, including:

- subsea BOP function testing in accordance with API Standard 53, 4th Edition
- *Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011*: accepted WOMP and application to drill
- notification of reportable and recordable incidents to NOPSEMA, if required, in accordance with **Section 7.8**
- mutual aid Memorandum of Understanding for relief well drilling is in place. Woodside develops a Well Blowout Contingency Plan for each well, which is signed off by the Drilling Engineering Manager and maintains a list of rigs that are currently operating in Western Australia.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 13 No loss of well integrity resulting in loss of hydrocarbons to the marine environment during Petroleum Activities Program.	**C 11.1** *Offshore Petroleum and Greenhouse Gas Storage (Resource Management and Administration) Regulations 2011*: accepted Well Operations Management Plan (WOMP), which describes the well design and barriers to be used to prevent a loss of well integrity, specifically: • all permeable zones penetrated by the well bore, containing hydrocarbons or over-pressured water, shall be isolated from the surface environment by a minimum of two barriers (primary and secondary) (a single fluid barrier may be implemented during the initial stages of well construction if	**PS 11.1** • Wells drilled in compliance with the accepted WOMP, including implementation of barriers to prevent a loss of well integrity.	**MC 11.1.1** Acceptance letter from NOPSEMA demonstrates the WOMP and application to drill were accepted by NOPSEMA prior to the drilling activity commencing. **MC 11.1.2** Records demonstrate minimum of two verified barriers (a single fluid barrier may be implemented during the initial stages of well construction if appropriateness is confirmed by a shallow hazard study) were in place for all permeable zones penetrated by the wellbore.

	appropriateness is confirmed by a shallow hazard study) • discrete hydrocarbon zones shall be isolated from each other (to prevent cross flow) by a minimum of one barrier where deemed required • all normally pressured permeable water-bearing formations shall be isolated from the surface by a minimum of one barrier. The barriers shall: • be effective over the lifetime of well construction. • Fluid barriers shall remain monitored and provide sufficient pressure to counter pore pressure during well construction. • Cementing barriers (including conductor, casing and liners) shall conform to the relevant minimum standards set out in the Woodside Engineering Standard – Well Cementation. Verification: • Effectiveness of primary and secondary barriers shall be verified (physical evidence of the correct placement and performance) during the drilling of the well.		**MC 11.1.3** Records demonstrate composition and weight of drilling fluids were applicable to down hole conditions.
	C 13.2 Implement requirements for permanent well abandonment: • well barrier as per the internal Woodside Standard and Procedure • placement, length, material and verification of a permanent barrier.	**PS 13.2** Woodside abandons the wells according to internal Woodside Procedure.	**MC 13.2.1** Records demonstrate Well Acceptance Criteria have been met.
	C 13.2 An approved Blowout Contingency Plan shall exist prior to drilling each well, including feasibility and any specific considerations for relief well kill.	**PS 13.2** Feasibility of performing a well kill operation confirmed in approved blowout contingency plan.	**MC 13.2.1** An approved Well Blowout Contingency Plan.

	C 13.3 Subsea BOP installed and function tested during drilling operations. The BOP shall include: • one annular preventer • two pipe rams (excluding the test rams) • a minimum of two sets of shear rams, one of which must be capable of sealing • deadman functionality • the capability of ROV intervention • independent power systems.	**PS 13.3** Subsea BOP specification, installation and function testing compliant with internal Woodside Standards and international requirements (API Standard 53 4th Edition) as agreed by Woodside and MODU contractor.	**MC 13.3.1** Records demonstrate that BOP and BOP control system specifications and function testing were in accordance with minimum standards for the expected drilling conditions as agreed by Woodside and MODU contractor.
	C 3.2 Project-specific Mooring Design Analysis.	**PS 3.2.1** Seabed disturbance from MODU mooring limited to that specified in the project-specific mooring design analysis and as required to ensure adequate MODU station keeping capacity.	**MC 3.2.1** Records demonstrate Mooring Design Analysis completed and implemented during anchor deployment.
For oil spill response outcomes, standards and measurement criteria refer to **Appendix D**.			

6.7.3 Accidental Hydrocarbon Release: Vessel Collision

Context		
Project vessels – **Section 3.5**	Physical environment – **Section 4.4** Biological environment – **Section 4.5** Socio-economic – **Section 4.6** Values and sensitivities – **Section 4.7**	Stakeholder consultation – **Section 5**

Risks Evaluation Summary														
Source of Risk	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Loss of hydrocarbons (diesel) to marine environment due to a vessel collision (e.g. support vessels or other marine users)			X		X	X	X	A	D	1	**M**	LCS GP PJ	Broadly Acceptable	EPO 11

Description of Source of Risk

Background

The temporary presence of the MODU and project vessels in the Operational Area will result in a navigational hazard for commercial shipping within the immediate area (as discussed in **Section 6.6.1**). This navigational hazard could result in a third party vessel colliding with the MODU and other vessels which could result in a loss of containment (**Section 6.7.2** of this EP).

The moored and DP MODU have a total marine diesel capacity of about 966–1400 m^3 and 3640 m^3 respectively that are distributed through a number of isolated tanks. MODU fuel tanks are located in the MODU pontoons, typically located on the inner sides of pontoons, and can be over 10 m below the waterline.

The marine diesel storage capacity of a support vessel can also be in the order of 1000 m^3 (total) that is distributed through multiple isolated tanks typically located mid-ships and can range in typical size from 22 to 105 m^3.

A typical installation vessel is likely to have multiple isolated fuel tanks distributed throughout the hull of the vessel. Individual fuel tanks are typically 500 m^3 but can be up to 1000 m^3 in volume. In the highly unlikely event of a collision involving an installation vessel during the Petroleum Activities Program, the vessel will have the capability to pump fuel from a ruptured tank to a tank with spare volume in order to reduce the potential volume of fuel released to the environment.

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 (AusSAR).

From a review of the ATSB marine safety and investigation reports, one vessel collision occurred in 2011–12 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 support vessel off Barrow Island. Two other vessel collisions occurred in 2010, one in the port of Dampier, where a 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 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 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 6-13**). The scenarios considered damage to single and multiple fuel storage tanks in the support vessel, installation vessel and MODU due to dropped objects and various combinations of vessel to vessel and vessel to MODU collisions. In summary:

- It is not a credible scenario that the total storage volume of the MODU would be lost, as fuel is stored in more than one tank.
- It is not a credible scenario that a storage tank on the MODU would be damaged due to the location of the tanks within the hull, behind the bilge tanks, below the waterline.
- It is not a credible scenario that a collision between the support vessel and MODU would damage any storage tanks, due to the location of the tanks on both vessel types, and secondary containment.
- It is highly unlikely that the full volume of the largest storage tank on a support vessel or installation vessel would be lost.

The last scenario considered was a collision between the support vessel or installation vessel with a third party vessel (i.e. commercial shipping, other petroleum related vessels and commercial fishing vessels). This was assessed as being credible but highly unlikely, given the standard vessel operations and equipment in place to prevent collision at sea, the short duration of installation vessel operations in the Permit Area, the standby role of a support vessel (low vessel speed) and its operation in close proximity to the MODU (exclusion areas), and the construction and placement of storage tanks. The largest tank of the support vessel is unlikely to exceed 105 m^3; the largest tank volume of an installation vessel is unlikely to exceed 1000 m^3.

Given the offshore location of the Permit Area, vessel grounding is not considered a credible risk.

Table 6-12: Summary of credible hydrocarbon spill scenario as a result of vessel collision

Scenario	Hydrocarbon Volumes	Preventative and Mitigation Controls	Credibility
Breach of MODU fuel tanks due to support vessel collision.	MODU has a fuel oil storage capacity of about 966–1400 m³ (up to 3640 m³ for DP MODU), distributed through multiple tanks.	Fuel tanks are located on the inside of pontoons and protected by location below water line, protection from other tanks, e.g. bilge tanks. The draught of vessel and location of tanks in terms of water line prevent the tanks from being breached.	**Not credible** Due to location of tanks.
Breach of support vessel fuel tanks due to collision with MODU.	Activity support vessel has multiple marine diesel tanks typically ranging between 22–105 m³ each.	Typically, double wall tanks which are located mid ship (not bow or stern). Slow support vessel speeds when in close proximity to MODU.	**Not credible** Collision with MODU at slow speeds is highly unlikely and if did occur is highly unlikely to result in a breach of support vessel (low energy contact from slow moving vessel).
Breach of installation vessel fuel tanks due to collision with third party vessel, including commercial shipping and fishing.	Installation vessel has multiple marine diesel isolated tanks; largest volume of a single tank is likely to be <1000 m³.	Tank locations midship (not bow or stern).	**Credible** Installation vessel–third party vessel collision could potentially result in the release from a fuel tank.
Breach of support vessel fuel tanks due to support vessel–other vessel collision including commercial shipping/fisheries.	Activity support vessel has multiple marine diesel tanks typically ranging between 22–105 m³ each.	Typically, double wall tanks which are located midship (not bow or stern). Vessels are not anchored and steam at low speeds when relocating within the Permit Area or providing stand-by cover. Normal maritime procedures would apply during such vessel movements.	**Credible** Activity support vessel–other vessel collision could potentially result in the release from a fuel tank.
Loss of well control due to third party vessel (e.g. large bulk carrier) collision with MODU during drilling activities.	Loss of containment of reservoir fluids – see **Section 6.7.2** for estimated volumes.	Refer to **Section 6.6.1** for preventative and mitigation controls.	**Credible** See **Section 6.7.2**.
Dropped object from back-loading/ offloading operations rupturing the MODU fuel tanks (e.g. a container or piece of equipment).	MODU has a fuel oil storage capacity of about 966–1400 m³, distributed through multiple tanks.	Fuel tanks are located on the inside of pontoons and protected by location below water line, protection from other tanks, e.g. bilge tanks. The draught of vessel and location of tanks in terms of water line prevent the tanks from being breached.	**Not credible** No direct pathway to tanks from dropped objects.

Quantitative Hydrocarbon Risk Assessment

Modelling was undertaken by RPS, on behalf of Woodside, to determine the fate of marine diesel released from a collision at a location within the Operational Area. The modelling assessed the extent of marine diesel spill volume of 1000 m³ (largest fuel tank on installation vessel) for all seasons, using an historic sample of wind and current data for the region.

Hydrocarbon Characteristics

Diesel characteristics are described in **Section 6.7.1** and **Table 6-4**. Marine diesel is a mixture of volatile and persistent hydrocarbons with low proportions of highly volatile and residual components. In general, about 6% of the oil mass should 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). About 5% of the oil is shown to be persistent.

Under a calm constant-wind scenario (**Figure 6-6**), about 40% of the oil is predicted to evaporate within 36 hours. Under these conditions the majority of the remaining oil on the water surface will weather at a slower rate. 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 more realistic variable-wind scenario (**Figure 6-7**), where the winds are of greater strength, entrainment of marine diesel into the water column is indicated to be significant. About two days after the spill, about 50% of the oil mass is forecast to have entrained and a further 45% is forecast to have evaporated, leaving only a small proportion of the oil floating on the water surface (<2%). The residual compounds will tend to remain entrained beneath the surface under conditions that generate wind waves (about >6 m/s).

Biological and photochemical degradation is predicted to contribute to the decay of the floating slicks and oil droplets in the water column. However, 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 considered.

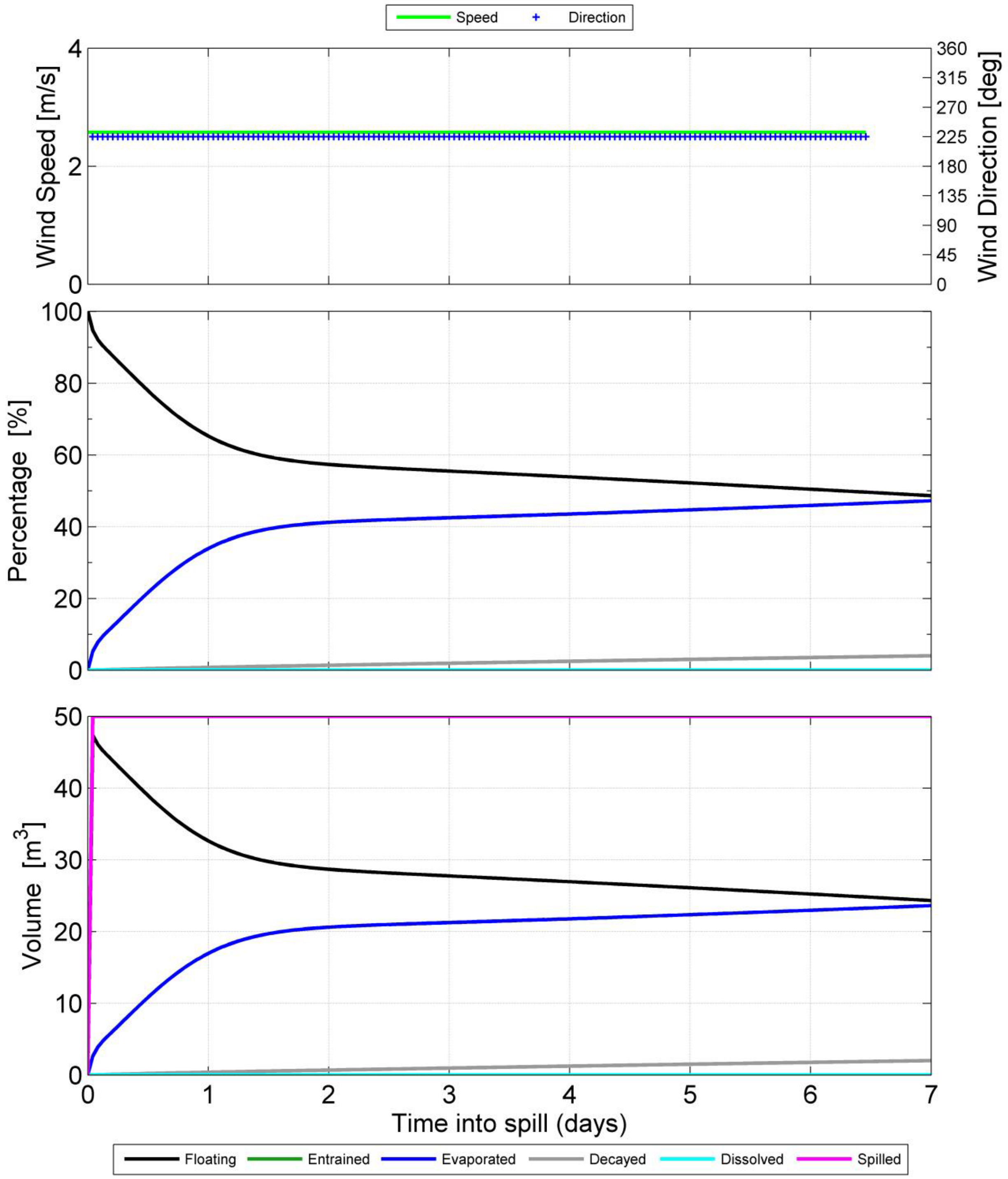


Figure 6-6: Mass balance plot representing, as proportion (middle panel) and volume (bottom panel), the weathering of marine diesel spilled onto the water surface as a one-off release (50 m³ over one hour) and subject to a constant 5 kn (2.6 m/s) wind at 27 °C water temperature and 25 °C air temperature

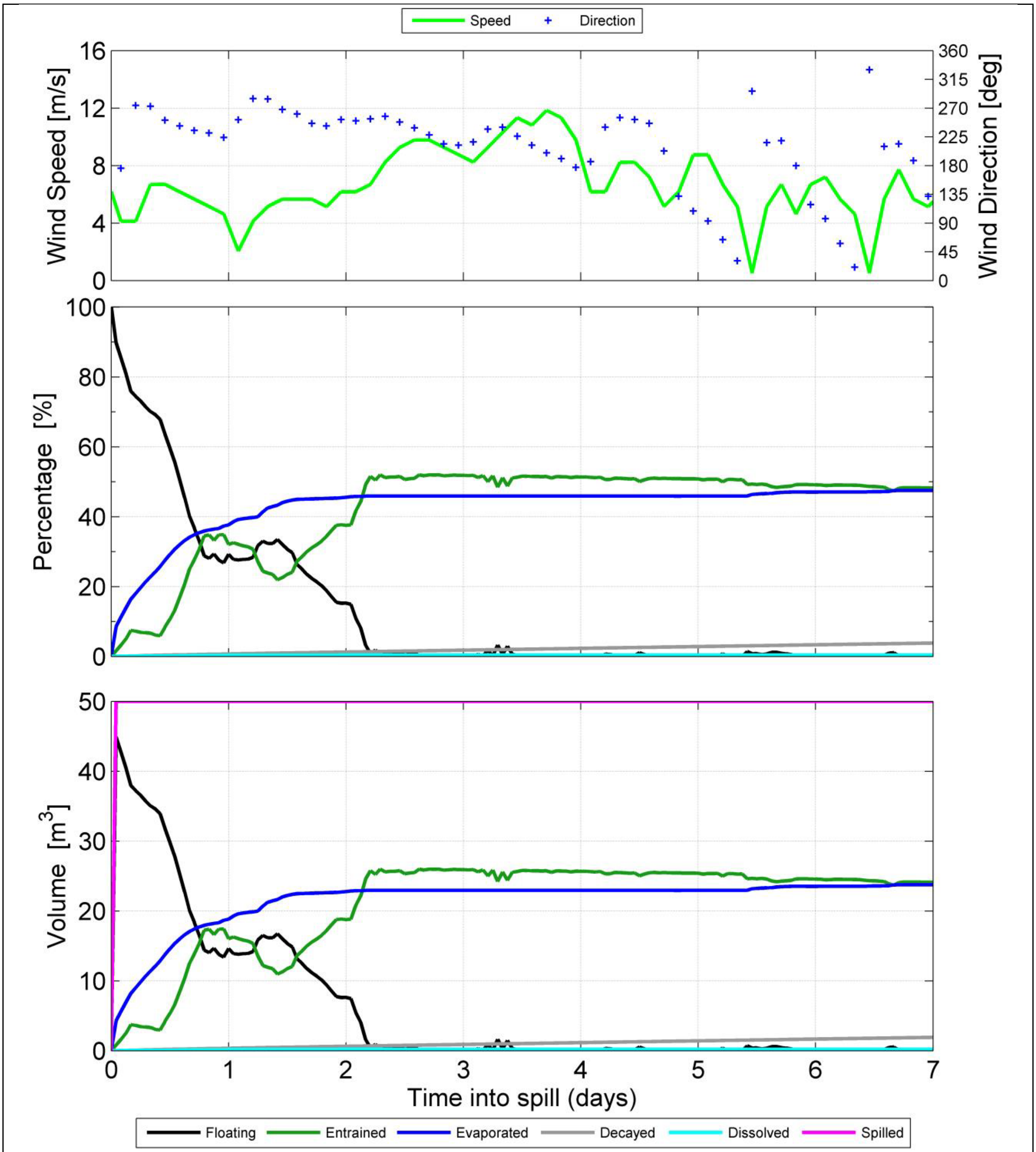


Figure 6-7: Mass balance plot representing, as proportion (middle panel) and volume (bottom panel), the weathering of marine diesel spilled onto the water surface as a one-off release (50 m³ over one hour) and subject to variable wind at 27 °C water temperature and 25 °C air temperature

Impact Assessment
Potential Consequence 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 6.7.1**). The EMBA therefore covers a larger area than the area that would be affected during any one single spill event, and

therefore represents the total extent of all the locations where hydrocarbon thresholds could be exceeded from all modelling runs. The trajectory of a single spill would have a considerably smaller footprint.

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 discussed for each fate.

Surface Hydrocarbons

Modelling of floating oil indicates that concentrations equal to or greater than the 10 g/m² thresholds could potentially be found up to 110 km from the spill site. Only Rankin Bank (6.5% probability), a submerged feature, is predicted to receive floating oil at concentrations equal to or greater than 10 g/m².

Entrained Hydrocarbons

Entrained oil at concentrations equal to or greater than the 500 ppb threshold is predicted to be found up to 500 km from the spill site. Contact by entrained oil at concentrations equal to or greater than 500 ppb is predicted with 1% probability at Rankin Bank, and 0.5% probability at Montebello Islands, Barrow Island, Ningaloo Coast North WHA and Ningaloo Coast Middle WHA. The maximum entrained oil concentration forecast for any receptor is predicted as 911 ppb at Rankin Bank (**Table 6-14**).

Table 6-13: Potential receptors contacted by entrained diesel >500 ppb

Receptor	Probability (%) of entrained oil concentration ≥500 ppb	Minimum time to receptor (hours) for entrained oil at ≥500 ppb	Maximum entrained oil concentration (ppb) averaged over all replicate simulations	Maximum entrained oil concentration (ppb), at any depth, in the worst replicate simulation
Barrow Island	0.5	393	7	615
Montebello Islands	0.5	558	6	512
Ningaloo Coast North WHA and Recreational Use Zone	0.5	280	15	885
Ningaloo Coast Middle WHA	0.5	345	10	509
Rankin Bank	1	18	72	911

Dissolved Hydrocarbons

Dissolved aromatic hydrocarbons at concentrations equal to or greater than the 500 ppb threshold are not predicted to occur within the model domain at any time. The maximum dissolved aromatic hydrocarbon concentration forecast for any receptor is predicted as 45 ppb at Rankin Bank.

Accumulated Hydrocarbons

Potential for accumulation of oil on shorelines is predicted to be low, with a maximum accumulated volume of <1 m³ and a maximum local accumulated concentration on shorelines of 24 g/m² forecast at Ningaloo Coast Middle WHA (**Table 6-15**).

Table 6-14: Accumulated shoreline concentration (diesel)

Receptor Location	Maximum local accumulated concentration (g/m²) in the worst replicate spill	Maximum accumulated volume (m³) along this shoreline, in the worst replicate simulation
Rowley Shoals – Imperieuse Reef incl AMP	<0.1	<1
Montebello Islands	<0.1	<1
Lowendal Islands	<0.1	<1
Barrow Island	<0.1	<1
Pilbara Islands – Southern Island group	11	<1
Muiron Islands Marine Management Area-WHA	6.3	<1
Ningaloo Coast North WHA and coast	4.1	<1
Ningaloo Coast Middle WHA and coast	24	<1
Ningaloo Coast South WHA and coast	<0.1	<1

Summary of Potential Impacts
Table 6-16 presents the full extent of the EMBA, i.e. the sensitive receptors and their locations that may be exposed to condensate (surface, entrained, dissolved and accumulated) at or above the set threshold concentrations in the highly unlikely event of a diesel spill during the Petroleum Activities Program. Details of these receptors are outlined in **Section 4**. The potential biological and ecological impacts of an unplanned diesel release as a result of a vessel collision during the Petroleum Activities Program are presented in the following sections.

Table 6-15: Environment that May Be Affected – Key receptor locations and sensitivities with the summary hydrocarbon spill contact for an instantaneous release of marine diesel

Environmental setting	Location/name	Environmental, Social, Cultural, Heritage and Economic Aspects presented as per the Environmental Risk Definitions (Woodside's Risk Management Procedure (WM0000PG10055394))																													Hydrocarbon contact and fate (≥1% probability)			
		Physical		Biological																						Socio-economic and Cultural								
		Water Quality	Sediment Quality	Marine Primary Producers			Other Communities/Habitats								Protected Species										Other Species									
		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)	Seasnakes	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 & Gas Infrastructure (topside and subsea)	Surface hydrocarbon (≥10 g/m²)	Entrained hydrocarbon (≥500 ppb)	Dissolved aromatic hydrocarbon (≥500 ppb)	Accumulated hydrocarbon (>100 g/m²)
Offshore[25]	Commonwealth waters	✓	✓					✓		✓					✓	✓				✓	✓	✓	✓	✓		✓		✓		✓	✓	✓	X	N/A
Submerged Shoals	Rankin Bank	✓	✓	✓			✓	✓		✓						✓				✓		✓		✓	✓	✓		✓			✓	✓	X	N/A

[25] Note: hydrocarbons cannot accumulate on open ocean, submerged receptors, or receptors not fully emergent.

Summary of Potential Impacts to Protected Species, Other Habitats and Communities, Water Quality and Socio-economic Values
No receptors are contacted by dissolved aromatic hydrocarbons >500 ppb or floating oil concentrations equal to or greater than 10 g/m² (Rankin Bank is a submerged feature). Entrained hydrocarbons >500 ppb may contact receptors, with the greatest likelihood and concentrations found at Rankin Bank (1% probability of contact at concentrations >500 ppb). All other sensitive locations identified in **Table 6-14** and **Table 6-16** are predicted to have less than 1% probability of contact at concentrations >500 ppb. The potential impacts of floating, dissolved and entrained hydrocarbons to species (protected and otherwise), marine primary producers, other habitats and communities, water quality, marine sediment quality, air quality, protected areas and socio-economic values are described in **Section 6.7.2**. While the loss of containment EMBA and the diesel spill EMBA do not completely overlap spatially, the main difference between the two is that the Montebello AMP would not be impacted above impact thresholds in the case of a diesel spill; but instead, Rankin Bank has the potential to be impacted. Considering the sensitive receptors potentially impacted are similar for the two spill scenarios except for Rankin Bank, the assessment provided in **Section 6.7.2** would also apply to the potential diesel spill scenario. Additional specific information about the potential impacts to Rankin Bank is provided below. It is noted that the toxic components in marine diesel include alkylated naphthalenes which can be rapidly accumulated by marine biota including invertebrates such as marine oysters, clams, shrimp, as well as a range of vertebrates such as finfish. Marine diesel also contains additives that contribute to its toxicity. ***Protected Areas (Rankin Bank) and Associated Species (protected or otherwise)*** Rankin Bank is on the continental shelf, about 25 km from the Permit Area at its closest point, and consists of three submerged shoals delineated by the 50 m depth contour with water depths of about 18–30.5 m. Rankin Bank represents a diverse marine environment, predominantly composed of consolidated reef and algae habitat (about 55% cover), followed by hard corals (about 25% cover), unconsolidated sand/silt habitat (about 16% cover), and benthic communities composed of macroalgae, soft corals, sponges and other invertebrates (about 3% cover) (AIMS, 2014b). Hard corals are a significant component of the benthic community of some parts of the bank, with abundance in the upper end of the range observed elsewhere on the submerged shoals and banks of North West Australia (Heyward et al., 2012). There is the potential for seasnakes to be present within the shallower waters of Rankin Bank. The potential impacts of exposure are as discussed previously in **Section 6.7.2**. A hydrocarbon spill may have a minor disruption to a portion of the population but there is no threat to overall population viability. Hydrocarbon exposure to offshore filter-feeding communities (e.g. communities within Rankin Bank) may occur depending on the depth of the entrained/dissolved hydrocarbons. Exposure to entrained hydrocarbons/dissolved aromatic hydrocarbons (≥500 ppb) has potential to result in lethal or sub-lethal toxic effects. Sub-lethal impacts, including mucus production and polyp retraction, have been recorded for gorgonians exposed to hydrocarbon (White et al., 2012). Any impacts may result in localised long-term effects to community structure and habitat. There is the potential for resident shark and ray populations to be impacted directly from hydrocarbon contact or indirectly through contaminated prey or loss of habitat. Spill model results indicate potential impacts to shallow waters of Rankin Bank which may host shark and ray populations. Sharks and rays present at these reefs may be exposed to fresh, unweathered hydrocarbons, which may have greater potential for toxic impacts. Any direct impacts are expected to be sub-lethal; however, no impacts at the population level. Pelagic sharks and rays are expected to move away from areas affected by spilled hydrocarbons. Impacts to such species are expected to be limited to behavioural responses/displacement. Shark and ray species that have associations with submerged shoals and oceanic atolls may not move in response to such habitat being contacted by spilled hydrocarbons. Such species may be more susceptible to a reduction in habitat quality resulting from a hydrocarbon spill. Impacts to sharks and rays at Rankin Bank are likely to be localised as they are comparable to other Australian reefs and the NWMR submerged shoals and banks. It is expected that there will be no impacts at the population level.
Summary of Potential Impacts to Environmental Value(s)
In the highly unlikely event of an unplanned hydrocarbon release to the marine environment due to vessel collision, combined with the adopted controls, it is considered that any potential impact to water quality would be localised, low and temporary in nature in comparison to background levels. Localised, low and temporary impacts to habitats, populations and shipping/fishing concerns are expected. The highest environmental consequence identified for the assessment of an unplanned hydrocarbon release to the marine environment due to vessel collision, as classified in **Table 2-4**, is defined as D, which equates to 'minor, short-term impact (1–2 years) on species, habitat (but not affecting ecosystems), physical or biological attributes'.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
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.	F: Yes. CS: Minimal cost. Standard practice.	Legislative requirements to be followed reduce the likelihood of interference with other marine users resulting in a collision.	Controls based on legislative requirements – must be adopted.	Yes **C 14.1**
Marine Order 21 (Safety of navigation and emergency procedures) 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 *Safety of Life at Sea* • Automatic Identification System that provides other users with information about the vessel's identity, type, position, course, speed, navigational status and other safety-related data.	F: Yes. CS: Minimal cost. Standard practice.	Legislative requirements to be followed reduce the likelihood of interference with other marine users resulting in a collision.	Controls based on legislative requirements – must be adopted.	Yes **C 14.2**
Establishment of a 500 m petroleum safety zone around MODU and installation vessels and communicated to marine users.	F: Yes. CS: Minimal cost. Standard practice.	Legislative requirements to be followed reduce the likelihood of a collision with a third party vessel.	Controls based on legislative requirements – must be adopted.	Yes **C 14.3**
Good Practice				
A support vessel is on standby as required during drilling activities to assist in third-party vessel interactions (including warning to vessels approaching the 500m petroleum safety zone).	F: Yes. CS: Minimal cost – support vessels available routinely in Operational Area during Petroleum Activities Program. Standard practice.	Provides a small reduction in likelihood of a collision with a third party vessel.	Benefits outweigh cost/sacrifice.	Yes **C 14.4**

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
When a support vessel is designated for standby it will undertake actions to prevent unplanned interactions, such as: • Maintain a 24 hour radio watch on designated radio channel(s). • Perform continuous surveillance and warn the MODU/ installation vessels of any approaching vessels reaching 500 m petroleum safety zone. Surveillance shall be conducted by a combination of: – visual lookout – radar watch – other electronic systems available including AIS – monitoring any additional/agreed radio communications channels – all other means available. • While complying with Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGS), approach any vessel attempting to transit through the 500 m zone and contact vessel by all available means. • Monitor and advise the MODU if: – MODU navigation signals are defective – visibility becomes restricted. Advise if any buoys in the area are not holding position or are not working as expected.	F: Yes. CS: Minimal cost – support vessels available routinely in Operational Area during Petroleum Activities Program. Standard practice.	Provides a reduction in likelihood of a collision with a third party vessel.	Benefits outweigh cost/sacrifice.	Yes **C 14.5**
Notify AHS of activities and movements no less than four working weeks prior to the scheduled activity commencement date.	F: Yes. CS: Minimal cost. Standard practice.	Notification to AHS will enable them to generate navigation warnings (Maritime Safety Information Notifications (MSIN) and Notice to Mariners (NTM) (including AUSCOAST warnings where relevant)).	Benefits outweigh cost/sacrifice. Control is also Standard Practice.	Yes **C 1.1**

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
Notify AMSA JRCC of activities and movements of the activity 24–48 hours before operations commence.	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 1.3**
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				
No additional controls identified.				
Professional Judgement – Engineered Solution				
No additional controls 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 risks and consequences of an unplanned loss of hydrocarbon as a result of vessel collision. As no reasonable additional/alternative controls were identified that would further reduce the risks and consequences without grossly disproportionate sacrifice, the risks and consequences are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that an unplanned loss of hydrocarbon as a result of a vessel collision represents a low current risk rating that is unlikely to result in potential impact greater than localised, minor and temporary disruption to a small proportion of the population and no impact on critical habitat or activity. Further opportunities to reduce the risks and consequences have been investigated above. The adopted controls are consistent with the most relevant regulatory guidelines, good oil-field practice/industry best practice, and in some cases are above industry best practice and meet legislative requirements of Marine Orders 30 and 21. The potential risks and consequences are considered acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the risks and consequences of a loss of vessel structural integrity to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 14 No release of hydrocarbons to the marine environment due to a vessel collision during the Petroleum Activities Program.	**C 14.1** 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 14.1** Support vessels, installation vessels and MODU compliant with Marine Order 30 (Prevention of collisions) 2016 (which requires vessels to be visible at all times) to prevent unplanned interaction with marine users.	**MC 14.1.1** Marine Assurance inspection records demonstrate compliance with standard maritime safety procedures (Marine Orders 21 and 30).
	C 14.2 Marine Order 21 (Safety of navigation and emergency procedures) 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 *Safety of Life at Sea* • Automatic Identification System that provides other users with information about the vessel's identity, type, position, course, speed, navigational status and other safety-related data.	**PS 14.2** Support vessels, installation vessels and MODU compliant with Marine Order 21 (Safety of navigation and emergency procedures) 2016 to prevent unplanned interaction with marine users.	

	C 14.3 Establishment of a 500 m petroleum safety zone around MODU and installation vessels and communicated to marine users.	**PS 14.3** No entry of unauthorised vessels within the 500 m safety exclusion zone.	**MC 14.3.1** Records demonstrate breaches by unauthorised vessels within the petroleum safety zone are recorded.
			MC 14.3.2 Consultation records demonstrate that AHS has been notified prior to commencement of the activity to allow generation of navigation warnings (Maritime Safety Information Notifications (MSIN) and Notice to Mariners (NTM) (including AUSCOAST warnings where relevant)), which communicate safety exclusion zones to marine users.
	C 14.4 Support vessel on standby as required during drilling activities to assist in third party vessel interactions (including warning to vessels approaching the 500 m petroleum safety zone).	**PS 14.4** Support vessel on standby as required to communicate with third-party vessels, prevent unplanned interaction and to assist in emergencies, as required.	**MC 14.4.1** Records demonstrate an activity support vessel was on standby as required as per definition or reference in Woodside's OneMarine Charterers Instructions.
	C 14.5 When a support vessel is designated for standby it will undertake actions to prevent unplanned interactions, such as: • maintain a 24 hour radio watch on designated radio channel(s) • perform continuous surveillance and warn the MODU/ installation vessels of any approaching vessels reaching 500 m petroleum safety zone. Surveillance shall be conducted by a combination of: – visual lookout – radar watch – other electronic systems available including Automatic Identification System – monitoring any additional/agreed	**PS 14.5** Define role of support vessels in maintaining petroleum safety zone, preventing unplanned third party vessel interactions, monitoring the effectiveness of navigation controls (e.g. signals), and warning third party vessels of navigation hazards.	**MC 14.5.1** Records of non-conformance against controls maintained.

	radio communications channels – all other means available. • While complying with the International Regulations for Preventing Collisions at Sea (COLREGS), approach any vessel attempting to transit through the 500 m zone and contact vessel by all available means. • Monitor and advise the MODU if: – MODU navigation signals are defective – visibility becomes restricted – any buoys in the area are not holding position or are not working as expected.		
	C 1.1 Notify AHS of activities and movements no less than four working weeks prior to the scheduled activity commencement date.	**PS 1.1** Notification to AHS of activities and movements to allow generation of navigation warnings (Maritime Safety Information Notifications (MSIN) and Notice to Mariners (NTM) (including AUSCOAST warnings where relevant)).	**MC 1.1.1** Consultation records demonstrate that AHS has been notified prior to commencement of an activity to allow generation of navigation warnings (MSIN and NTM (including AUSCOAST warnings where relevant)).
	C 1.3 Notify AMSA JRCC of activities and movements 24–48 hours before operations commence.	**PS 1.3** Notification to AMSA JRCC to prevent activities interfering with other marine users. AMSA's JRCC will require the MODU's details (including name, callsign and MMSI), satellite communications details (including INMARSAT-C and satellite telephone), area of operation, requested clearance from other vessels and need to be advised when operations start and end.	**MC 1.3.1** Consultation records demonstrate that AMSA JRCC has been notified before commencing the activity within required timeframes.
Detailed preparedness and response performance outcomes, standards and measurement criteria for the Petroleum Activities Program are presented in **Appendix D**.			

6.7.4 Accidental Hydrocarbon Release: Bunkering

Context		
Project vessels – **Section 3.5**	Physical environment – **Section 4.4** Biological environment – **Section 4.5**	Stakeholder consultation – **Section 5**

Risks Evaluation Summary														
Source of Risk	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Loss of hydrocarbons (diesel/jet fuel) to marine environment from bunkering/refuelling			X			X		A	E	2	**L**	LCS GP PJ	Broadly Acceptable	EPO 15

Description of Source of Risk

Bunkering of marine diesel between the support vessel(s) and the MODU or installation vessel may occur at the drilling/installation location. Additionally, refuelling of helicopters using aviation jet fuel may take place onboard the MODU.

Three 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 coupling 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 shut off fuel pumps, for a period of up to five minutes, resulting in about 8 m³ marine diesel loss to the deck and/or into the marine environment.
- Partial or total failure of a bulk transfer hose or fittings during helicopter refuelling could spill aviation jet fuel to the helicopter deck and/or into the marine environment. All helicopter refuelling activities are closely supervised and leaks on the helideck are considered to be easily detectable. In the event of a leak, transfer would cease immediately. The credible volume of such a release during helicopter refuelling would be in the order of <100 L.

Likelihood

The likelihood of 2 “unlikely” corresponds to “Has occurred many times in the industry but not at Woodside.”
A search of the Woodside spill records indicates that while there have been smaller releases (<30L) associated with bunkering, there have been no recorded partial or total failures of bulk transfer hose or fittings during bunkering, combined with a failure in procedure to shut off fuel pumps for a period of up to five minutes, resulting in the worst case credible scenario of an 8 m³ loss of diesel.

International Tanker Owners Pollution Federation Limited (IOTPF) (2018) data reports that for tanker operations during 1970-2017, 7% of small (<7 tonnes) spills occurred during bunkering and 2% of medium (7-700 tonnes) spills. Whilst this data is from the oil tanker industry it has been used as an indicator of potential for spills associated with bunkering activities. A risk assessment by AMSA of oil spills in Australian ports and waters (Det Norske Veritas, 2011) identifies transfer spills as a risk.

Quantitative Spill Risk Assessment

Woodside has commissioned RPS to model several small marine diesel spills, including surface spill volumes of 8 m³ in the offshore waters of north-west WA. The results of these models have indicated that exposure to surface hydrocarbons above the 10 g/m² 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 thresholds concentrations from an 8 m³ surface spill from bunkering activities would be well within the EMBA for the vessel collision scenario detailed in **Section 6.7.3**. Given this, the offshore location of the Permit Area, and the fact that the same hydrocarbon type is involved for both scenarios, specific modelling for an 8 m³ marine diesel release was not undertaken for this Petroleum Activities Program.

Given the physical and chemical similarities, and the relatively small credible spill volumes, marine diesel is considered to be a suitable substitute for aviation jet fuel for the purposes of this environmental risk assessment. Aviation jet fuel would behave similarly to diesel and have similar impacts and, considering small size of spill volumes likely to be contained on the helideck, this has not been modelled.

Hydrocarbon Characteristics

Refer to **Section 6.7.3** for a description of the characteristics of marine diesel, including detail on the predicted fate and weathering of a spill to the marine environment.

Impact Assessment

Potential Consequence Overview

Previous modelling studies for 8 m³ marine diesel releases, spilled at the surface as a result of bunkering activities, indicated that the potential for exposure to surface hydrocarbons exceeding 10 g/m² was confined to within the immediate vicinity (about 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/m²), entrained (500 ppb) or dissolved (500 ppb) threshold concentrations from an 8 m³ spill of marine diesel within the Permit Area.

Summary of Potential Impacts to Protected Species and Water Quality

The potential biological and ecological impacts associated with much larger hydrocarbon spills are presented in **Section 6.7.2** and **6.7.3**; 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 and no impacts to commercial fisheries are expected. Refer to **Section 6.7.3** for the detailed potential impacts of unplanned hydrocarbon release to the marine environment from vessel collision; 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 very minor.

Demonstration of ALARP

Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)*** [26]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Marine Order 91 (Marine pollution prevention – oil) 2014, requires Ship Oil Pollution Emergency Plan (SOPEP)/Spill Monitoring Programme Execution Plan (SMPEP) (as appropriate to vessel class).	F: Yes. CS: Minimal cost. Standard practice.	By ensuring a SOPEP/ SMPEP is in place for the vessel, the likelihood of a spill entering the marine environment is reduced. Although no significant reduction in consequence	Controls based on legislative requirements – must be adopted.	Yes **C 15.1**

[26] Qualitative measure

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)*** [26]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
		could result, the overall risk is reduced.		
Good Practice				
Bunkering equipment controls: • All hoses that have a potential environmental risk following damage or failure shall be linked to the MODU's preventative maintenance system. • All bulk transfer hoses shall be tested for integrity before use (tested in accordance with Original Equipment Manufacturer recommendations) and re-certified annually as a minimum. • 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.	Yes **C 15.2**
Contractor procedures include requirements to be implemented during bunkering/refuelling operations, including: • A completed PTW and/or Job Safety Assessment (JSA) shall be implemented for the hydrocarbon bunkering/refuelling operation. • Visual monitoring of gauges, hoses, fittings and the sea surface during the operation. • Hose checks 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.	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.	Yes **C 15.3**
Mitigation: Oil spill response.	Refer to **Appendix D**.			
Professional Judgement – Eliminate				
No refuelling of helicopter on MODU.	F: No. Given the distance of the Permit Area from the airports suitable for helicopter operations, and the	Not considered, control not feasible.	Not considered, control not feasible.	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)*** [26]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
	endurance of available helicopters, eliminating helicopter refuelling is not feasible. Helicopter flights cannot be eliminated, and may be required in emergency situations. CS: Not assessed, control cannot feasibly be implemented.			
The MODU/installation vessel brought into port to refuel.	F: No. Does not eliminate the fuel transfer risk. It is not operationally practical to transit MODU back to port for refuelling based on the frequency of the refuelling requirements and distance from the nearest port (Dampier 257 km). CS: Significant due to schedule delay and vessel transit costs and day rates.	Eliminates the risk in the Permit Area, However, moves risk to another location. Therefore, no overall benefit.	Disproportionate. The cost/ sacrifice outweighs the benefit gained.	No
Professional Judgement – Substitute				
No additional controls identified.				
Professional Judgement – Engineered Solution				
No additional controls 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 a bunkering spill. As no reasonable additional/alternative controls were identified that would further reduce the risks and consequences without grossly disproportionate sacrifice, the risks and consequences 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 impacts to megafauna, plankton and fish populations (surface and water column biota) that are within the spill-affected area, and no impacts to commercial fisheries. Further opportunities to reduce the risks and consequences have been investigated above. The adopted controls are considered good oil-field practice/industry best practice. The potential risks and consequences are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the risks and consequences of the described emissions to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 15 No unplanned loss of hydrocarbons to the marine environment from bunkering greater than a consequence level of F [27] during the Petroleum Activities Program.	**C 15.1** Marine Order 91 (marine pollution prevention – oil) 2014, requires SOPEP/ SMPEP (as appropriate to vessel class).	**PS 15.1** Appropriate initial responses prearranged and exercised for response to a hydrocarbon spill, as appropriate to vessel class in compliance with Marine Order 91 (marine pollution prevention – oil) 2014, requires SOPEP/ SMPEP (as appropriate to vessel class).	**MC 15.1.1** Marine Assurance inspection records demonstrate compliance with Marine Order 91.
	C 15.2 Bunkering equipment controls: • All hoses that have a potential environmental risk following damage or failure shall be placed on the MODU's preventative maintenance system. • All bulk transfer hoses shall be tested for integrity before use (tested in accordance with Original Equipment Manufacturer recommendations and re-certified annually as a minimum). • 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 15.2.1** Bunkering equipment will be put on the MODU preventative maintenance system to ensure damaged equipment is replaced prior to failure.	**MC 15.2.1** Records confirm the MODU bunkering equipment is subject to systematic integrity checks.
		PS 15.2.2 Inventory loss from hydrocarbon containing equipment minimised in the event of a failure.	**MC 15.2.2** Records confirm presence of dry break of couplings and flotation on fuel hoses.
		PS 15.2.3 Adequate resources are available to allow implementation of SOPEP.	**MC 15.2.3** Records confirm presence of spill kits.
	C 15.3 Contractor procedures include requirements to be implemented during bunkering/refuelling operations, including: • Implement a completed PTW and/or JSA for the hydrocarbon bunkering/refuelling operation. • Visually monitor gauges, hoses, fittings and the sea surface during the operation.	**PS 15.3** Comply with Contractor procedures for managing bunkering/helicopter operations.	**MC 15.3.1** Records demonstrate bunkering/refuelling performed in accordance with contractor bunkering procedures.

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

	• Check hoses prior to commencement. • Commence bunkering/refuelling 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. Do not transfer hydrocarbons in marginal weather conditions.		
Detailed oil spill preparedness and response performance outcomes, standards and measurement criteria for the Petroleum Activities Program are presented in **Appendix D**.			

6.7.5 Unplanned Discharges: Drilling Fluids

Context	
Project fluids – **Section 3.10**	Physical environment – **Section 4.4** Biological environment – **Section 4.5**

Risks Evaluation Summary														
Source of Risk	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Accidental discharge of drilling fluids (WBM/NWBM/ base oil) to marine environment due to failure of slip joint packers, bulk transfer hose/fitting, emergency disconnect system or from routine MODU operations		X	X		X	X		A	E	1	**L**	LCS GP PJ	Broadly Acceptable	EPO 16

Description of Source of Risk

Transfers

A support vessel will undertake bulk transfer of mud or base oil to the MODU, if and when required. Failure of a transfer hose or fittings during a transfer or backload, as a result of an integrity or fatigue issue, could result in a spill of mud or base oil to either the bunded deck or into the marine environment.

Similar to a spill event during bunkering/refuelling (**Section 6.7.4**), the most likely spill volume of mud is likely to be less than 0.2 m³, based on the volume of the transfer hose and the immediate shutoff of the pumps by personnel involved in the bulk transfer process. However, the worst-case credible spill scenario could result in up to 8 m³ of mud being discharged. This scenario represents a complete failure of the bulk transfer hose combined with a failure to follow procedures requiring transfer activities to be monitored, coupled with a failure to immediately shut off pumps (e.g. mud pumped through a failed transfer hose for a period of about five minutes).

Slip Joint Packer Failure

The slip joint packer enables compensation for the dynamic movement of the MODU (heave) in relation to the static location of the BOP. A partial or total failure of the slip joint packer could result in a loss of mud to the marine environment. The likely causes of this failure include a loss of pressure in the pneumatic (primary) system combined with loss of pressure in the back-up (hydraulic) system.

Catastrophic sequential failure of both slip joint packers (pneumatic and hydraulic) would trigger the alarm and result in a loss of the volume of fluid above the slip joint (conservatively 1.5 m³) plus the volume of fluid lost in the one minute (maximum) taken to shut down the pumps. At a flow rate of 1000 gallons per minute, this volume would equate to an additional 3.8 m³. In total, it is expected that this catastrophic failure would result in a loss of 5.3 m³.

Failure of either of the slip joint packers at a rate not large enough to trigger the alarms could result in an undetected loss of 20 bbl (3 m³) maximum, assuming a loss rate of 10 bbl/hr and that MODU personnel would likely walk past the moon pool at least every two hours.

Activation of the Emergency Disconnect Sequence

The Emergency Disconnect Sequence (EDS) is an emergency system that provides a rapid means of shutting in the well (i.e. BOP closed) and disconnecting the MODU from the BOP. There are two main scenarios where the EDS could be activated: (1) automatic activation of the EDS due to a loss of MODU station keeping resulting from loss of multiple moorings; and (2) manual activation of the EDS due to an identified threat to the safety of the MODU including potential collision by a third-party vessel or a loss of well control.

When drilling, this could result in a subsurface release of a combination of mud (including NWBM) and cuttings at the seabed and a release of base fluid. The volume of material released depends on the water depth and hence the length of the riser (i.e. the entire riser volume would be lost). At the deepest well, PYA01, the volume for the full length of the riser, is estimated to be 203 m^3 . Of this total volume base oil accounts for ~ 70%. Therefore, the hydrocarbon release would be ~ 142 m^3. The base oil of the NWBM would remain in an emulsion with the other components of the mud system and drill cuttings.

NWBM Drilling Fluid System

The selection of an NWBM drilling fluid system will be based on Woodside processes (as outlined in **Section 3.10**); however, for the purposes of this risk assessment an example base oil (Saraline 185V) has been used. Saraline 185V is a mixture of volatile to low volatility hydrocarbons. Predicted weathering of base oil, based on typical conditions in the region, indicates that about 50% by mass is predicted to evaporate over the first day or two (refer to **Table 6-17**). At this time the majority of the remainder could be entrained into the water column, in calm conditions entrained hydrocarbons are likely to resurface with up to 100% will be able to evaporate over time.

Table 6-16: Characteristics of the non-water based mud base oil

Oil type	Initial density (kg/m³)	Viscosity (cP @ 20 °C)	Volatiles (%) <180	Semi volatiles (%) 180–265	Low volatility (%) 265–380	Residual (%) >380	Aromatic (%) of whole oil <380 °C BP
			Non-Persistent		Persistent		
Base oil (Saraline 185V)	0.7760	2.0 @ 40 °C	8.5	41.1	50.4	0	0

Impact Assessment

Potential Impacts to Water Quality, Other Habitats and Communities and Protected Species

NWBM is made up of a number of components detailed in **Section 3.10.2** including base oil, which generally has a high volatile to semi-volatile fraction. If released to the marine environment at surface, this generally evaporates within the first 48 hours, with the remaining fraction being on the sea surface and weathering at a slower rate. As a result of this volatility, combined with the worst-case credible spill scenario volumes (8 m³), and based on Woodside's experience of modelling base oil, it is considered there would be an extremely small footprint area associated with any release. Therefore, any surface oil would be confined to open waters with a minor surface slick that would not reach any sensitive receptors. Therefore, impacts on water quality would be minor and temporary in nature. The material safety datasheet for Saraline 185V indicates that it is readily biodegradable, non-toxic in the water column and has low sediment toxicity (Shell, 2014). Marine fauna may be affected if they come in direct contact with a release (i.e. by traversing the immediate spill area), but due to the small footprint of such a spill, it is anticipated that any impacts would be negligible and temporary in nature.

WBM is made up of a number of components detailed in **Section 3.10** including a variety of chemicals, incorporated into the selected drilling fluid system to meet specific technical requirements. If released to the marine environment at surface, there would be an extremely small impact footprint area associated with a release. Any release would be confined to the open waters of the Operational Area that would not reach any sensitive receptors. Components of the WBM would settle out in the water column and be subject to dilution. Given the low toxicity of WBM and its planned discharge during drilling, any impacts on water quality would be minor and temporary in nature.

The EMBA associated with the release of NWBM from the activation of the EDS would be small, and limited to deeper water seabed surrounding the well site (the release point). The environmental consequence of such a release would include a highly localised area at the discharge location. It is expected the weight of NWBM would result in the majority of the release settling to the seabed and/or remaining at depth within the water column.

As described in **Section 6.6.5** base fluids for NWBM are designed to be biodegradable in offshore marine sediments. Biodegradation can result in a low oxygen (anoxic) environment resulting in changes in benthic community structure. NWBMs are designed to be low in toxicity and are not readily bioavailable, based on their physical/chemical properties, for bioaccumulation to infauna and epifauna. Lethal impacts to the underlying infauna may occur but are considered unlikely, and recolonisation would occur over time. Elevated hydrocarbon and metal concentrations in the localised area of deposition would also occur, with reduction over time. It is likely that any impacts to water and sediment quality and low-sensitivity deeper water benthos would be short term, localised and a full recovery expected.

Summary of Potential Impacts to Environmental Value(s)

Given the adopted controls, it is considered that accidental discharge of NWBM/base oil or WBM will not result in a potential impact to protected species and water quality greater than E with no significant impact on environmental receptors predicted. It is considered that the release of NWBM cuttings from an unplanned discharge will not result in a potential impact greater than negligible and/or temporary contamination above background levels, water quality standards, or known effect concentrations.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)*** [28]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Where there is potential for loss of primary containment of oil and chemicals on the MODU, deck drainage must be collected via a closed drainage system. e.g. drill floor.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of contaminated deck drainage water being discharged to the marine environment. No change in consequence would occur.	Benefits outweigh cost/sacrifice.	Yes **C 5.3**
Marine riser's telescopic joint to be: • comprised of a minimum of two packers (one hydraulic and one pneumatic) pressure-tested in accordance with manufacturer's recommendations.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of equipment failure leading to an unplanned release of drilling fluids. Although the consequence of an unplanned release would be reduced, the reduction in likelihood reduces the overall risk providing an overall environmental benefit.	Benefits outweigh cost/sacrifice.	Yes **C 16.1**
Good Practice				
Drilling, completions, cementing, flowline pre-commissioning and subsea control fluids and additives will have an environmental assessment completed prior to use.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the consequence of impacts resulting from discharges to the marine environment by ensuring chemicals have been assessed for environmental acceptability. Planned discharges are required for safely executing activities; therefore, no reduction in likelihood can occur.	Benefits outweigh cost/sacrifice.	Yes **C 4.1**

[28] Qualitative measure.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)*** [28]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
No overboard disposal of bulk NWBM.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the consequence of the release on the environment. Although no change in likelihood is provided, the decrease in consequence results in an environmental benefit.	Benefits outweigh cost/sacrifice.	Yes **C 4.4**
Contractor procedure for the management of drilling fluids transfers onto, around and off the MODU, which requires: • emergency shutdown systems for stopping losses of containment (e.g. burst hoses) • break-away dry-break couplings for oil based mud hoses • transfer hoses to have flotation devised to allow detection of a leak • the valve line-up will be checked prior to commencing mud transfers • constant monitoring of the transfer process • direct radio communications • completed PTW and JSA showing contractor procedures are implemented • recording and verification of volumes moved to identify any losses • mud pit dump valves will be locked closed when not in use for mud transfers and operated under a PTW.	F: Yes. CS: Minimal cost. Standard practice for Woodside to review contractor systems prior to undertaking activity.	Reduces the likelihood of an unplanned release occurring. Although no change in consequence would occur, the reduction in likelihood decreases the overall risk, providing environmental benefit	Benefits outweigh cost/sacrifice.	Yes **C 16.2**
Check the functionality of: • additional SCE (augers and cuttings dryers) • mud tanks • mud tank room • transfer hoses • NWBM base fluid transfer lines • NWBM base fluid transfer station base fluid storage.	F: Yes. CS: Minimal cost. Standard practice	Reduces the likelihood of an event occurring and reduces the potential consequences (by limiting volume released).	Benefits outweigh cost/sacrifice.	Yes **C 16.3**
Professional Judgement – Eliminate				
No additional controls identified.				

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/Sacrifice (CS)*** [28]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Professional Judgement – Substitute				
Only use WBM.	F: Not feasible. A NWBM drilling fluid system is required for safety and technical reasons; therefore option to use must be maintained. CS: Not considered – control not feasible.	Not considered – control not feasible.	Not considered – control not feasible.	No
Professional Judgement – Engineered Solution				
Use a MODU which may have a larger tank storage capacity for WBM. As such, there would be fewer bulk transfer movements.	F: Not feasible. The use of a MODU with greater storage capacity cannot be confirmed. CS: Significant cost and schedule delay would occur if the MODU was limited to greater storage capacity.	Not considered – control not feasible.	Not considered – control not feasible.	No

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 the accidental discharge of drilling fluids, described above. As no reasonable additional/alternative controls were identified that would further reduce the risks and consequences without grossly disproportionate sacrifice, the risks and consequences are considered ALARP.

Demonstration of Acceptability

Acceptability Statement

The impact assessment has determined that, given the adopted controls, unplanned discharges of drilling fluids represent a medium current risk rating that is unlikely to result in a potential impact greater than minor and/or temporary contamination above background levels and/or national/international quality standards and/or known biological effect concentrations on a localised scale. Further opportunities to reduce the risks and consequences have been investigated above. The adopted controls are considered good oil-field practice/industry best practice. The potential risks and consequences are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the risks and consequences of an unplanned discharge of NWBM/base oil or WBM to a broadly acceptable level.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 16 No unplanned loss of WBM/ NWBM/base oil greater than a consequence level of F [29] during the Petroleum Activities Program.	**C 5.3** Where there is potential for loss of primary containment of oil and chemicals on the MODU, deck drainage must be collected via a closed drainage system. E.g. drill floor.	**PS 5.3** Contaminated drainage contained, treated and/or separated prior to discharge.	**MC 5.3.1** Records demonstrate MODU has a functioning bilge/oily water management system.
	C 6.1 Drilling, completions, cementing, flowline pre-commissioning and subsea control fluids and additives will have an environmental assessment completed prior to use.	**PS 6.1** Reduces to ALARP the impact potential of all chemicals intended or likely to be discharged into the marine environment.	**MC 6.1.1** Records demonstrate chemical selection, assessment and approval process for selected chemicals is followed.
	C 6.4 Backload of NWBM	**PS 6.4** No overboard disposal of bulk NWBM	**MC 6.4.1** Incident reports of any unplanned discharges of NWBM.
	C 16.1 Marine riser's telescopic joint to be: • comprised of a minimum of two packers (one hydraulic and one pneumatic) • pressure tested in accordance with manufacturers recommendations.	**PS 16.1** MODU's joint packer deigned and maintained to reduce hydrocarbons discharged to the environment.	**MC 16.1.1** Records demonstrate that MODU's joint packer is compliant.
	C 16.2 Contractor procedure for the management of drilling fluids transfers onto, around and off the MODU, which requires: • emergency shutdown systems for stopping losses of containment (e.g. burst hoses) • break-away dry-break couplings for oil based mud hoses • transfer hoses to have flotation devised to allow detection of a leak • the valve line-up will be checked prior to	**PS 16.2** Compliance with contractor procedures to limit accidental loss to the marine environment.	**MC 16.2.1** Records demonstrate drilling fluid transfers are performed in accordance with the applicable contractor procedures.

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

	commencing mud transfers • constant monitoring of the transfer process • direct radio communications • completed PTW and JSA showing contractor procedures are implemented • recording and verification of volumes moved to identify any losses • mud pit dump valves will be locked closed when not in use for mud transfers and operated under a PTW.		
	C 16.3 Check the functionality of: • SCE (augers and cuttings dryer) • mud tanks • mud tank room • transfer hoses • NWBM base fluid transfer lines • NWBM base fluid transfer station • base fluid storage.	**PS 16.3** Functionality checks on mud handling equipment prevent unacceptable use or discharge of NWBM/base oil.	**MC 16.3.1** Records demonstrate functionality of the specified equipment.

6.7.6 Unplanned Discharges: Deck and Subsea Spills

Context	
Project fluids **– Section 3.10**	Physical environment – **Section 4.4** Biological environment – **Section 4.5**

Risks Evaluation Summary														
Source of Risk	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Accidental discharge to the ocean of other hydrocarbons/ chemicals from MODU or support vessel deck activities and equipment (e.g. cranes) including subsea ROV hydraulic leaks			X		X	X		A	E	1	**L**	LCS GP PJ	Broadly Acceptable	EPO 17

Description of Source of Risk
Deck spills can result from spills from stored hydrocarbons/chemicals or equipment. Support vessels, installation vessel and the MODU typically store hydrocarbon/chemicals in various volumes (20 L, 205 L; up to about 4000–6000 L). 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). Subsea spills can result from a loss of containment of fluids from subsea equipment including the BOP or ROVs. The ROV hydraulic fluid is supplied through hoses containing about 20 L of fluid. Hydraulic lines to the ROV arms and other tooling may become caught, resulting in minor leaks to the marine environment. Small volume hydraulic leaks may occur from equipment operating via hydraulic controls subsea (subsea control fluid). These include the diamond wire cutter, bolt tensioning equipment, ROV tooling, etc. Minor leaks during wireline activities (a contingent activity) with a live well are described to include leaks such as: • leaks from the lubricator, stuffing box and hose or fitting failure, which are expected to be less than 10 L (0.01 m³) • loss of containment – fluids – surface holding tanks • backloading of raw slop fluids in an intermediate bulk container(s) • stuffing box leak/under pressure • draining of lubricator contents • lubricant used to lubricate hole • excess grease/lubricant leaking from the grease injection head. Wind-blown lubricant dripping from cable/on deck. 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.

Impact Assessment
Potential Impacts to Water Quality, Other Habitats and Communities and Protected Species
Accidental spills of hydrocarbons or chemicals from the MODU, installation vessel and support vessels will decrease the water quality in the immediate area of the spill; however, the impacts are expected to be temporary and very localised due to dispersion and dilution in the open ocean environment. Given the offshore/open water location, receptors such as marine fauna may be affected if they come in direct contact with a release (i.e. by traversing the immediate spill area). In the event that marine fauna come into contact with a release, they could suffer fouling, ingestion, inhalation of toxic vapours, irritation of sensitive membranes in the eyes, mouth, digestive and respiratory tracts, and organ or neurological damage. Cetaceans may exhibit avoidance behaviour patterns and given they are smooth skinned, hydrocarbons and other chemicals are not expected to adhere. Given the small area of the potential spill and the dilution and weathering of any spill, the likelihood of ecological impacts to marine fauna (protected species), other communities and habitats is likely to be negligible to very minor. No impacts on socio-economic receptors are expected due to the low levels of fishing activity in the Permit Area, the small volumes of hydrocarbons/chemicals that could be accidentally spilled, and the localised and temporary nature of the impacts.
Summary of Potential Impacts to Environmental Value(s)
Given the adopted controls, it is considered that other hydrocarbon/chemical spills to the marine environment will not result in a potential impact greater than slight, short term local impacts on species, habitat (but not affecting ecosystems function), physical and biological attributes (i.e. Environment Impact – E).

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Marine Order 91 (marine pollution prevention – oil) 2014, requires SOPEP/SMPEP (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 15.1**
Liquid 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.	Controls based on legislative requirements – must be adopted.	Yes **C 17.1**
Good Practice				
Where there is potential for loss of primary containment of oil and chemicals on the MODU, deck drainage must be collected via a closed drainage system. E.g. drill floor.	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.	Yes **C 5.3**
Spill kits positioned in high risk locations around the rig (near potential spill points such as transfer stations).	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 17.2**
Installation vessels have self-containing hydraulic oil drip tray management system.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of a deck spill from entering the marine environment. The	Benefits outweigh cost/sacrifice.	Yes **C 17.3**

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
		consequence is unchanged.		
Detailed oil spill preparedness and response performance outcomes, standards and measurement criteria for the Petroleum Activities Program are presented in **Appendix D**.				
Professional Judgement – Eliminate				
No additional controls identified.				
Professional Judgement – Substitute				
No additional controls 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 MODU/vessels.	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 drilling activities to occur.	Disproportionate. The cost/ sacrifice outweighs the benefit gained.	No
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 the potential unplanned accidental spills described above. As no reasonable additional/alternative controls were identified that would further reduce the risks and consequences without grossly disproportionate sacrifice, the risks and consequences are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that an unplanned minor discharge of hydrocarbons as a result of minor deck and subsea spills represents a low current risk rating that is unlikely to result in potential impact greater than localised, minor and temporary disruption to a small proportion of the population and no impact on critical habitat or activity. Further opportunities to reduce the risks and consequences 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 risks and consequences are considered acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the risks and consequences of minor unplanned deck and subsea spills to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 17 No unplanned spills to the marine environment from deck activities greater than a consequence level of F [30] during the Petroleum Activities Program.	**C 5.3** Where there is potential for loss of primary containment of oil and chemicals on the MODU, deck drainage must be collected via a closed drainage system. E.g. drill floor.	**PS 5.3** Contaminated drainage contained, treated and/or separated prior to discharge.	**MC 5.3.1** Records demonstrate MODU has a functioning deck drainage management system.
	C 15.1 Marine Order 91 (marine pollution prevention – oil) 2014, requires SOPEP/SMPEP (as appropriate to vessel class).	**PS 15.1** Appropriate initial responses prearranged and exercised for response to a hydrocarbon spill, as appropriate to vessel class in compliance with Marine Order 91 (marine pollution prevention – oil) 2014, requires SOPEP/ SMPEP (as appropriate to vessel class).	**MC 15.1.1** Marine assurance inspection records demonstrate compliance with Marine Order 91.
	C 17.1 Liquid chemical and fuel storage areas are bunded or secondarily contained when they are not being handled/ moved temporarily.	**PS 17.1** Failure of primary containment in storage areas does not result in loss to the marine environment.	**MC 17.1.1** Records confirms all liquid chemicals and fuel are stored in bunded/ secondarily contained areas when not being handled/moved temporarily.
	C 17.2 Spill kits positioned in high risk locations around the rig (near potential spill points such as transfer stations).	**PS 17.2** Spill kits to be available for use to clean up deck spills.	**MC 17.2.1** Records confirms spill kits are present, maintained and suitably stocked.
	C 17.3 Installation vessels have self-containing hydraulic oil drip tray management system.	**PS 17.3** Contain any on-deck spills of hydraulic oil.	**MC 17.3.1** Records demonstrate project installation vessels are equipped with self-containing hydraulic oil drip tray management system.

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

6.7.7 Unplanned Discharges: Loss of Solid Hazardous and Non-hazardous Wastes/Equipment

Context														
Project vessels – **Section 3.5**								Physical environment – **Section 4.4** Biological environment – **Section 4.5**						
Risks Evaluation Summary														
Source of Risk	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Accidental loss of hazardous or non-hazardous wastes/ equipment to the marine environment (excludes sewage, grey water, putrescible waste and bilge water)			X		X	X		A	F	2	**L**	LCS GP PJ	Broadly Acceptable	EPO 18
Description of Source of Risk														
The MODU and 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. Equipment that has been recorded as being lost on previous campaigns (primarily windblown or dropped overboard) have included a metal pole and hardhat. These have occurred during backloading activities, periods of adverse weather and incorrect waste storage.														
Impact Assessment														
Potential Impacts to Water Quality, Other Habitats and Communities, and Protected Species														
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 individual animals. The temporary or permanent loss of waste materials into the marine environment is not likely to have a significant environmental impact, based on the location of the Operational Area, the types, size and frequency of wastes that could occur, and species present.														
Summary of Potential Impacts to Environmental Value(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 (i.e. Environment Impact – F).														

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)*** [31]	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Marine Order 95 – Pollution prevention – garbage (as appropriate to vessel class), which requires putrescible waste and food scraps are passed through a macerator so that it is capable of passing through a screen with no opening wider than 25 mm.	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 5.1**
Good Practice				
Drilling and Completions Waste Management Plan, which requires: • dedicated space for waste segregation bins and skips shall be provided on the MODU • records of all waste to be disposed, treated or recycled • waste streams shall be handled and managed according to their hazard and recyclability class • all non-putrescible waste (excludes all food, greywater or sewage waste) shall be transported from the MODU and disposed of onshore.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of an unplanned release. The consequence is unchanged.	Benefit outweighs cost/ sacrifice.	Yes **C 18.1**
Installation Vessel Waste Management Plan, which requires: • dedicated waste segregation bins • records of all waste to be disposed, treated or recycled • waste streams shall 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 18.2**
MODU/project vessel ROV, crane or support vessel may be used to attempt recovery of hazardous solid wastes lost overboard. 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, or ROV availability and suitable weather).	F: Yes. CS: Minimal cost. Standard practice.	Occurs after an unplanned release of solid waste and therefore no change to the likelihood. Since the waste objects may be recovered, a reduction in consequence is possible.	Benefit outweighs cost/ sacrifice.	Yes **C 18.3**

[31] Qualitative measure.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)*** [31]	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
Professional Judgement – Eliminate				
No additional controls identified.				
Professional Judgement – Substitute				
No additional controls identified.				
Professional Judgement – Engineered Solution				
No additional controls 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 accidental discharges of waste. As no reasonable additional/alternative controls were identified that would further reduce the risks and consequences without grossly disproportionate sacrifice, the risks and consequences 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 slight, short term impacts on species, habitat (but not affecting ecosystems function), physical and biological attributes. Further opportunities to reduce the risks and consequences have been investigated above. The adopted controls are considered good oil-field practice/industry best practice and meet legislative requirements (Marine Orders 95 and 94). The potential risks and consequences are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the risks and consequences of these discharges to a level that is broadly acceptable.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 18 No unplanned releases of solid hazardous or non-hazardous waste to the marine environment greater than a consequence level of F [32] during the Petroleum Activities Program.	**C 5.1** Drilling, completions, cementing, flowline pre-commissioning and subsea control fluids and additives will have an environmental assessment completed prior to use.	**PS 5.1** Reduces to ALARP the impact potential of all chemicals intended or likely to be discharged into the marine environment.	**MC 5.1.1** Records demonstrate chemical selection, assessment and approval process for selected chemicals is followed.
	C 18.1 Drilling and Completions Waste Management Plan, which requires: • dedicated space for waste segregation bins and skips shall be provided on the MODU • records of all waste to be disposed, treated or recycled • waste streams shall be handled and managed	**PS 18.1** Hazardous and non-hazardous waste will be managed in accordance with the Drilling and Completions Waste Management Plan.	**MC 18.1.1** Records demonstrate compliance against Drilling and Completions Waste Management Plan.

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

	according to their hazard and recyclability class • all non-putrescible waste (excludes all food, greywater or sewage waste) shall be transported from the MODU and disposed of onshore.		
	C 18.2 Installation Vessel Waste Management Plan, which requires: • dedicated waste segregation bins • records of all waste to be disposed, treated or recycled • waste streams shall be handled and managed according to their hazard and recyclability class.	**PS 18.2** Hazardous and non-hazardous waste will be managed in accordance with the Installation Vessel Waste Management Plan.	**MC 18.2.1** Records demonstrate compliance against Installation Vessel Waste Management Plan.
	C 18.3 MODU/project vessel ROV, crane or support vessel may be used to attempt recovery of hazardous solid wastes lost overboard. 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, o, ROV availability and suitable weather).	**PS 18.3** Any hazardous solid waste dropped to the marine environment will be recovered where safe and practicable to do so.	**MC 18.3.1** Records detail the recovery attempt consideration and status of any hazardous waste lost to marine environment.

6.7.8 Physical Presence: Vessel Collision with Marine Fauna

Context	
Project vessels **– Section 3.5**	Biological environment – **Section 4.5**

Risks Evaluation Summary														
Source of Risk	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Accidental collision between project vessels and protected marine fauna						X		A	E	1	**L**	LCS GP PJ	Broadly Acceptable	EPO 19

Description of Source of Risk
The MODU and project vessels operating in and around the Permit Area may present a potential hazard to cetaceans (e.g. humpback whales, pygmy blue whales) and other protected marine fauna such as marine turtles. 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. Support vessels are typically stationary or moving at low speeds when supporting drilling operations; support vessels typically transit to and from the Permit Area between two and four trips per week (e.g. to port) when the MODU is present in the Operational Area.

Impact Assessment

Potential Impacts to Protected Species

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.

Support vessels within the Operational Area are likely to be travelling less than eight knots; therefore, the chance of a vessel collision with protected species resulting in lethal outcome is reduced. No known key aggregation areas (resting, breeding or feeding) are located within or immediately adjacent to the Permit Area. However, the following BIAs overlap with the Permit Area (refer to **Section 4.5** for more detail of seasonal timings):

- pygmy blue whale migration corridor (northern migration April to August; southern migration October to January) from Indonesian waters to south-west Australia
- flatback turtle internesting buffer around the Montebello Islands and Dampier Archipelago during their summer nesting period
- whale shark foraging area off Ningaloo Coast along the 200 m isobath, with seasonally high use (April to June).

It is possible that these species will occur in the vicinity of the Permit Area at various times during the year, with increased numbers during peak periods (**Section 4.5.2**).

According to the data of Vanderlaan and Taggart (2007), it is estimated that the risk is less than 10% at a speed of four knots. Vessel–whale collisions at this speed are uncommon and, based on reported data contained in the US NOAA database (Jensen and Silber, 2004), there are 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 placed among whales.

Whale sharks are at risk from vessel strikes when feeding at the surface or in shallow waters (where there is limited option to dive). Whale sharks may traverse offshore North West Shelf waters including the Permit Area during their migrations to and from Ningaloo Reef (the Permit Area overlaps with the foraging BIA for this species). However, it is expected that whale shark presence within the Permit Area would not comprise significant numbers, given there is no main aggregation area within the vicinity of the Permit Area, and their presence would be transitory and of a short duration.

Marine mammals and fish are at risk of mortality through being caught in thrusters during station keeping operations (dynamic positioning). The risk of marine life getting caught in operating thrusters is unlikely, given the low presence of individuals, combined with the avoidance behaviour commonly displayed during dynamic positioning operations.

Considering the absence of potential nesting or foraging habitat (i.e. no emergent islands, reef habitat or shallow shoals) and the water depth, it is unlikely that the Permit Area represents important habitat for marine turtles. However, individuals may transit the area, particularly during internesting periods. It is acknowledged that there are significant nesting sites along the mainland coast and islands of the region (e.g. Montebello Islands located 50 km from the Permit Area).

It is unlikely that vessel movement associated with the Petroleum Activities Program will have a significant impact on marine fauna populations given: (1) the low presence of transiting individuals; (2) avoidance behaviour commonly displayed by whales and turtles; and (3) low operating speed of the support vessels (generally less than eight knots or stationary, unless operating in an emergency).

Summary of Potential Impacts to Environmental Value(s)

Given the adopted controls, it is considered that a collision, were it to occur, will not result in a potential impact greater than slight, short term impact on species (i.e. Environment Impact – E).

Demonstration of ALARP

Control Considered	*Control Feasibility (F) and Cost/Sacrifice (CS)*	*Benefit in Impact/Risk Reduction*	*Proportionality*	*Control Adopted*
Legislation, Codes and Standards				
EPBC Regulations 2000 – Part 8 Division 8.1 Interacting with cetaceans, including the following measures[33]: • Project vessels will not travel greater than 6 knots within 300 m of a cetacean or turtle (caution zone) and not approach closer than 100 m from a whale. • 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	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 19.1**

[33]For safety reasons, the distance requirements below are not applied for a vessel holding station or with limited manoeuvrability, e.g. anchor handling, 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)***	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
whale shark and not allow the vessel to approach closer than 30 m of a whale shark.				
Good Practice				
Variation of the timing of the Petroleum Activities Program to avoid whale migration periods.	F: No. Timing of activities is linked to MODU schedule. Timing of all activities is currently not determined, and due to MODU availability and operational requirements, undertaking activities during migration seasons may not be able to be avoided. CS: Not considered, control not feasible.	Not considered, control not feasible.	Not considered, control not feasible.	No
Professional Judgement – Eliminate				
No additional controls identified.				
Professional Judgement – Substitute				
No additional controls identified.				
Professional Judgement – Engineered Solution				
No additional controls identified.				
The use of dedicated MFOs on support vessels for the duration of each activity to watch for whales and provide direction on and monitor compliance with Part 8 of the EPBC Regulations.	F: Yes. However, vessel bridge crews already maintain a constant watch during operations in compliance with the Woodside Marine – Charterers Instructions on the requirements of vessel and whale interactions, and crew undertake specific cetacean observation training. CS: Additional cost of MFOs considered unnecessary.	Given that support vessel bridge crews already maintain a constant watch during operations in compliance with the Woodside Marine – Charterers Instructions, additional MFOs would not significantly further reduce the risk.	Disproportionate. The cost/ sacrifice outweighs the benefit gained.	No
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 potential vessel collision with protected marine fauna. As no reasonable additional/alternative controls were identified that would further reduce the risks and consequences without grossly disproportionate sacrifice, the risks and consequences are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement
The impact assessment has determined that, given the adopted controls, vessel collision with marine fauna represents a low current risk rating that is unlikely to result in a potential impact greater than minor and temporary disruption to a small proportion of the population and no impact on critical habitat or activity. Further opportunities to reduce the risks and consequences 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 risks and consequences are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the risks and consequences 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 19 No vessel strikes with protected marine fauna (whales, whale sharks, turtles) during the Petroleum Activities Program.	**C 19.1** EPBC Regulations 2000 – Part 8 Division 8.1 Interacting with cetaceans, including the following measures[34]: • Project vessels will not travel greater than 6 knots within 300 m of a cetacean or turtle (caution zone) and not approach closer than 100 m from a whale. • 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.	**PS 19.1** Compliance with EPBC Regulations 2000 – Part 8 Division 8.1 (Regulation 8.05 and 8.06) Interacting with cetaceans to minimise potential for vessel strike.	**MC 19.1.1** Records demonstrate no breaches with EPBC Regulations 2000 – Part 8 Division 8.1 Interacting with cetaceans.
		PS 19.2 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).	**MC 19.2.1** Records demonstrate reporting cetacean ship strike incidents to the National Ship Strike Database.

[34]For safety reasons, the distance requirements below are not applied for a vessel holding station or with limited manoeuvrability e.g. anchor handling, loading, back-loading, bunkering, close standby cover for overside working and emergency situations.

6.7.9 Physical Presence: Disturbance to Seabed from Loss of Station Keeping

Context	
Project vessels – **Section 3.5** Project vessels-based activities **– Section 3.7**	Physical environment – **Section 4.4** Biological environment – **Section 4.5** Socio-economic – **Section 4.6** Values and sensitivities – **Section 4.7**

Risks Evaluation Summary

Source of Risk	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Loss of station keeping of MODU leading to seabed disturbance			X		X			A	E	1	**L**	GP PJ RBA	Broadly Acceptable	EPO 20

Description of Source of Risk

If dynamic positioning of the MODU cannot be used due to prevailing conditions (e.g. depth of well) and/or availability of suitable DP MODU, the MODU will be secured on station by a number of morning lines, as dictated by the mooring analysis, which are held in place by anchors deployed to the seabed (**Section 3.7.1**). High energy weather events such as cyclones, while the MODU is on station, can lead to excessive loads on the mooring lines resulting in failure (either anchor(s) dragging or mooring lines parting). A failure of mooring integrity may lead to the mooring lines and anchors attached to the MODU being trailed across the seabed. If mooring failure is sufficient, the MODU may move off station, increasing the likelihood of anchor drag across the seafloor.

When a moored MODU for the Petroleum Activities Program is used, personnel on-board the MODU are typically evacuated during cyclones. Woodside implements a risk-based assessment process to aid in decision making for cyclone evacuations, with the well suspended prior to MODU evacuation. Support vessels also demobilise from the Permit Area during the passage of a cyclone. While the MODU is temporarily abandoned, the position of the MODU is monitored remotely for any deviation. Support vessels and MODU personnel return to the Operational Area as soon as safe to do so following a cyclone evacuation. Operational experience indicates cyclone evacuations typically last for seven days.

Industry statistics from the North Sea show that a single mooring line failure for MODUs is the most common failure mechanism (33×10^{-4} per line per year), followed by a double mooring line failure (11×10^{-4} per line per year) (Petroleumstilsynet, 2014). Note that single and double mooring line failures do not typically result in the loss of station keeping. In the event of partial or complete mooring failures that are sufficient to result in a loss of station keeping, industry experience indicates that MODUs may drift considerable distances from their initial position (Offshore: Risk & Technology Consulting Inc., 2002). Partial mooring failures leading to a loss of station keeping resulted in smaller MODU displacements due to the remaining anchors dragging along the seabed when compared to complete mooring failures; complete mooring failures resulted in a freely drifting MODU (Offshore: Risk & Technology Consulting Inc., 2002).

NOPSEMA has recorded four cases of anchor drag due to loss of MODU holding station during cyclone activity between 2004 and 2015 (NOPSEMA, 2015).

Impact Assessment
Potential Impacts to Benthic Communities
Benthic habitats in the Permit Area are expected to largely consist of fine grained muddy sands and silts with only discrete areas of hard substrates (**Section 4.4.3**). In the highly unlikely event of a cyclone resulting in the MODU breaking its moorings, the anchors could cause physical damage to soft sediment and potentially limited hard bottom habitats and associated benthic communities (e.g. epifauna and infauna). This would result in localised short-term impacts to habitat and biological attributes. Given the low abundance, diversity and broad-scale distribution of the benthic habitat types within and adjacent to the Permit Area, the scale of impact will not be significant.
Summary of Potential Impacts to Environmental Value(s)
Given the adopted controls, seabed disturbance from a loss of station keeping will result in impacts to soft sediment benthic communities would result in only slight, short-term local impacts (i.e. Environment Impact – E).

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)***	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
No additional controls identified.				
Good Practice				
Specifications and requirements for station keeping equipment (mooring systems) require that: • systems are tested and inspected in accordance with API RP 21 • systems have sufficient capability such that a failure of any single component will not cause progressive failure of the remaining anchoring arrangement.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of mooring failure leading to loss of station keeping. Should mooring failure occur, no significant reduction in consequence could occur.	Benefit outweighs cost/ sacrifice.	Yes **C 20.1**
Professional Judgement – Eliminate				
Only use a DP MODU (no anchoring required) for all wells.	F: No. It is feasible to use a DP MODU for the Pyxis wells but unlikely for the Xena wells due to shallower depths. CS: Restricting MODU selection to only DP-capable rigs would introduce unacceptable additional costs and operational delays. Woodside has a demonstrated capacity to manage the environmental risks and impacts from mooring to a level that is ALARP and acceptable.	Application of control would eliminate the risk.	Disproportionate. The cost/ sacrifice associated with only using a DP capable MODU outweighs the benefit gained.	No
Professional Judgement – Substitute				
No additional controls identified.				

Professional Judgement – Engineered Solution				
MODU tracking equipment operational when the MODU unmanned.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of a loss of station keeping occurring. Although no reduction in consequence could occur, the overall risk is reduced	Benefit outweighs cost/ sacrifice.	Yes **C 20.2**
Risk Based Analysis				
Project-specific Mooring Design Analysis.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of mooring failure occurring. Although no reduction in consequence would occur, the overall risk is reduced.	Benefit outweighs cost/ sacrifice.	Yes **C 3.2**
Mooring system is tested to recommended tension as per API RP 2SK.	F: Yes. CS: Minimal cost. Standard practice.	Reduces the likelihood of anchor drag leading to seabed disturbance.	Benefit outweighs cost/ sacrifice.	Yes **C 20.3**

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 seabed disturbance from a loss of station keeping. As no reasonable additional/alternative controls were identified that would further reduce the risks and consequences without grossly disproportionate sacrifice, the risks and consequences are considered ALARP.

Demonstration of Acceptability

Acceptability Statement

The impact assessment has determined that, given the adopted controls, seabed disturbance from a loss of station represents a low current risk rating (E) that is unlikely to result in a potential impact greater than localised and short term effects to benthic habitat. Further opportunities to reduce risks and consequences have been investigated above. The adopted controls are considered good oil-field practice/industry best practice. The potential consequences and risks are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the consequences and risks of seabed disturbance from existing subsea flowlines/export pipelines from a loss of station keeping to an acceptable level.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 20 No mooring failure for the MODU during the Petroleum Activities Program.	**C 20.1** Specification and requirements for station keeping equipment (mooring systems), require that: • systems are tested and inspected in accordance with API RP 21 • systems have sufficient capability such that a failure of any single component will not cause progressive failure of the remaining anchoring arrangement.	**PS 20.1** MODU mooring system tested and in place to ensure no complete mooring failure.	**MC 20.1.1** Records demonstrate mooring system tests and inspection.
	C 20.2 MODU tracking equipment operational when the MODU is unmanned.	**PS 20.2** Tracking of the MODU is possible when the MODU is unmanned.	**MC 20.2.1** Records show the MODU has functional tracking equipment for instances when MODU is unmanned.
	C 20.3 Mooring system is tested to recommended tension as per API RP 2SK.	**PS 20.3** Monitoring compliant with ISO 19901-7:2013.	**MC 20.3.1** Records confirm mooring system is tested to recommended tension as per API RP 2SK.
	C 2.2 Project-specific Mooring Design Analysis.	**PS 2.2.1** Anchors installed as per Mooring Design Analysis to ensure adequate MODU station holding capacity.	**MC 2.2.1** Records demonstrate Mooring Design Analysis completed and implemented during anchor deployment.

6.7.10 Physical Presence: Dropped Object Resulting in Seabed Disturbance

Context	
Project vessels – **Section 3.5** Project vessels-based activities **– Section 3.7** Drilling activities **– Section 3.8** Subsea installation and pre-commissioning activities **– Section 3.9** Contingent activities **– Section 3.11**	Biological environment – **Section 4.5** Physical environment – **Section 4.4**

Risks Evaluation Summary

Source of Risk	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Dropped objects resulting in the disturbance of benthic habitat		X			X			A	F	2	**L**	LCS GP PJ	Broadly Acceptable	EPO 21

Description of Source of Risk

There is the potential for objects to be dropped overboard from the MODU and project vessels to the marine environment. Objects that have been dropped during previous offshore projects include small numbers of personal protective gear (e.g. glasses, gloves, hard hats), small tools (e.g. spanners) hardware fixtures (e.g. riser hose clamp) and drill equipment (e.g. drill pipe). The spatial extent in which dropped objects can occur is restricted to the Permit Area.

Impact Assessment

Potential Impacts to Other Benthic Communities

In the unlikely event of loss of equipment or materials to the marine environment, potential environmental effects would be limited to localised physical impacts on benthic communities. As a result of recovery of any dropped objects, this impact will be temporary in nature; however, if the object cannot be recovered due to health and safety, operational constraints and other factors (locating dropped objects at depth), then the impact will be long term.

The temporary or permanent loss of dropped objects into the marine environment is not likely to have a significant environmental impact, as the benthic communities associated with the Permit Area are of low sensitivity and are broadly represented throughout the NWMR (**Section 4.5**).

As described in **Section 4.7.3.1**, the Continental Slope Demersal Fish Communities KEF overlaps the Permit Area and the Ancient Coastline at 125 m Depth Contour KEF is located within 1 km of the Permit Area. The habitat types associated with the hard substrate that characterises the Ancient Coastline at 125 m Depth Contour KEF are not considered to be unique by Falkner et al. (2009) in their review of KEFs in the NWMR. Furthermore, extensive surveys of the field have been undertaken which have shown the substrates being mostly composed of soft sediments and sand with limited areas of hard substrates (**Section 4.4.3**). As described in **Sections 4.4.3** and **4.5.1.4**, discrete hard substrates recorded include a small field of rock pinnacles which provide habitat for a diversity of fauna including fish and invertebrates. Given the nature and scale of risks and consequences from dropped objects, seabed sensitivities associated with the Permit Area will not be significantly impacted. Further, considering the types, size and frequency of dropped objects that could occur, it is unlikely that a dropped object would have a significant impact on any benthic community.

Summary of Potential Impacts to Environmental Value(s)
Given the adopted controls and the predicted small footprint of a dropped object, it is considered that a dropped object will result in only localised impacts to a small area of the seabed and a small proportion of the benthic population; however, no significant impact to environmental receptors, and with no lasting effect (i.e. Environment Impact – F).

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)*** [35]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
No additional controls identified.				
Good Practice				
The MODU/ installation vessels' work procedures for lifts, bulk transfers and cargo loading, which require: • The security of loads shall be checked prior to commencing lifts. • Loads shall be covered if there is a risk of loss of loose materials. • Lifting operations shall be conducted using the PTW and JSA systems to manage the specific risks of that lift, including consideration of weather and sea state.	F: Yes. CS: Minimal cost. Standard practice.	Occurs after a dropped object event and therefore no change to the likelihood. Since the object may be recovered, a reduction in consequence is possible.	Benefits outweigh cost/sacrifice.	Yes **C 21.1**
MODU/ installation vessel inductions include control measures and training for crew in dropped object prevention.	F: Yes. CS: Minimal cost. Standard practice.	By ensuring crew are appropriately trained in dropped object prevention, the likelihood of a dropped object event is reduced. No change in consequence will occur.	Benefits outweigh cost/sacrifice.	Yes **C 18.2**
MODU/project vessel ROV, crane or support vessel may be used to attempt recovery of hazardous solid wastes lost overboard. 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, or ROV availability and suitable weather).	F: Yes. CS: Minimal cost. Standard practice.	Occurs after an unplanned release of solid waste and therefore no change to the likelihood. Since the waste objects may be recovered, a reduction in consequence is possible.	Benefit outweighs cost/ sacrifice.	Yes **C 18.3**

[35] Qualitative measure.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)*** [35]	***Benefit in Impact/Risk Reduction***	***Proportionality***	***Control Adopted***
Professional Judgement – Eliminate				
No additional controls identified.				
Professional Judgement – Substitute				
No additional controls identified.				
Professional Judgement – Engineered Solution				
No additional controls 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 seabed disturbance from dropped objects. As no reasonable additional/alternative controls were identified that would further reduce the risks and consequences without grossly disproportionate sacrifice, the risks and consequences are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that, given the adopted controls, dropped objects will not result in a potential impact greater than minor and temporary disruption to a small area of the seabed, a small proportion of the benthic population and no impact on critical habitat or activity. Further opportunities to reduce the risks and consequences have been investigated above. The adopted controls are considered good oil-field practice/industry best practice. The potential risks and consequences are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the risks and consequences of seabed disturbance from dropped objects to an acceptable level.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 21 No incidents of dropped objects to the marine environment greater than a consequence level of F [36] during the Petroleum Activities Program.	**C 21.1** The MODU/installation vessels' work procedures for lifts, bulk transfers and cargo loading, which require: • the security of loads to be checked prior to commencing lifts • loads to be covered if there is a risk of losing loose materials • lifting operations to be conducted using the PTW and JSA systems to manage the specific risks of that lift, including consideration of weather and sea state.	**PS 21.1** All lifts conducted in accordance with applicable MODU/ installation vessel work procedures to limit potential for dropped objects.	**MC 21.1.1** Records show lifts conducted in accordance with the applicable MODU/ installation vessel work procedures.

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

	C 21.2 MODU/ installation vessel inductions include control measures and training for crew in dropped object prevention.	**PS 21.2** Awareness of requirements for dropped object prevention.	**MC 21.2.1** Records show dropped object prevention training is provided to the MODU/ installation vessels.
	C 18.3 MODU/project vessel ROV, crane or support vessel may be used to attempt recovery of hazardous solid wastes lost overboard. 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, or, ROV availability and suitable weather).	**PS 18.3** Any hazardous solid waste dropped to the marine environment will be recovered where safe and practicable to do so.	**MC 18.3.1** Records detail the recovery attempt consideration and status of any hazardous waste lost to marine environment.

6.7.11 Physical Presence: Accidental Introduction and Establishment of Invasive Marine Species

Context		
Project vessels **– Section 3.5**	Physical environment – **Section 4.4** Biological environment – **Section 4.5** Socio-economic **– Section 4.6**	Stakeholder consultation – **Section 5**

Risks Evaluation Summary

Source of Risk	***Environmental Value Potentially Impacted***							***Evaluation***						
	Soil and Groundwater	***Marine Sediment***	***Water Quality***	***Air Quality (incl Odour)***	***Ecosystems/Habitat***	***Species***	***Socio-Economic***	***Decision Type***	***Consequence***	***Likelihood***	***Current Risk Rating***	***ALARP Tools***	***Acceptability***	***Outcome***
Introduction of invasive marine species					X	X	X	A	D	0	**L**	LCS	Broadly Acceptable	EPO 22

Description of Source of Risk

Vessels

During the Petroleum Activities Program, vessels will be transiting to and from the Operational Areas, potentially including traffic mobilising from beyond Australian waters. These project vessels may include the MODU, installation vessels, light well intervention vessel, anchor handling vessels, heavy lift vessels and activity support vessels (**Section 3.6**).

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 onboarding of ballast water as cargo is loaded or to balance vessels under load.

During the Petroleum Activities Program, project vessels have the potential to introduce IMS to the Permit Area through biofouling (containing IMS) on vessels as well as within high risk ballast water discharge. Cross contamination between vessels can also occur (e.g. IMS translocated between project vessels).

Impact Assessment

Potential Impacts to Ecosystems/Habitats, Species and Socio-economic 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 and the majority of NIMS around the world are relatively benign and few have spread widely beyond sheltered ports and harbours.

Potential IMS have historically been introduced and translocated around Australia by a variety of natural and human means including biofouling 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). The undisturbed, deep water, offshore location of the Operational Area is therefore unlikely to represent suitable habitat for the establishment of IMS.

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.

While project vessels have the potential to introduce IMS into the Operational Area, the deep offshore open waters of the Operational Area and broader Permit Area (>100 m) are not conducive to the settlement and establishment of IMS.

Furthermore, the Operational Area is away from shorelines and/or critical habitat. Although a small portion of the Montebello Marine Park overlaps with the Operational area, the depths of the offshore section are greater than 50 m, while the shallower nearshore waters of the Montebello Islands is approximately 40 km from the Operational Area. It is therefore not expected that settlement and establishment of IMS within the Marine Park could occur as a result of the Petroleum Activities Program. The likelihood of IMS being introduced and establishing viable populations within the Operational Area or surrounds is considered not credible.

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 a marine pest translocation. The results of this assessment are presented in **Table 6-18**.

As a result of this assessment, Woodside has presented the highest potential consequence as a D and likelihood as Remote (0), resulting in an overall Low risk following the implementation of identified controls.

Table 6-17: Evaluation of risks and impacts from marine pest translocation

IMS Introduction Location	Credibility of Introduction	Consequence of Introduction	Likelihood
Introduced to Operational Area and establishment on the seafloor or subsea structures.	***Not Credible*** The deep offshore open waters of the Permit Area, away from shorelines and/or critical habitat, more than 50 km from a shoreline and in waters >100 m deep are not conducive to the settlement and establishment of IMS.		
Introduced to Operational Area and establishment on a project vessel.	***Credible*** There is potential for the transfer of marine pests between project vessels within the Operational Area.	***Environment – Not credible*** The translocation of IMS from a colonised MODU or project vessel to shallower environments via natural dispersion is not considered credible, given the distances of the Operational Area from nearshore environments (i.e. greater than 12 nm/50 water depth). There is therefore no credible environmental risk and the assessment is limited to Woodside's reputation. **Reputation – D** If IMS were to establish on a project vessel (i.e. MODU, installation vessels, activity support vessels), this could potentially impact the vessel operationally through the fouling of intakes, result in translocation of an IMS into the Operational Area and, depending on the species, 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 to perform. Such introduction would be expected to have minor impact to Woodside's	***Remote (0)*** Interactions between project vessel will be limited during the Petroleum Activities Program, with minimum 500 m safety exclusion zones being adhered to around the MODU, and interactions limited to short periods of time alongside (i.e. during backloading, bunkering activities). There is also no direct contact (i.e. they are not tied up alongside) during these activities. Spread of marine pests via ballast water or spawning in these open ocean environments is also considered remote.

		reputation, particularly with Woodside's contractors, and would likely have a reputational impact on future proposals.	
Transfer between project vessels and from project vessels to other marine environments beyond the Operational Area.	***Not Credible*** This risk is considered so remote that it is not credible for the purposes of the activity. The transfer of a marine pest between project vessels was already considered remote, given the offshore open ocean environment (i.e. transfer pathway discussed above). For a marine pest to then establish into a mature spawning population on the new project vessel (which would have been through Woodside's IMS process) and then transfer to another environment is not considered credible (i.e. beyond the Woodside risk matrix). Project vessels will be located in an offshore, open ocean, deep environment, where IMS survival is implausible. Furthermore, this marine pest once transferred would need to survive on a new vessel with good vessel hygiene (i.e. has been through Woodside's risk assessment process), and survive the transport back from the Operational Area to shore. In the event it was to survive this trip, it would then need to establish a viable population in nearshore waters.		

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)*** [1]	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
Legislation, Codes and Standards				
Project vessels will manage their ballast water using one of the approved ballast water management options, as specified in the Australian Ballast Water Management Requirements.	F: Yes. CS: Minimal cost. Standard practice.	The use of an approved ballast water treatment system will reduce the likelihood of transfer of 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 22.1**
Good Practice				
IMS risk assessment process applied to project vessels which enter the Operational Area. 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.	F: Yes. CS: Minimal cost. Good practice implemented across all Woodside Operations.	The IMS risk assessment process will identify potential risks and additional controls implemented accordingly. In doing so, the likelihood of transfer of marine pests between project vessels within the Operational Area is reduced. No change in consequence would occur.	Benefits outweigh cost/sacrifice.	Yes **C 22.2**

[1] Qualitative measure.

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)*** [1]	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
Professional Judgement – Eliminate				
No discharge of ballast water during the Petroleum Activities Program.	F: No. Ballast water discharges are critical for maintaining 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 MODU/vessels.	F: No. Given that vessels must be used to implement project, 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 time and duration of sourcing a vessel, as well as the ability of the local vessels to perform the required tasks. For example, there are limited installation vessels based in Australian waters. While the project will attempt to source support vessels locally, it is not always possible. Availability cannot always be guaranteed when considering competing oil and gas activities in the region. In addition, sourcing Australian based vessels only will cause increases in cost due to pressures of vessel availability. CS: Significant cost and schedule impacts due to restrictions of vessel hire opportunities.	Sourcing vessels from within Australia will reduce the likelihood of IMS from outside Australian waters; however, it does not reduce the likelihood of introduction of species native to Australia but alien to the Operational Area and NWMR, or of IMS that have established elsewhere in Australia. The consequence is unchanged.	Disproportionate. Sourcing vessels from Australian waters may result in a reduction in the likelihood of IMS introduction to the Operational Area; however, the potential cost of implementing this control is grossly disproportionate to the minor environmental gain (or reducing an already remote likelihood of IMS introduction) potentially achieved by using only Australian based vessels, consequently this risk is considered not reasonably practicable.	No

Demonstration of ALARP				
Control Considered	***Control Feasibility (F) and Cost/ Sacrifice (CS)*** [1]	***Benefit in Impact/ Risk Reduction***	***Proportionality***	***Control Adopted***
IMS Inspection of all vessels.	F: Yes. Approach to inspect vessels could be a feasible option. CS: Significant cost and schedule impacts. In addition, Woodside's IMS risk assessment process (**C 19.2**) is seen to be more cost-effective as this control allows Woodside to manage the introduction of marine pests through biofouling, while targeting its efforts and resources to areas of greatest concern.	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 change in consequence would occur.	Disproportionate. The cost/sacrifice outweighs the benefit gained, as other controls to be implemented achieve an ALARP position.	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 risks and consequences of IMS introduction. As no reasonable additional/alternative controls were identified that would further reduce the risks and consequences without grossly disproportionate sacrifice, the risks and consequences are considered ALARP.				

Demonstration of Acceptability
Acceptability Statement The impact assessment has determined that, given the adopted controls, translocation of IMS may result in a temporary impact with no lasting effect and the likelihood of introducing IMS to the Permit Area is considered remote [37]. Further opportunities to reduce the risks and consequences have been investigated above. The adopted controls are considered good oil-field practice/industry best practice. The potential risks and consequences are considered broadly acceptable if the adopted controls are implemented. Therefore, Woodside considers the adopted controls appropriate to manage the risks and consequences of invasive marine species to an acceptable level.

[37] All project vessels including the MODU will undergo Woodside's IMS risk assessment process therefore the risk of introducing IMS to the Operational Area and then onto nearshore or coastal areas was considered not credible.

Environmental Performance Outcomes, Standards and Measurement Criteria			
Outcomes	***Controls***	***Standards***	***Measurement Criteria***
EPO 22 No introduction and establishment of invasive marine species into the Operational Area as a result of the Petroleum Activities Program.	**C 22.1** Project vessels will manage their ballast water using one of the approved ballast water management options, as specified in the Australian Ballast Water Management Requirements.	**PS 22.1** Project vessels manage ballast water in accordance with Australian Ballast Water Management Requirements.	**MC 22.1.1** Ballast Water Records System maintained by vessels which verifies compliance against Australian Ballast Water Management Requirements.
	C 22.2 IMS risk assessment process applied to project vessels which enter the Operational Area. 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.	**PS 22.2** Project vessels that enter the Operational Area subjected to the IMS risk assessment process.	**MC 22.2.1** Records of IMS risk assessments maintained for all project vessels undertaking the Petroleum Activities Program.
			MC 22.2.2 Records maintained of management measures which have been implemented where identified through the IMS Vessel Risk Assessment process.

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 environmental risks and impacts are continually being reduced to ALARP and are acceptable, and that environmental performance outcomes and standards outlined in this EP are achieved.

Woodside, as Operator, is responsible for ensuring the Petroleum Activities Program is managed in accordance with this Implementation Strategy and the WMS (see **Section 1.9**).

7.2 Systems, Practice and Procedures

All operational activities are planned and performed in accordance with relevant legislation and standards, management measures identified in this EP and internal environment standards and procedures (**Section 6**).

The systems, practices and procedures that will be implemented are listed in the Performance Standards (PS) contained in this EP. Document names and reference numbers may change during the statutory duration of this EP and is managed through a changes register and update 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 Project Manager	• 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 an HSE induction. • Verify that contractors meet environmental related contractual obligations. • Confirm environmental incident reporting meets regulatory requirements (as outlined in this EP) and Woodside's Health, Safety and Environment Reporting and Investigation Procedure. • Monitor and close out corrective actions identified during environmental monitoring or audits.
Woodside Well Delivery Manager	• Ensure drilling operations are performed as per this EP and approval conditions. • Provide sufficient resources to implement the drilling-related management measures (i.e. controls, EPOs, PSs and MC) in this EP. • Ensure MODU and support vessel personnel are given an Environmental Induction as per **Section 7.4.2** of this EP at the start of the drilling programs. • Confirm controls and performance standards in this EP are actioned, as required, before drilling commences. • Ensure the MODU start-up meets the requirements of the Drilling & Managing Rig Operations Process.
Subsea Delivery Manager	• Ensure the subsea installation activities are performed as per this EP and approval conditions. • Provide sufficient resources to implement the subsea installation-related management measures (i.e. controls, EPOs, PSs and MC) in this EP. • Ensure installation vessel personnel are given an Environmental Induction, as per **Section 7.4.2**, of this EP at the start of the installation activities. • Confirm controls and performance standards in this EP are actioned, as required, before installation activities commence. • Ensure relevant vessels meet the requirements of Woodside's Marine Operations Operating Standard. • Manage change requests for the activity and notify the Woodside Environment Adviser in a timely manner of any scope changes. • Confirm that site-based personnel are given an Environmental Induction, as per **Section 7.4.2**, of this EP at the start of the activity. • Communicate changes to the subsea and flowline/pipeline installation program to the Woodside Environmental Adviser in a timely manner. • Ensure all chemicals and drill fluids proposed to be discharged are assessed and approved as per the requirements of the EP.

Title (role)	Environmental Responsibilities
Woodside Drilling Superintendent	• Ensure the drilling program meets the requirements detailed in this EP. • Ensure changes to the drilling program are communicated to the Woodside Environmental Adviser. • Ensure Woodside's Well Site Manager is provided with the resources required to ensure the management measures (i.e. controls, EPOs, EPs and MC) in this EP are implemented. • Confirm environmental incident reporting meets regulatory requirements (as outlined in this EP) and Woodside's Health, Safety and Environment Reporting and Investigation Procedure. • Monitor and close out corrective actions identified during environmental monitoring or audits.
Woodside Drilling Engineers	• Ensure changes to the drilling program are communicated to the Woodside Environmental Adviser. • Ensure all drilling and completions fluid chemical components and other fluids that may be used downhole have been reviewed by the Drilling and Completions Environmental Adviser.
Woodside Environmental Adviser	• Verify relevant Environmental Approvals for the activities exist before commencing activity. • Track compliance with performance outcomes and performance standards as per the requirements of this EP. • Prepare environmental component of relevant Induction Package. • Assist with the review, investigation and reporting of environmental incidents. • Ensure environmental monitoring and inspections/audits are performed as per the requirements of this EP. • 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. • Monitor and close out corrective actions (Campaign Action Register) identified during environmental monitoring or audits. • Provide advice to relevant Woodside personnel and contractors to help them understand their environment responsibilities. • Liaise with installation contractors to ensure communication and understanding of environment requirements as outlined in this EP and in line with Woodside's Compass values and management systems.
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	• Conduct relevant audit and inspection to confirm vessels comply with relevant Marine Orders and Woodside Marine Charters Instructions requirements to meet safety, navigation and emergency response requirements.

Title (role)	Environmental Responsibilities
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 including objectives for action. • Approve, implement and manage the Incident Action Plan. • Communicate within and beyond the incident management structure. • Manage and review safety of responders. • Address the broader public safety considerations. • Conclude and review activities.
MODU-based Personnel	
MODU Offshore Installation Manager	• Ensure the MODU's management system and procedures are implemented. • Ensure personnel starting work on the MODU receive an environmental induction that meets the requirements specified in this EP. • Ensure personnel are competent to perform the work they have been assigned. • Verify that emergency drills are conducted as per the MODU's schedule. • Ensure the MODU's Emergency Response Team has been given sufficient training to implement the MODU's SOPEP. • Ensure any environmental incidents or breaches of outcomes or standards are reported immediately to the Well Site Manager. • Ensure corrective actions for incidents or breaches are developed, communicated to the Well Site Manager, and tracked to close-out in a timely manner.
Woodside Well Site Manager	• Ensure the drilling program is performed as detailed in this EP. • Ensure the management measures (i.e. controls, EPOs, PSs and MC) detailed in this EP (relevant to offshore activities) are implemented on the MODU (other controls will be implemented onshore). • Ensure environmental incidents or breaches of outcomes or standards are reported as per the Woodside Corporate Event Notification Matrix. Ensure corrective actions for incidents and breaches are developed, tracked and closed out in a timely manner. • Ensure actions in the Drilling and Completions HSE Improvement Plan are performed. • Ensure periodic environmental inspections/reviews are completed. Ensure corrective actions from inspections are developed, tracked and closed out in a timely manner.

Title (role)	Environmental Responsibilities
Woodside Offshore HSE Adviser	• Support the Well Site Manager to ensure the controls detailed in this EP relevant to offshore activities are implemented on the MODU, and help collect and record evidence of implementation (other controls are implemented and evidence collected onshore). • Support the Well Site Manager to ensure the EPOs are met and the PSs detailed in this EP are implemented on the MODU. • Confirm actions in the Drilling and Completions HSE Improvement Plan are performed. • Support the Well Site Manager to ensure environmental incidents or breaches of outcomes or standards outlined in this EP, are reported, and corrective actions for incidents and breaches are developed, tracked and closed out in a timely manner. • Ensure periodic environmental inspections/reviews are completed and corrective actions from inspections are developed, tracked and closed out in a timely manner. • Review contractors' procedures, input into Toolbox talks and JSAs. • Provide day-to-day environmental support for activities in consultation with the Woodside Environment Adviser.
Drilling Logistics Coordinator	• Ensure waste is managed on the MODU and sent to shore as per the Drilling and Completions Waste Management Plan.
Vessel-based Personnel	
Installation 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 Woodside Well Site Manager. • Ensure corrective actions for incidents or breaches are developed, communicated to the Well Site Manager, and tracked to close-out in a timely manner. Ensure close-out of actions is communicated to the Well Site Manager.
Vessel Logistics Coordinators	• Ensure waste is managed on the relevant support vessels or installation vessels and sent to shore as per the relevant Waste Management Plan.
Vessel HSE Advisers	Refer to Woodside HSE Offshore Adviser responsibilities detailed above under MODU-based personnel.

Title (role)	Environmental Responsibilities
Contractor Project Manager	• Confirm activities are performed in accordance with this EP, as detailed in the Woodside-approved Contactor Environmental Management Plan. • Ensure personnel commencing work on the project receive a relevant environmental induction that meets the requirements specified in this EP. • Ensure personnel are competent to perform the work they have been assigned. • Ensure any environmental incidents or breaches of objectives, standards or criteria outlined in this EP, are reported immediately to the Woodside Responsible Engineer or Vessel Master.

It is the responsibility of all Woodside employees and contractors to implement the Woodside *Corporate Health, Safety, Environment and Quality Policy* (**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

7.4.1 Overview

Woodside as part of its contracting process assesses a proposed contractor's environmental management systems to determine the level of compliance with the standard AS/NZ ISO 14001. This assessment is performed for the Petroleum Activities Program as part of the pre-mobilisation process. The assessment determines whether there is a clearly defined organisational structure that clearly defines the roles and responsibilities for key positions. The assessment also assesses whether there is an up-to-date training matrix that defines any corporate and site/activity-specific environmental training and competency requirements.

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.

7.4.2 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 will be 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.

7.4.3 Petroleum Activity Specific Environmental Awareness

Before commencing drilling and subsea installation campaigns associated with the Petroleum Activities Program, a pre-activity meeting will be held on the MODU/ installation vessels with all relevant personnel. The pre-activity meeting provides an opportunity to reiterate specific environmental sensitivities or commitments associated with the activity. Relevant sections of the pre-activity meeting will also be communicated to the support vessel personnel. Attendance lists are recorded and retained.

During operations, regular HSE meetings will be held on the MODU and project vessels. During these meetings, recent environmental incidents are reviewed and awareness material presented regularly.

7.4.4 Management of Training Requirements

All personnel on the MODU and project 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 undertake a program of periodic monitoring during the Petroleum Activities Program – starting at mobilisation of each activity and continuing through the duration of each 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** and **Appendix D**.

The collection of this data (against the measurement criteria) will form part of the permanent record of compliance maintained by Woodside and 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 to record and submit safety and environment risk observation cards routinely (frequency varies with contractor)
- collection of evidence of compliance with the controls detailed in the EP relevant to offshore activities by the Woodside Offshore HSE Adviser (other compliance evidence is collected onshore)
- environmental discharge reports that record volumes of planned and unplanned discharges downhole (in the well), to ocean and atmosphere
- monitoring of progress against the Drilling and Completions function scorecard for 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 7.5.2**.

7.5.1.2 Receptor-Based Knowledge Updates

Under the Woodside Environmental Knowledge Management System, regular monitoring to maintain currency of receptor knowledge is performed as follows:

- DoEE EPBC Act listed species status, listed species Recovery/Management and Conservation Plans, and other environmental matters is reviewed quarterly and recorded by Environment Science team. The outcome of each review is summarised and issued to the relevant Environment personnel responsible for implementing the EP for their consideration.
- Under the Oil Spill Scientific Monitoring Programme preparedness, an annual review and update to the environmental baseline studies database is completed and documented.
- Periodic location-focused environmental studies 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.

7.5.2 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 Performance Outcomes, Controls and Standards detailed in this EP.

Internal auditing will be performed to cover each key project activity as summarised below.

7.5.2.1 MODU Activities

Internal auditing is performed on a MODU-specific schedule, rather than a schedule to align with each well. This enables continuous review and improvement of environmental performance over the term of the MODU contract. The following internal audits, inspections and reviews will be performed to review the environmental performance of the activities:

- Survey environment rig equipment for a newly contracted MODU (if not previously contracted to Woodside within the last two years) against Woodside's Engineering Standard – Rig Equipment. This standard covers functional and technical requirements for Woodside-contracted rigs and their associated equipment. An environment rig equipment survey scope typically includes mud and solids control systems, environmental discharge control (including drainage management), and loss of containment management.
- Complete a minimum of monthly environmental inspection (conducted by offshore Woodside personnel or a delegate) which may include verifying:
  - bunkering/transfers between support vessels and MODU/project vessels
  - environment containment including chemical storage, spill response equipment and housekeeping
  - general MODU environment risks including waste management, drilling fluids oil/water separation, and inspection of subsea and moonpool areas.

- Perform at least one environment audit during the Petroleum Activities Program, while the MODU is on location (by a Woodside Environment Adviser or delegate), which may include:
  - operational compliance audits relevant to environmental risk of activities which may include compliance with training commitments, discharge requirements, bunkering activities, verification of use of approved chemicals, and satisfactory close-out of items from previous audits
  - inspection of selected risk areas/activities (which may include shaker house, drill floor and mud management while commencing riser drilling or reservoir interception) during routine MODU visits throughout the MODU campaign, determined by risk, previous incidents or operation specification requirements.

7.5.2.2 Subsea Scope Activities

The following internal auditing will be performed for the subsea installation and pre-commissioning scopes:

- Pre-mobilisation inspection/audit report will be conducted by a relevant person (before commencing). The scope of the audits are risk-based and specific to the relevant activity, but will generally focus on aspects relating to ensuring appropriate understanding of environmental commitments and the operational readiness of the activity scope, including appropriate environmental controls in place. All primary vessels associated with the above scopes will be audited by Woodside, including the installation vessels. Support or transport vessels will be assessed on a risk-based approach, but will be audited via the primary subsea installation contractor’s process.
- At least one operational compliance audit relevant to applicable EP commitments will be conducted by a Woodside Environment Adviser for the subsea campaign. The audit may be conducted offshore or office-based, subject to the duration of the activity and logistics of performing the audit offshore for short duration scopes (e.g. pipelay).
- Contractor-specific HSE audits will also be conducted of the installation vessels and associated support vessels. The audits will consider the implementation of HSE management, risk management, as well as pre-mobilisation and offshore readiness.
- Vessel-based HSE inspections will be conducted fortnightly by vessel HSE personnel. Each inspection will focus on a specific risk area relevant to the project activity and a formal report will be issued (for example, bunkering controls, chemical and discharge management, cetacean reporting, etc.).

The internal audits 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 may also be 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.

This Environmental Commitments and Actions Register is used to track subsea support vessel and subsea activity compliance with EP commitments, including any findings and corrective actions.

Non-conformances identified will be reported and/or tracked in accordance with **Section 7.5.4**.

7.5.3 Marine Assurance

Woodside's marine assurance is managed by the Marine Assurance Team of the Marine Services Group. The Woodside process is 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 process is mandatory for all vessels hired for Woodside operations, including for short term hires (i.e. <3 months in duration). It defines applicable marine offshore assurance activities, ensuring all vessel operators operate seaworthy vessels that meet the requirements for a defined scope of work and are managed with a robust safety management system.

The process is multi-faceted and encompasses the following marine assurance activities:

- Offshore Vessel Safety Management System assessment (OVMSA)
- DP system verification
- OVID
- project support for tender review, evaluation and pre/post contract award.

OVID inspections are objective in nature and reflect what was observed by the Inspector while conducting the inspection. The inspection provides observations as opposed to non-conformities.

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 performed (i.e. short term vessel hire), the Marine Assurance Specialist Offshore may approve the use of an alternate means of inspection, known as a risk assessment.

7.5.3.1 Risk Assessment

Woodside conducts a risk assessment of vessels where either an OVMSA Verification Review and/or an OVID inspection cannot be completed. 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 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.

7.5.4 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 internal event recording, investigation and learning requirements.

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**). Detailed investigations are completed for all categories A, B, C and high potential environmental incidents.

7.5.5 Review

7.5.5.1 Management Review

Within the Environment Function, senior management regularly monitor and review environmental performance and the effectiveness of managing environmental risks and performance. Within each Function and Business Unit Leadership Team (e.g. Drilling and Completions, Subsea and Developments/Projects), managers review environmental performance regularly, including through quarterly HSE review meetings.

Woodside's Drilling and Completions Environment Team will perform six-monthly reviews of the effectiveness of the implementation strategy and associated tools. This will involve reviewing the:

- Drilling and Completions environment key performance indicators (leading and lagging)
- tools and systems to monitor environmental performance (detailed in **Section 7.5.1**)
- lessons learned about implementation tools and throughout each campaign.

Reviews of oil spill arrangements and testing are performed in accordance with **Section 7.9**.

7.5.5.2 Learning and Knowledge Sharing

Learning and knowledge sharing occurs via a number of different methods including:

- event investigations
- event bulletins

- after action review conducted at the end of each well, including review of environmental incidents as relevant
- ongoing communication with MODU operators
- formal and informal industry benchmarking
- cross asset learnings
- engineering and technical authorities discipline communications and sharing.

7.5.5.3 Review of Impacts, Risks and Controls Across the Life of the EP

In the unlikely case that activities described in this EP do not occur continuously or sequentially, before recommencing activities after a cessation period greater than 12 months, impacts, risks and controls will be reviewed.

The process will identify or review impacts and risks associated with the newly-commencing activity, and will identify or review controls to ensure impacts and risks remain/are reduced to ALARP and acceptable levels. Information learned from previous activities conducted under this EP will be considered. Controls which have previously been excluded on the basis of proportionality will be reconsidered. Any required changes will be managed by the MOC process outlined below (**Section 7.6**).

7.6 Environment Plan Management of Change and Revision

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, including all current advice from DoEE on species protected under the EPBC Act and current requirements for Australian Marine Parks (**Section 4**); and potential new advice from external stakeholders (**Section 5**), 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 2.5**) 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 Record Keeping

Compliance records (outlined in Measurement Criteria in **Section 6**) will be maintained.

Record keeping will be in accordance with Regulation 14(7) that addresses maintaining records of emissions and discharges.

7.8 Reporting

To meet the environmental performance outcomes and standards outlined in this EP, Woodside reports at a number of levels, as outlined in the next sections.

7.8.1 Routine Reporting (Internal)

7.8.1.1 Daily Progress Reports and Meetings

Daily reports for drilling activities are prepared and issued to key support personnel and stakeholders, by relevant managers responsible for the well. The report provides performance information about drilling 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.

7.8.1.2 Regular HSE Meetings

Regular dedicated HSE meetings are held with the offshore and Perth-based management and advisers to address targeted HSE incidents and initiatives. Minutes of these meetings are produced and distributed as appropriate.

7.8.1.3 Performance Reporting

Monthly and quarterly performance reports are developed and reviewed by the Function and Business Unit Leadership Teams (e.g. Drilling and Completions). 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.

7.8.2 Routine Reporting (External)

7.8.2.1 Start and End Notifications of the Petroleum Activities Program

In accordance with Regulation 29, Woodside will notify NOPSEMA and DMIRS of the commencement of the Petroleum Activities Program at least ten days before the activity commences, and will notify NOPSEMA and DMIRS within ten days of completing the activity.

7.8.2.2 Environmental Performance Review and Reporting

In accordance with applicable environmental legislation for the activity, Woodside is required to report information about 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 Reports (**Appendix E**)	NOPSEMA	Monthly, by the 15th of each month.	Details of recordable incidents that have occurred during the Petroleum Activities Program for previous month (if applicable).
Environmental Performance Report	NOPSEMA	Annually, with the first report submitted within 12 months of the commencement of the Petroleum Activities Program covered by this EP (as per the requirements of Regulation 14(2).	Compliance with environmental performance outcomes, controls and standards outlined in this EP, in accordance with the Environment Regulations.

7.8.2.3 End of the Environment 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.

7.8.3 Incident Reporting (Internal)

The process for reporting environmental incidents is described in **Sections 7.8.3** and **7.8.4** of this EP. 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.

7.8.4 Incident Reporting (External) – Reportable and Recordable

7.8.4.1 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 **Figure 2-4**))
- 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 **Figure 2-4**)).

The environmental risk assessment (**Section 6**) for the Petroleum Activities Program identifies those risks with a potential consequence level of C+ for environment. The incidents that have the potential to cause this level of impact include hydrocarbon loss of containment events to the marine environment resulting from a loss of well integrity.

Any such incidents represent potential events which would be reportable incidents. Incident reporting is undertaken 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) as soon as practicable, 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 and the Department of the responsible State Minister (DMIRS) as soon as practicable 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 as soon as practicable, but within three days of the incident or of its detection by Woodside
- provide a copy of the written report to the National Offshore Petroleum Titles Administrator and DMIRS, within seven days of the written report being provided to NOPSEMA.

AMSA will be notified of oil spill incidents as soon as practicable after their occurrence, and DoEE notified if MNES are to be affected by the oil spill incident.

7.8.4.2 Recordable Incidents

Definition

A recordable incident as defined under Regulation 4 of the Environment Regulations is an incident arising from the activity that '*breaches an environmental performance outcome or environmental performance standard, in the EP that applies to the activity, that is not a reportable incident'*.

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 (**Appendix E**) 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.

7.8.4.3 Other External Incident Reporting Requirements

In addition to the notification and reporting of environmental incidents defined under the Environment Regulations and Woodside requirements, **Table 7-3** describes the incident reporting requirements that also apply in the Permit Area.

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	As per Article 8 and Protocol I of MARPOL within two hours via the national emergency 24-hour notification contacts and a written report within 24 hours of the request by AMSA	AMSA Rescue Coordination Centre (RCC) Australia	If the ship is at sea, reports are to be made to: Free call: 1800 641 792 Phone: 08 9430 2100 (Fremantle)
Oil pollution incidents in Commonwealth waters	Vessel Master	AMSA	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 as soon as practicable after verbal notification	RCC Australia	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	Vessel Master	Department of Environment and Energy	Reported verbally, as soon as practicable	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	Vessel Master	Department of Environment and Energy	Within seven days of becoming aware	Secretary of the DoEE	Phone: 1800 803 772 Email: protected.species@environment.gov.au

The following pollution activity should also be reported to AMSA via RCC Australia by the Vessel Master:

- any loss of plastic material
- 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 WA-34-L Pyxis Drilling and Subsea Installation Oil Pollution First Strike Plan.

External incident reporting requirements required under the Offshore Petroleum and Greenhouse Gas Storage (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.

7.8.5 Cetacean and Whale Shark Sightings Reporting:

All project vessels and the MODU will be provided with sighting recording sheets which will be posted on notice boards for opportunistic reporting of cetacean and whale shark sightings. Awareness of sightings reporting will also be included in project inductions. These sightings reports will be collated and summarised on an annual basis during this activity (Regulation 29 notifications) and submitted to the Australian Antarctic Division of the Department of the Environment and Energy to satisfy condition 1(c)(vi) of EPBC Approval Decision 2006/2968.

7.9 Emergency Preparedness and Response

7.9.1 Overview

Under Regulation 14(8), the implementation strategy must contain an Oil Pollution Emergency Plan 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 for the WA-34-L Pyxis Drilling and Subsea Installation EP (**Appendix D**)
Describes the OPEP	Regulation 14(8)	Environment Plan: Woodside's oil pollution emergency plan has the following components: • Woodside Oil Pollution Emergency Arrangements (Australia) • WA-34-L Pyxis Drilling and Subsea Installation Oil Pollution First Strike Plan • Oil Spill Preparedness and Response Mitigation Assessment for the WA-34-L Pyxis Drilling and Subsea Installation EP (**Appendix D**)
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 for the WA-34-L Pyxis Drilling and Subsea Installation EP (**Appendix D**) WA-34-L Pyxis Drilling and Subsea Installation Oil Pollution First Strike Plan
Details the arrangements for updating and testing the oil pollution response arrangements	Regulation 14(8), (8A), (8B), (8C)	Environment Plan: **Section 7.9.4** Oil Spill Preparedness and Response Mitigation Assessment for the WA-34-L Pyxis Drilling and Subsea Installation EP (**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 for the WA-34-L Pyxis Drilling and Subsea Installation EP (**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)

7.9.2 Emergency Response Preparation

The Corporate Incident Coordination Centre, based in Woodside's head office in Perth, is the onshore coordination point for an offshore emergency. The CICC is staffed by a roster of appropriately skilled personnel available on call 24 hours a day. The CICC, under the leadership of the CICC Duty Manager, supports the site-based Incident Management Team by providing operations, logistics, planning, people management and public information (corporate affairs) support. A description of Woodside's Incident Command Structure and arrangements is further detailed 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 rig and location of operations to control, coordinate and respond to an emergency or incident. For a drilling activity, the ERP will be a bridging document to the contracted rig's emergency documentation. This document summarises the emergency command, control and communications processes for the integrated operation and management of an emergency. It is developed in collaboration with the contracted rig and ensures roles and responsibilities between the contracted rig and Woodside personnel are identified and understood. The ERPs 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 the event of an emergency of any type:

- On the MODU the Offshore Installation Manager will assume overall onsite command and act as the Incident Controller (IC). All persons aboard the MODU will be required to act under the IC's directions. The MODU/vessels will maintain communications with the onshore Drilling Superintendent and/or other emergency services in the event of an emergency. Emergency response support can be provided by the contractor's emergency centre or WCC if requested by the IC.
- Vessel Master (depending on the location of the emergency) will assume overall onsite command and act as the IC. All persons will be required to act under the IC's directions. The vessels will maintain communications with the onshore project manager and/or other emergency services in the event of an emergency. Emergency response support can be provided by the contractor's emergency centre or WCC if requested by the IC.
- The MODU and project vessels will have on-board equipment for responding to emergencies including medical equipment, fire-fighting equipment and oil spill response equipment.

7.9.3 Oil and Other Hazardous Materials Spill

A significant hydrocarbon spill during the proposed Petroleum Activities Program is unlikely, but should such an event occur, it has the potential to result in a serious safety or environmental incident and cause asset and reputational damage if not managed properly. The Woodside Oil Pollution Emergency Arrangements (Australia) document, supported by the WA-34-L Pyxis Drilling and Subsea Installation – Oil Pollution First Strike Plan which provides tactical response guidance to the activity/area and **Appendix D** of this EP, cover spill response for this Petroleum Activities Program.

In accordance with Woodside's Hydrocarbon Spill Preparedness and Response Procedure, the oil spill preparedness manager is responsible for managing Woodside's oil spill response equipment, and for maintaining oil spill preparedness and response documentation. In the event of a major spill, Woodside will request that AMSA (administrator of the National Plan) provides support to 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). AMSA and Woodside have a Memorandum of Understanding in place to support Woodside in the event of an oil spill.

The WA-34-L Pyxis Drilling and Subsea Installation – Oil Pollution First Strike Plan provides immediate actions required to commence a response.

The MODU and project vessels will have SOPEPs in accordance with the requirements of MARPOL 73/78 Annex I. These plans outline responsibilities, specify procedures and identify resources available in the event of a hydrocarbon or chemical spill from vessel activities. The Oil Pollution First Strike Plan is intended to work in conjunction with the SOPEPs, if hydrocarbons are released to the marine environment from a vessel.

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**.

7.9.4 Emergency and Spill Response Drills and Exercises

Woodside categorises incidents and emergencies in relation to response requirements as follows:

7.9.4.1 Level 1

Level 1 incidents are those that can be resolved using 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.

7.9.4.2 Level 2

Level 2 incidents are characterised by a response that requires external operational support to manage the incident. It is triggered if the capabilities of the tactical level response are exceeded. This support is provided to the activity by activating all or part of the responsible CICC.

7.9.4.3 Level 3

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 manages the strategic impacts to respond to and recover from the threat to the company (material impacts, litigation, legal & commercial, reputation, etc.). The CICC may also be activated as required to manage the operational response to the Level 3 incident.

7.9.5 Emergency and Spill Response Drills and Exercises

Woodside's capability to respond to incidents will be tested, with the frequency of these tests conducted as prescribed in **Table 7-5**. 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 developing emergency and crisis management exercises. External participants may be invited to attend crisis exercises and may include government agencies, specialist service providers, oil spill response organisations or industry members with which we have 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 Major Accident Events and Major Environment Events. After each exercise, the team holds a debrief session during which the exercise is reviewed. Any lessons learned or areas for improvement are identified and incorporated into emergency procedures where appropriate.

Table 7-5: Testing of response capability to incidents

	Response Testing
Level 1 Response	One Level 1 oil spill response exercise to be conducted within two weeks of new well commencement. This drill should test elements of the recommended response identified in the WA-34-L Pyxis Drilling and Subsea Installation – Oil Pollution First Strike Plan in relation to the level of the incident.
Level 2 Response	Minimum of one emergency management exercise per MODU per year, and one within one month of commencing a new activity in a new region.
Level 3 Response	The number of Crisis Management Team exercises conducted each year is determined by the Chief Executive Officer, in consultation with the General Manager Security and Emergency Management.

7.9.5.1 Testing of Oil Spill Response Arrangements

There are a number of arrangements which in a spill will underpin Woodside's ability to implement a response across its petroleum activities. To ensure each arrangement is adequately tested, the Security and Emergency Management Capability and Development Team ensures tests are conducted in alignment with the Hydrocarbon Spill Arrangements Testing Schedule.

Woodside's testing schedule aligns with international good practice for spill preparedness & response management; the testing is compatible with the International Petroleum Industry Environmental Conservation Association' Good Practice Guide and the Australian Emergency Management Institute Handbook.

Woodside's testing schedule 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 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. 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. The activity-specific Hydrocarbon Pollution First Strike Plan will be tested in alignment with **Table 7-5**. This ensures 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.

7.9.6 Cyclone and Dangerous Weather Preparation

As the timing of some activities associated with the Petroleum Activities Program are not yet determined, it is possible drilling and subsea installation activities will overlap with the cyclone season (November to April, with most cyclones occurring between January and March). If drilling in cyclone season, the MODU contractor and vessel contractors must have a Cyclone Contingency Plan (CCP) in place outlining the processes and procedures that would be implemented during a cyclone event, which will be reviewed and accepted by Woodside.

The MODU and project vessels will receive daily forecasts from the BoM. If a cyclone (or severe weather event) is forecast, the path and its development will be plotted and monitored using the BoM data. If there is the potential for the cyclone (severe weather event) to affect the Petroleum Activities Program, the CCP will be actioned. If required, vessels can transit from the proposed track of the cyclone (severe weather event).

7.10 Implementation Strategy and Reporting Commitments Summary

Table 7-6 provides a summary of key components within the implementation strategy.

Table 7-6: Implementation Strategy and Reporting Commitments Summary

Implementation Strategy (IS) Performance Outcome	Implementation Strategy Performance Standard	Implementation Strategy Measurement Criteria
PO IS-1 All crew will be aware of their roles and responsibilities regarding environmental risks throughout the Petroleum Activities Program.	**PS IS-1.1** All personnel are required to attend an induction prior to commencing work. These inductions cover health, safety and environmental requirements for the MODU and project vessels, and environmental information specific to the Petroleum Activities Program location.	**MC IS-1.1.1** Induction attendance records.
	PS IS-1.2 Pre-activity meeting held on the MODU and installation vessels with relevant personnel prior to undertaking the Petroleum Activities Program, focusing on any specific environmental sensitivities associated with the activity.	**MC IS-1.1.2** Pre-activity meeting attendance records and minutes.
	PS IS-1.3 During execution campaign, regular HSE meetings will be held on the MODU and project vessels which cover all crew. Recent environmental incidents are reviewed and awareness material presented on a regular basis.	**MC IS-1.3** Attendance is recorded and lists retained on the MODU/project vessels.
	PS IS-1.4 The MODU contractor and vessel contractors must have a Cyclone Contingency Plan (CCP) accepted by Woodside, and in place outlining the processes and procedures that would be implemented during a cyclone event, if drilling is to take place during cyclone season.	**MC IS-1.4** Record of Woodside approved Contractor CCP in place prior to activities commencing.
PO IS-2 Woodside and its Contractors will undertake a program of periodic monitoring during the Petroleum Activities Program – starting at mobilisation of each activity and continuing through the duration of each activity to activity completion.	**PS IS-2.1** Monitoring information will be collected using Woodside tools and systems.	**MC-IS 2.1.1** Monitoring reports including daily reports, periodic reports, risk observation cards, environmental discharge reports.
	PS IS-2.2 Periodic review of the Woodside Environmental Knowledge Management System to maintain currency of receptor knowledge.	**MC-IS 2.2.1** Review records of Corporate Environment Baseline Database.
PO IS-3 Woodside will undertake environmental performance auditing.	**PS IS-3.1** Start-up or pre-mobilisation audit for newly contracted installation vessel and MODU (if not previously contracted to Woodside within the last two years)	**MC IS-3.1.1** Woodside's start up or pre-mobilisation report for the installation vessel and MODU.

Implementation Strategy (IS) Performance Outcome	Implementation Strategy Performance Standard	Implementation Strategy Measurement Criteria
	PS IS-3.2 Offshore Woodside personnel conduct a minimum of monthly environmental inspections.	**MC IS-3.2.1** Completed environmental inspection checklists.
	PS IS-3.3 Woodside Environment Adviser (or delegate) completes at least one quarterly environment audit during the Petroleum Activities Program.	**MC IS-3.3.1** Quarterly Environment Audit report.
	PS IS-3.4 A pre-mobilisation inspection/audit report will be conducted by a relevant person prior to the commencement of subsea installation and pre-commissioning scopes.	**MC IS-3.4.1** Completed pre-mobilisation inspection/audit report.
	PS IS-3.5 At least one operational compliance audit relevant to applicable EP commitments will be conducted by a Woodside environment adviser for the subsea campaign.	**MC IS-3.5.1** Completed Operational Compliance Audit report.
	PS IS-3.6 Contractor-specific HSE audits will be conducted of the primary installation vessels and associated support vessels.	**MC IS-3.6.1** Completed HSE audits report.
	PS IS-3.7 Vessel based HSE inspections will be conducted fortnightly by vessel HSE personnel.	**MC IS-3.7.1** Completed HSE inspection checklists.
	PS IS-3.8 Audit findings relevant to continuous improvement of environmental performance will be tracked through the MODU or vessel compliance action register, a contractor register between the MODU operator or vessel contractor and Woodside.	**MC IS-3.8.1** MODU or vessel compliance action register records demonstrate tracking of audit findings.
	PS IS-3.9 Marine assurance will be undertaken in accordance with Woodside's Marine Offshore Vessel Assurance Procedure and is mandatory for all vessels hired for Woodside.	**MC IS-3.9.1** Records demonstrate marine assurance reviews conducted as required.

Implementation Strategy (IS) Performance Outcome	Implementation Strategy Performance Standard	Implementation Strategy Measurement Criteria
PO IS-4 Woodside employees and Contractors report all environmental incidents and non-conformance with environmental performance outcomes and standards in this EP.	**PS IS-4.1** Non-conformances to be notified, investigated and reported in accordance with the Woodside Health, Safety and Environment Event Reporting and Investigation Procedure.	**PS IS-4.1.1** Records demonstrate non-conformances are notified, investigated and reported in accordance with the Woodside Health, Safety and Environment Event Reporting and Investigation Procedure.
PO IS-5 Woodside will undertake regular reviews to monitor environmental performance and share knowledge and learning.	**PS IS-5.1** Woodside holds quarterly HSE review meetings.	**PS IS-5.1.1** Records demonstrate meetings reviewed HSE performance.
	PS IS-5.2 Woodside's Drilling and Completions Environment Team is to perform six-monthly reviews of the effectiveness of the implementation strategy and associated tools.	**PS IS-5.2.1** Records demonstrate six monthly reviews of the effectiveness of the implementation strategy.
	PS IS-5.3 After action review conducted at the end of each well for learning and knowledge sharing, including review of environmental incidents as relevant.	**PS IS-5.3.2** After action review report.
PO IS-6 Changes in activity scope, understanding of the environment and potential new advice from external stakeholders will be tracked and the EP updated as required.	**PS IS-6.2** Management of changes relevant to this EP to be managed in accordance with Woodside's Environmental Approval Requirements Australia Commonwealth Guideline.	**PS IS-6.2.1** Records of minor revisions to the EP tracked in an MOC Register. Revision and resubmission of the EP as required.
PO IS-7 All internal and external reporting requirements relevant to this EP will be met.	**PS IS-7.1** Woodside will submit an environmental performance report to NOPSEMA (annually with the first report submitted within 12 months of the start of the activity).	**MC IS-7.1.1** Record of submission of environmental performance reports to NOPSEMA.
	PS IS-7.2 Regular HSE meetings. Monthly and quarterly HSE performance reports.	**MC IS-7.2.1** HSE performance reports. Minutes of HSE meetings.

Implementation Strategy (IS) Performance Outcome	Implementation Strategy Performance Standard	Implementation Strategy Measurement Criteria
	PS IS-7.3 Woodside will submit a monthly recordable incident report to NOPSEMA.	**MC IS-7.3.1** Record of submission of monthly recordable incident report to NOPSEMA.
PO IS-8 All external notification requirements, as applicable to this EP, will be met.	**PS IS-8.1** Woodside will notify NOPSEMA and DMIRS of the start of the Petroleum Activities Program at least ten days before the activity commences. Woodside will notify NOPSEMA and DMIRS within ten days of the completion of the activity.	**MC IS-8.1.1** Record of notification to NOPSEMA. Record of notification to DMIRS.
	PS IS-8.2 The EP will end when Woodside notifies NOPSEMA that the Petroleum Activities Program has ended, and all the obligations identified in this EP have been completed, and NOPSEMA has accepted the notification, in accordance with Regulation 25A.	**MC IS-8.2 1** Record of notification to NOPSEMA.
	PS IS-8.3 NOPSEMA will be notified of all reportable incidents, according to the requirements of Regulations 26, 26A and 26AA of the Environment Regulations.	**MC IS-8.3.1** Record of notification to NOPSEMA.
	PS IS-8.4 DoEE (if MNES affected) will be notified of oil spill incidents as soon as practicable following the occurrence.	**MC IS-8.4.1** Record of notification to DoEE if MNES is affected.
	PS IS-8.5 Notify the Department of Primary Industries and Regional Development (formerly Department of Fisheries), peak fishing bodies and known regional commercial fishing operators identified in this EP prior to and upon completion of the proposed activity, including MODU and support vessel details.	**MC IS-8.5.1** Records of notification to the department, peak fishing bodies and known commercial regional fishing operators identified in this EP.

Implementation Strategy (IS) Performance Outcome	Implementation Strategy Performance Standard	Implementation Strategy Measurement Criteria
	PS IS-8.6 Any oil pollution incidents in Commonwealth waters will be reported without delay (by the Vessel Master) to AMSA RCC as per the *Protection of the Sea (Prevention of Pollution from Ships) Act*, Part II, Section 11(1). The verbal report shall be made via the national emergency 24-hour notification contact, and if AMSA requests a written report, it should be provided within 24 hours of AMSA's request.	**MC IS-8.6.1** Records of notification to AMSA.
PO IS-9 Planned and unplanned emissions and discharges will be documented and records maintained	**PS IS-9.1** The volumes of planned and unplanned emissions and discharges that could result from the risks described in **Section 6.6 and 6.7** are documented in the daily drilling, pipeline or subsea reports.	**MC IS-9.1.1** Records of planned and unplanned emissions and discharges are maintained in daily drilling, pipeline or subsea reports.
PO IS-10 Personnel holding responsibilities in a response will test the arrangements supporting the activities OPEP to ensure they are effective and communicated.	**PS IS-10.1** Exercises will be conducted in alignment with the frequency identified in **Table 7-5**. These arrangements are conducted in accordance with Regulation 14 (8B) of the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009.* • Arrangements are tested when introduced. • Arrangements are tested in accordance with Woodside's Hydrocarbon Spill Arrangements Testing Schedule as per the frequency identified in **Table 7-5**. • Arrangements will be tested when the OPEP is significantly amended, and further testing will occur if a new activity location is added to the EP.	**MC IS-10.1.1** Spill response exercise reports and key participants maintained in the Woodside IMS system. Records managed in Hydrocarbon Spill Preparedness Unit (HSPU) Testing of Arrangements Register.
	PS IS-10.2 Post exercise reports will be developed for each exercise to measure performance against the objectives and the learnings from the plan are updated in the OPEP following these learnings.	**MC IS-10.2.1** Spill response exercise reports and key participants maintained in the Woodside IMS system. Records managed in HSPU Testing of Arrangements Register.

Implementation Strategy (IS) Performance Outcome	Implementation Strategy Performance Standard	Implementation Strategy Measurement Criteria
	PS IS-10.3 Close out of Hydrocarbon Spill Preparedness Unit (HSPU) actions from exercises are managed in the HSPU Testing of Arrangements Register.	**MC IS-10.3.1** Records managed in HSPU Testing of Arrangements Register.
PO IS-11 Woodside will ensure the arrangements supporting the activities OPEP are validated.	**PS IS-11.1** Activity OPEPs will be revised at a minimum every five years.	**MC IS-11.1.1** OPEP current and available.
PO IS-12 The OPEP will only be updated under specific circumstances to ensure the information is current.	**PS IS-12.1** Relevant documents from the OPEP will be reviewed in the following circumstances: • Implementation of improved preparedness measure. • 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.	**MC IS-12.1.1** The following records with be maintained: • Woodside's HSPU Testing of Arrangements Register • Woodside Internal Equipment Maintenance Register • OPEP current and available.
PO IS-13 Woodside will undertake a vessel risk assessment where an OVID inspection and/or OVMSA Verification Review is not available (i.e. short term vessel hire).	**PS IS-13.1** 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.	**MC IS-13.1.1** Marine Vessel Risk Assessment sheet demonstrates the assessment has been undertaken.
PO IS-14 Prior to recommencement of activities after a cessation period greater than 12 months, conduct a review of impacts, risks and controls.	**PS IS-14.1** Impacts and risks associated with recommencing activities (if commencing after a cessation period greater than 12 months) remain/are reduced to ALARP and acceptable levels.	**MC IS-14.1.1** Records demonstrate a review is undertaken of impacts, risks and controls prior to recommencement of activities (if commencing after a cessation period greater than 12 months).

Implementation Strategy (IS) Performance Outcome	Implementation Strategy Performance Standard	Implementation Strategy Measurement Criteria
PO IS-15 Cetacean and whale shark sightings will be reported. All project vessels and the MODU will be provided with sighting recording sheets which will be posted on notice boards for opportunistic reporting of cetacean and whale shark sightings. Awareness of sightings reporting will also be included in project inductions. These sightings reports will be collated and summarised on an annual basis and submitted to the Australian Antarctic Division of the Department of the Environment and Energy to satisfy condition 1(c)(vi) of **EPBC Approval Decision 2006/2968.**	**PS IS-15.1** Project personnel will report opportunistic sightings of cetaceans and whale sharks during this activity (Regulation 29 notifications) and submitted to the Australian Antarctic Division of the Department of the Environment and Energy to satisfy condition 1(c)(vi) of EPBC Approval Decision 2006/2968. Inductions will include information to inform personnel of sightings reporting requirements.	**MC IS-15.1.1** All project vessels and the MODU will be provided with sighting recording sheets which will be posted on notice boards. Awareness of sightings reporting will also be included in project inductions. Sightings reports submitted to the Australian Antarctic Division of the Department of the Environment and Energy to satisfy condition 1(c)(vi) of **EPBC Approval Decision 2006/2968.**

8 REFERENCES

Abascal, F.J., Quintans, M., Ramos-Cartelle, A., Mejuto, J., 2011. Movements and environmental preferences of the shortfin mako, *Isurus oxyrinchus*, in the southeastern Pacific Ocean. Marine biology 158, 1175–1184.

Patterson, H, Larcombe, J, Nicol, S and Curtotti, R 2018, Fishery status reports 2018, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra.

Abdul Wahab, M. A, Radford, B., Cappo, M., Colquhoun, J., Stower, M., Depczynski, M., Miller, K., Heyward, A., 2018. Biodiversity and spatial patterns of benthic habitat and associated demersal fish communities at two tropical submerged reef ecosystems. Coral Reefs, 37; 327–343.

Advisian, 2019. Scarborough Offshore Benthic Marine Habitat Assessment. Prepared on behalf of Woodside Energy Ltd.

Aichinger Dias, L., Litz, J., Garrison, L., Martinez, A., Barry, K., Speakman, T., 2017. Exposure of cetaceans to petroleum products following the Deepwater Horizon oil spill in the Gulf of Mexico. Endangered Species Research 33, 119–125. Doi:10.3354/esr00770.

Amoser, S., Ladich, F., 2005. Are hearing sensitivities of freshwater fish adapted to the ambient noise in their habitats? Journal of Experimental Biology 208, 3533–3542.

Austin, M.E. and Z. Li. 2016. Marine Mammal Monitoring and Mitigation During Exploratory Drilling by Shell in the Alaskan Chukchi Sea, July–October 2015: Draft 90-day report. In: Ireland, D.S. and L.N. Bisson (eds.). Underwater Sound Measurements. LGL Rep. P1363D. Report from LGL Alaska Research Associates Inc., LGL Ltd., and JASCO Applied Sciences Ltd. For Shell Gulf of Mexico Inc, National Marine Fisheries Service, and U.S. Fish and Wildlife Service. 188 pp + appendices.

Australian Fisheries Management Authority, 2010. Annual status report: southern bluefin tuna fishery 2010. Australian Fisheries Management Authority, Canberra.

Australian Institute of Marine Science, 2014. AIMS 2013 biodiversity survey of Glomar Shoal and Rankin Bank (Report prepared by the Australian Institute of Marine Science for Woodside Energy Ltd). Australian Institute of Marine Science, Townsville.

Australian Transport Safety Bureau, 2011. ATSB annual report: 2010–2011. Australian Transport Safety Bureau, Canberra.

Baker, C., Potter, A., Tran, M., Heap, A.D., 2008. Sedimentology and geomorphology of the northwest marine region: a spatial analysis (Geoscience Australia Record No. 2008/07). Geoscience Australia, Canberra.

Balcom, B.J., Graham, B.D., Hart, A.D., Bestall, G.P., 2012. Benthic impacts resulting from the discharge of drill cuttings and adhering synthetic based drilling fluid in deep water, in: International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production. Presented at the International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production, Society of Petroleum Engineers, Perth, p. SPE-157325-MS.

Bamford, M., Watkins, D., Bancroft, W., Tischler, G., Wahl, J., 2008. Migratory shorebirds of the East Asian-Australasian flyway: population estimates and internationally important sites. Wetlands International – Oceania, Canberra.

Bannister, J., Kemper, C.M., Warneke, R.M., 1996. The action plan for Australian cetaceans. Australian Nature Conservation Agency, Canberra.

Batteen, M.L., Rutherford, M.J., Bayler, E.J., 1992. A numerical study of wind- and thermal-forcing effects on the ocean circulation off Western Australia. Journal of Physical Oceanography 22, 1406–1433.

Batten, S., Allen, R., Wotton, C., 1998. The effects of the Sea Empress oil spill on the plankton of the southern Irish Sea. Marine Pollution Bulletin 36, 764–774.

Bishop, S., Francis, M., Duffy, C., Montgomery, J., 2006. Age, growth, maturity, longevity and natural mortality of the shortfin mako shark (*Isurus oxyrinchus*) in New Zealand waters. Marine and Freshwater Research 57, 143–154.

BMT Asia Pacific, 2005. Environmental Impact Assessment Study for construction of helipads at Peng Chau and Yung Shue Wan, Lamma Island (Reference No. R/8109/10). BMT Asia Pacific, Hong Kong.

BMT Oceanica, 2015. Offshore water quality monitoring verification and sediment quality study – Goodwyn A survey report (No. 1178_003/1 Rev 0). BMT Oceanica Pty Ltd, Perth.

Bond, T., Partridge, J.C, Taylor, M.D., Langlois, T.J., Malseed, B.E., Smith, L.D., McLean, D.L., 2018. Fish associated with a subsea pipeline and adjacent seafloor of the North West Shelf of Western Australia. *Marine Environmental Research* 141:53–65.

Bonn Agreement, 2015. Bonn Agreement Counter Pollution Manual, December 2015. Ed. Bonn Agreement Secretariat, London.

Brewer, D., Lyne, V., Skewes, T., Rothlisberg, P., 2007. Trophic systems of the North-west Marine Region. Commonwealth Scientific and Industrial Research Organisation (CSIRO) Marine and Atmospheric Research, Cleveland.

Bruce, B., 2013. Shark futures: a synthesis of available data on mako and porbeagle sharks in Australasian waters. Current and future directions (Tactical Research Fund No. FRDC 2011/045). Fisheries Research and Development Corporation, Canberra.

Bruce, B.D., 2008. The biology and ecology of the white shark, *Carcharodon carcharias*, in: Camhi, M.D., Pikitch, E.K., Babcock, E.A. (Eds.), Sharks of the Open Ocean : Biology, Fisheries and Conservation. Blackwell Publishing Limited, Oxford, pp. 69–81.

Bruce, B.D., Stevens, J.D., Malcolm, H., 2006. Movements and swimming behaviour of white sharks (*Carcharodon carcharias*) in Australian waters. Marine Biology 150, 161–172.

Burbidge, A.A., Fuller, P.J., 1989. Numbers of breeding seabirds on Pelsaert Island, Houtman Abrolhos, Western Australia. Corella 13, 57-61.

Bureau of Meteorology, 2017. Summary statistics for Barrow Island [WWW Document]. Climate statistics for Australian locations. URL http://www.bom.gov.au/climate/averages/tables/cw_005058.shtml. Accessed 12-Jun-2018.

Bureau of Meteorology, n.d. Tropical Cyclones Affecting the Karratha/Dampier/Roebourne region [WWW Document]. Tropical Cyclones Affecting the Karratha/Dampier/Roebourne region. URL http://www.bom.gov.au/cyclone/history/wa/roebourne.shtml. Accessed 12-Jun-2018.

Campana, S.E., Marks, L., Joyce, W., 2005. The biology and fishery of shortfin mako sharks (*Isurus oxyrinchus*) in Atlantic Canadian waters. Fisheries Research 73, 341–352. Doi:10.1016/j.fishres.2005.01.009

Cavanagh, R.D., Kyne, P.M., Fowler, S.L., Music, J.A., and Bennett, M.B. (eds) (2003). The conservation status of *Australia Chondrichthyans*. Report to the IUCN park specialist group Australia and Oceania Regional Red List workshop. (University of Queensland, Brisbane).

Chevron Australia Pty Ltd, 2014. Wheatstone project conservation-significant marine fauna interaction management plan (No. WS0–0000–HES–PLN–CVX–000–00037–000 Rev 5). Chevron Australia Pty Ltd, Perth.

Chevron Australia Pty Ltd, 2015. Gorgon gas development and Jansz feed gas pipeline: Long-term marine turtle management plan (No. G1- NT-PLNX0000296). Chevron Australia Pty Ltd, Perth.

Chidlow, J., Gaughan, D., McAuley, R., 2006. Identification of Western Australian grey nurse shark aggregation sites: final report to the Australian Government, Department of Environment and Heritage (Fisheries Research Report No. 155). Department of Fisheries, Perth.

Clancy, GP 2005. Feeding behaviour of the Osprey *Pandion haliateus* on the north coast of New South Wales. Corella 29(4): 91–96.

Cohen, A., Gagnon, M.M., Nugegoda, D., 2005. Alterations of metabolic enzymes in Australian bass, *Macquaria novemaculeata*, after exposure to petroleum hydrocarbons. Archives of Environmental Contamination and Toxicology 49: 200–205. Doi:10.1007/s00244-004-0174-1.

Commonwealth of Australia, 2015a. Conservation management plan for the blue whale: A recovery plan under the *Environment Protection and Biodiversity Conservation Act 1999* 2015–2025. Department of the Environment, Canberra.

Commonwealth of Australia, 2015b. Sawfish and river shark multispecies recovery plan (Recovery Plan). Department of the Environment, Canberra.

Commonwealth of Australia, 2015c. Wildlife conservation plan for migratory shorebirds. Department of the Environment, Canberra.

Commonwealth of Australia, 2015d. Sawfish and river sharks multispecies issues paper. Department of the Environment, Canberra.

Commonwealth of Australia, 2017. Recovery Plan for Marine Turtles in Australia 2017–2027.

Condie, S., Andrewartha, J., Mansbridge, J., Waring, J., 2006. Modelling circulation and connectivity on Australia's North West (Technical Report No. 6), North West Shelf Joint Environmental Management Study. CSIRO Marine and Atmospheric Research, Perth.

Corkeron, P.J., Morissette, N.M., Porter, L., Marsh, H., 1997. Distribution and status of hump-backed dolphins *Sousa chinensis* in Australian waters. Asian Marine Biology 14, 49–59.

Couturier, L.I.E., Jaine, F.R.A., Townsend, K.A., Weeks, S.J., Richardson, A.J., Bennett, M.B., 2011. Distribution, site affinity and regional movements of the manta ray, *Manta alfredi*, along the east coast of Australia. Marine and Freshwater Research 62, 628. Doi:10.1071/MF10148.

Craig, P.D., 1988. A numerical model study of internal tides on the Australian Northwest Shelf. Journal of Marine Research 46, 59–76.

Crecelius, E., Trefry, J., McKinley, J., Lasorsa, B., Trocine, R., 2007. Study of barite solubility and the release of trace components to the marine environment (OCS Study No. MMS 2007-061). United States Department of the Interior, New Orleans.

D'Anastasi, B., Simpfendorfer, C., van Herwerden, L., 2013. *Anoxypristis cuspidata*. The IUCN Red List of Threatened Species 2013: e.T39389A18620409. In ed. Pp.

Davis, T.L., Jenkins, G.P., Young, J.W., 1990. Diel patterns of vertical distribution in larvae of southern bluefin *Thunnus maccoyii*, and other tuna in the East Indian Ocean. Marine Ecology Progress Series 59, 63–74.

Deakos, M., Baker, J., Bejder, L., 2011. Characteristics of a manta ray *Manta alfredi* population off Maui, Hawaii, and implications for management. Marine Ecology Progress Series 429, 245–260. Doi:10.3354/meps09085.

Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016. Deepwater Horizon Oil Spill: Final Programmatic Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement.

Department of Conservation and Land Management, 2005. Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area 2005–2015 (Management Plan No. 52). Department of Conservation and Land Management, Perth.

Department of Environment and Conservation, 2007. Management plan for the Montebello/Barrow Islands Marine Conservation Reserves. Marine Parks and Reserves Authority, Perth.

Department of Environmental Protection, 2001. Shark Bay World Heritage Property: Environmental values, cultural uses and potential petroleum industry impacts. Department of Environmental Protection, Perth.

Department of Parks and Wildlife, 2015. Barrow group nature reserves management plan (Management Plan No. 82). Department of Parks and Wildlife, Kensington.

Department of Sustainability, Environment, Water, Population and Communities, 2011a. Approved Conservation Advice for *Aipysurus apraefrontalis* (Short-nosed Sea Snake). Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1115-conservation-advice.pdf. In effect under the EPBC Act from 15-Feb–2011.

Department of Sustainability, Environment, Water, Population and Communities, 2012. Conservation Management Plan for the Southern Right Whale. A Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999 2011-2021. Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/resource/conservation-management-plan-southern-right-whale-recovery-plan-under-environment. In effect under the EPBC Act from 26-Feb-2013 as *Eubalaena australis*.

Department of Sustainability, Environment, Water, Population and Communities, 2011. National recovery plan for threatened albatrosses and giant petrels. Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Department of Sustainability, Environment, Water, Population and Communities, 2012a. Marine bioregional plan for the North-west Marine Region: prepared under the *Environment Protection and Biodiversity Conservation Act 1999*. Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Department of Sustainability, Environment, Water, Population and Communities, 2012b. Conservation management plan for the southern right whale: a recovery plan under the *Environment Protection and Biodiversity Conservation Act 1999* 2011–2021. Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Department of Sustainability, Environment, Water, Population and Communities, 2012d. Species group report card – seabirds and migratory shorebirds. Supporting the marine bioregional plan for the North-west Marine Region prepared under the *Environment Protection and Biodiversity Conservation Act 1999*. Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Department of Sustainability, Environment, Water, Population and Communities, 2013. Recovery plan for the white shark (*Carcharodon carcharias*). Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Department of the Environment and Energy, 2017. Recovery Plan for Marine Turtles in Australia. Department of the Environment and Energy, Canberra.

Department of the Environment and Energy, 2018. Threat abatement plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans.

Department of the Environment and Energy, 2018. Australian National Shipwreck Database [WWW Document]. Australian National Shipwreck Database. URL http://www.environment.gov.au/heritage/historic-shipwrecks/australian-national-shipwreck-database. Accessed 12-Jun-2018.

Department of the Environment and Energy (n.d.), a. Montebello Australian Marine Park – Overview [WWW Document]. Montebello Commonwealth Marine Reserve. URL https://www.environment.gov.au/topics/marine/marine-reserves/north-west/montebello. Accessed 12-Jun-2018.

Department of the Environment and Energy (n.d.), b. Ningaloo Australian Marine Park (renamed) – Home page [WWW Document]. Ningaloo Commonwealth Marine Reserve. URL https://www.environment.gov.au/topics/marine/marine-reserves/north-west/ningaloo. Accessed 12-Jun-2018.

Department of the Environment and Heritage, 2005a. Blue, fin and sei whale recovery plan 2005–2010 (Recovery Plan). Department of the Environment and Heritage, Canberra.

Department of the Environment, 2013a. *Megaptera novaeangliae* – Humpback Whale [WWW Document]. Species Profile and Threats Database. URL http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=38. Accessed 12-Jun-2018.

Department of the Environment, 2013d. *Pristis clavate* – Dwarf Sawfish, Queensland Sawfish [WWW Document]. Species Profile and Threats Database. URL http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=68447. Accessed 12-Jun-2018.

Department of the Environment, 2014. Recovery plan for the grey nurse shark (*Carcharias taurus*). Department of the Environment, Canberra.

Department of the Environment, 2015a. *Balaenoptera edeni* – Bryde's Whale [WWW Document]. Species Profile and Threats Database. URL http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=35. Accessed 12-Jun-2018.

Department of the Environment, 2016b. *Manta alfredi* – Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [WWW Document]. Species Profile and Threats Database. URL http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=35. Accessed 12-Jun-2018.

Department of the Environment, 2016c. *Eubalaena australis* – Southern Right Whale, Department of Environment, Canberra, Australian Capital Territory. Available at http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=40.

Department of the Environment, 2017. *Aipysurus apraefrontalis* – Short-nosed Seasnake [WWW Document]. Species Profile and Threats Database. URL http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=35. Accessed 12-Jun-2018.

Department of the Environment, Water, Heritage and the Arts, 2008. The north-west marine bioregional plan: bioregional profile. Department of the Environment, Water, Heritage and the Arts, Canberra.

Department of the Environment, Water, Heritage and the Arts, 2009a. Approved conservation advice for *Pristis clavata* (dwarf sawfish).

Department of the Environment, Water, Heritage and the Arts, 2010. Legislative changes for recreational fishing of three shark species. Department of the Environment, Water, Heritage and the Arts, Canberra.

Det Norske Veritas, 2011. Assessment of the risk of pollution from marine oil spills in Australian ports and waters (Report No. PP002916). Det Norske Veritas Ltd, London.

Director of National Parks, 2018. North-west Commonwealth Marine Reserves Network Management Plan. Director of National Parks, Canberra.

Dix, G.R., James, N.P., Kyser, T.K., Bone, Y., Collins, L.B., 2005. Genesis and dispersal of carbonate mud relative to late quaternary sea-level change along a distally-steepened carbonate ramp (Northwestern Shelf, Western Australia). Journal of Sedimentary Research 75, 665–678.

Double, M., Gales, N., Jenner, K., Jenner, M., 2010. Satellite tracking of southbound female humpback whales in the Kimberley region of Western Australia. Australian Marine Mammal Centre, Hobart.

Double, M., Jenner, K., Jenner, M., Ball, I., Childerhouse, S., Loverick, S., Gales, N., 2012a. Satellite tracking of northbound humpback whales (*Megaptera novaeangliae*) off Western Australia. Australian Marine Mammal Centre, Hobart.

Double, M., Jenner, K., Jenner, M.-N., Ball, I., Laverick, S., Gales, N., 2012b. Satellite tracking of pygmy blue whales (*Balaenoptera musculus brevicauda*) off Western Australia. Australian Marine Mammal Centre, Hobart.

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.

Dunlop, J., Wooller, R., Cheshire, N., 1988. Distribution and abundance of marine birds in the Eastern Indian Ocean. Marine and Freshwater Research 39, 661–669.

Environment Australia, 2002. Ningaloo marine park (Commonwealth waters) management plan. Environment Australia, Canberra.

Falkner, I., Whiteway, T., Przeslawski, R., Heap, A.D., 2009. Review of Ten Key Ecological Features (KEFs) in the Northwest Marine Region: a report to the Department of the Environment, Water, Heritage and the Arts by Geoscience Australia, Geoscience Australia Record. Geoscience Australia, Canberra.

Finneran, J.J., E. Henderson, D.S. Houser, K. Jenkins, S. Kotecki, and J. Mulsow. 2017. Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III). Technical report by Space and Naval Warfare Systems Center Pacific (SSC Pacific). 183 p. https://apps.dtic.mil/dtic/tr/fulltext/u2/a561707.pdf.

Fletcher, W., Friedman, K., Weir, V., McCrea, J., Clark, R., 2006. Pearl oyster fishery (ESD Report Series No. 5). Department of Fisheries, Perth.

Fodrie, F.J., Heck, K.L., 2011. Response of coastal fishes to the Gulf of Mexico oil disaster. PloS ONE 6, e21609. Doi:10.1371/journal.pone.0021609.

Ford, J., Ellis, G., Matkin, D., Balcomb, K., Briggs, D., Morton, A., 2005. Killer Whale Attacks on Minke Whales: Prey Capture and Antipredator Tactics. Marine Mammal Science 24, 603–618.

French, D.P., Schuttenberg, H.Z., Isaji, T., 1999. Probabilities of oil exceeding thresholds of concern: examples from an evaluation for Florida Power and Light. Presented at the Arctic and Marine Oilspill Program Technical Seminar, Ministry of Supply and Services, Ottawa, pp. 243–270.

French-McCay, D., 2009. State-of-the-art and research needs for oil spill impact assessment modelling, in: Proceedings of the 32nd AMOP Technical Seminar on Environmental Contamination and Response. Presented at the 32nd AMOP Technical Seminar on Environmental Contamination and Response, Environment Canada, Ottawa, pp. 601–653.

Gagnon, M.M., Rawson, C., 2010. Montara well release: Report on necropsies from a Timor Sea green turtle. Curtin University, Perth.

Gates, A.R., Jones, D.O.B., 2012. Recovery of benthic megafauna from anthropogenic disturbance at a hydrocarbon drilling well (380 m depth in the Norwegian Sea). PloS ONE 7, e44114. Doi:10.1371/journal.pone.0044114.

Gaughan, D.J., Santoro, K. (eds), 2018. Status Reports of the Fisheries and Aquatic Resources of Western Australia 2016/17: The State of the Fisheries. Department of Primary Industries and Regional Development, Western Australia.

Georgeson, L Stobutzki, I. and Curtotti, R. (eds 2014), Fishery status reports 2013-14, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra

Geraci, J., 1988. Physiologic and toxicologic effects of cetaceans, in: Geraci, J., St Aubin, D. (Eds.), Synthesis of Effects of Oil on Marine Mammals, OCS Study. Department of Interior, Ventura, pp. 168–202.

Godfrey, J., Ridgway, K., 1985. The large-scale environment of the poleward-flowing Leeuwin Current, Western Australia: longshore steric height gradients, wind stresses and geostrophic flow. Journal of Physical Oceanography 15, 481–495.

Gordon, J., Gillespie, D., Potter, J., Frantzis, A., Simmonds, M.P., Swift, R., Thompson, D., 2003. A review of the effects of seismic surveys on marine mammals. Marine Technology Society Journal 37, 16–34.

Gratwicke, B., Speight, M.R., 2005. The relationship between fish species richness, abundance and habitat complexity in a range of shallow tropical marine habitats. Journal of Fish Biology 66, 650–667.

Guinea, M., 2009. Long term monitoring of the marine turtles of Scott Reef. Charles Darwin University, Darwin.

Guinea, M., Limpus, C., Whiting, S., 2004. Marine snakes, in: Description of Key Species Groups in the Northern Planning Area. National Oceans Office, Hobart, pp. 137–146.

Hanson, C.E., Waite, A.M., Thompson, P.A., Pattiaratchi, C.B., 2007. Phytoplankton community structure and nitrogen nutrition in Leeuwin Current and coastal waters off the Gascoyne region of Western Australia. Deep Sea Research Part II: Topical Studies in Oceanography 54, 902–924.

Hart, A., Ferridge, R., Syers, C., Kalinowski, P., 2018. Statewide specimen shellfish resources status report 2017. Status Report of the Fisheries and Aquatic Resources of Western Australia 2016/2017: The State of the Fisheries. Department of Fisheries, Perth.

Hassan, A., Javed, H., 2011. Effects of Tasman Spirit oil spill on coastal birds at Clifton, Karachi coast, Pakistan. Journal of Animal and Plant Sciences 21: 333–339.

Hazel, J., Lawler, I.R., Marsh, H., Robson, S., 2007. Vessel speed increases collision risk for the green turtle Chelonia mydas. Endangered Species Research 3, 105–113.

Heatwole, H., Cogger, H.G., 1993. Chapter 36: Family *Hydrophiidae*, in: Fauna of Australia. Australian Government Publishing Service, Canberra.

Heck Jr., K.L., Hays, G., Orth, R.J., 2003. Critical evaluation of the nursery role hypothesis for seagrass meadows. Marine Ecology Progress Series 253, 123–136.

Helm, R.C., Costa, D.P., DeBruyn, T.D., O'Shea, T.J., Wells, R.S., Williams, T.M., 2015. Overview of effects of oil spills on marine mammals, in: Fingas, M. (Ed.), Handbook of Oil Spill Science and Technology. Wiley, pp. 455–475.

Heyward, A., Jones, R., Travers, M., Burns, K., Suosaari, G., Colquhoun, J., Case, M., Redford, B., Meekan, M., Markey, K., Schenk, T., O'Leary, R.A., Brooks, K., Tinkler, P., Cooper, T., Emslie, M., 2012. Montara: 2011 shallow reef surveys at Ashmore, Cartier and Seringapatam reefs (Monitoring Study No. S6B Coral Reefs). Australian Institute of Marine Science, Townsville.

Heyward, A., Rees, M., Wolff, C., 2001a. Vincent-Enfield-Laverda field report on initial deepwater benthos sampling survey. Australian Institute of Marine Science, Townsville.

Heyward, A., Rees, M., Wolff, C., Smith, L., 2001b. Exploration of biodiversity – data report on benthic habitats and biological collections from an initial benthic survey conducted in the region of WA-271-P. Australian Institute of Marine Science, Perth.

Hjermann, D.Ø., Melsom, A., Dingsør, G.E., Durant, J.M., Eikeset, A.M., Røed, L.P., Ottersen, G., Storvik, G., Stenseth, N.C., 2007. Fish and oil in the Lofoten–Barents Sea system: synoptic review of the effect of oil spills on fish populations. Marine Ecology Progress Series 339: 283–299.

Holloway, P., 1983. Tides on the Australian north-west shelf. Marine and Freshwater Research 34, 213–230.

Holloway, P., Nye, H., 1985. Leeuwin Current and wind distributions on the southern part of the Australian North West Shelf between January 1982 and July 1983. Marine and Freshwater Research 36, 123–137.

Holloway, P.E., Chatwin, P.G., Craig, P., 2001. Internal tide observations from the Australian north west shelf in summer 1995. Journal of Physical Oceanography 31, 1182–1199.

How, J., Yerman, M., 2018. West coast deep sea crustacean managed fishery status report 2017, in: Fletcher, W., Santoro, K. (Eds.), Status Reports of the Fisheries and Aquatic Resources of Western Australia 2014–15: The State of the Fisheries. Department of Fisheries, Perth.

Hughes, S.J.M., Jones, D.O.B., Hauton, C., Gates, A.R., Hawkins, L.E., 2010. An assessment of drilling disturbance on *Echinus acutus* var. *norvegicus* based on in-situ observations and experiments using a remotely operated vehicle (ROV). Journal of Experimental Marine Biology and Ecology 395, 37–47. Doi:10.1016/j.jembe.2010.08.012.

International Association of Oil and Gas Producers, 2010. Blowout frequencies (Risk Assessment Data Directory No. 434–2). International Association of Oil and Gas Producers, London.

International Association of Oil and Gas Producers, 2016. Environmental fates and effects of ocean discharge of drill cuttings and associated drilling fluids from offshore oil and gas operations (Report No. 543). International Association of Oil and Gas Producers, London.

International Tanker Owners Pollution Federation, 2011. Effects of oil pollution on the marine environment (Technical Information Paper No. 13). International Tanker Owners Pollution Federation Limited, London.

International Tanker Owners Pollution Federation Limited, 2018. Oil Tanker Spill Statistics 2017. International Tanker Owners Pollution Federation Limited, London.

James, N.P., Bone, Y., Kyser, T.K., Dix, G.R., Collins, L.B., 2004. The importance of changing oceanography in controlling late Quaternary carbonate sedimentation on a high-energy, tropical, oceanic ramp: north-western Australia. Sedimentology 51, 1179–1205. Doi:10.1111/j.1365-3091.2004.00666.x.

Jarman, S., Wilson, S., 2004. DNA-based species identification of krill consumed by whale sharks. Journal of Fish Biology 65, 586–591.

Jefferson, T.A., Rosenbaum, H.C., 2014. Taxonomic revision of the humpback dolphins (*Sousa* spp.), and description of a new species from Australia. Marine Mammal Science 30, 1494–1541.

Jenner, K., Jenner, M., McCabe, K., 2001a. Geographical and temporal movements of humpback whales in Western Australian waters. APPEA Journal 41, 692–707.

Jenner, K., Jenner, M., McCabe, K., 2001b. Geographical and temporal movements of humpback whales in Western Australian waters. APPEA Journal 41, 692–707.

Jenner, K.C.S., Jenner, M.N., 2009. Humpback Whale Distribution and Abundance in the Near Shore South West Kimberley during Winter 2008 using Aerial Surveys. Report produced for Woodside Energy Limited.

Jensen, A., Silber, G., 2004. Large whale ship strike database (NOAA Technical Memorandum No. NMFS-OPR). National Marine Fisheries Service, Silver Spring.

Jimenez-Arranz, G., Glanfield, R., Banda, N. and Wyatt, R., 2017. Review on Existing Data on Underwater Sounds Produced by the Oil and Gas Industry. Submitted to E&P Sound & Marine Life.

Johansen, J.L., Allan, B.J., Rummer, J.L., Esbaugh, A.J., 2017. Oil exposure disrupts early life-history stages of coral reef fishes via behavioural impairments. Nature Ecology & Evolution 1: 1146–1152. Doi:10.1038/s41559-017-0232-5.

Kangas, M., Sporer, E., Wilkin, S., Cavalli, P., Oliver, R., 2018. Gascoyne Shark Bay Prawn Resource Status Report 2017. In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2016/17: The State of the Fisheries eds. D.J. Gaughan and K. Santoro. DPIRD, WA.

Kangas, M., Sporer, E., Wilkin, S., Cavalli, P., Oliver, R., Pickles, L., 2017. Saucer Scallop Resource Status Report 2017. In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2016/17: The State of the Fisheries eds. D.J. Gaughan and K. Santoro. DPIRD, WA.

Kangas, M., Sporer, E., Wilkin, S., Koefoed, I., Cavalli, P., Pickles, L., 2017. Gascoyne Exmouth Gulf Prawn Resource Status Report 2017. In: Status Reports of the Fisheries and Aquatic Resources of Western Australia 2016/17: The State of the Fisheries eds. D.J. Gaughan and K. Santoro. DPIRD, WA.

King, D., Lyne, R., Girling, A., Peterson, D., Stephenson, R., Short, D., 1996. Environmental risk assessment of petroleum substances: The hydrocarbon block method (CONCAWE No. 96/52). CONCAWE, Brussels.

Koops, W., Jak, R., van der Veen, D., 2004. Use of dispersants in oil spill response to minimize environmental damage to birds and aquatic organisms. Interspill 2004.

Kyne, P.M., Carlson, J., Smith, K., 2013. *Pristis pristis*. The IUCN Red List of Threatened Species Version 2015.1. www.iucnredlist.org.

Ladich, F., 2013. Effects of noise on sound detection and acoustic communication in fishes, in: Brumm, H. (Ed.), Animal Communication and Noise. Springer Berlin Heidelberg, Berlin, pp. 65–90.

Laist, D.W., Knowlton, A.R., Mead, J.G., Collet, A.S., Podesta, M., 2001. Collisions between ships and whales. Marine Mammal Science 17, 35–75.

Last, P.R., Lyne, V., Yearsley, G., Gledhill, D., Gomon, M., Rees, T., White, W., 2005. Validation of national demersal fish datasets for the regionalisation of the Australian continental slope and outer shelf (>40 m depth). National Oceans Office, Hobart.

Lewis, P., Jones, R., 2018. Statewide large pelagic finfish resources status report 2017.

Li, Z., Spaulding, M.L., French-McCay, D., 2017. 'An algorithm for modelling entrainment and naturally and chemically dispersed oil droplet size distribution under surface breaking wave conditions', Marine Pollution Bulletin, vol. 119, no. 1, pp. 145-152.

Limpus, C.J., 2007. A biological review of Australian marine turtles. 5. Flatback turtle, *Natator depressus* (Garman), A biological review of Australian marine turtles. Queensland Government Environmental Protection Agency, Brisbane.

Limpus, C.J., 2008a. A biological review of Australian marine turtles. 1. Loggerhead turtle, *Caretta caretta* (Linnaeus), A biological review of Australian marine turtles. Queensland Government Environmental Protection Agency, Brisbane.

Limpus, C.J., 2008b. A biological review of Australian marine turtles. 2. Green turtle, *Chelonia mydas* (Linnaeus), A biological review of Australian marine turtles. Queensland Government Environmental Protection Agency, Brisbane.

Limpus, C.J., 2009a. A biological review of Australian marine turtles. 6. Leatherback turtle, *Dermochelys coriacea* (Vandelli), A biological review of Australian marine turtles. Queensland Government Environmental Protection Agency, Brisbane.

Limpus, C.J., 2009b. A biological review of Australian marine turtles. 3. Hawksbill turtle, *Eretmochelys imbricata* (Linnaeus), A biological review of Australian marine turtles. Queensland Government Environmental Protection Agency, Brisbane.

Lutcavage, M., Lutz, P., Bossart, G., Hudson, D., 1995. Physiologic and clinicopathologic effects of crude oil on loggerhead sea turtles. Archives of Environmental Contamination and Toxicology 28, 417–422.

MacDonnell, J., 2016. Shelburne Basin Venture Exploration Drilling Project: Sound Source Characterization, 2016 Field Measurements of the Stena IceMAX. Document 01296, Version 3.0. Technical report by JASCO Applied Sciences for Shell Canada Limited.

Mackie, M., Buckworth, R.C., Gaughan, D.J., 2003. Stock assessment of narrow-barred Spanish mackerel (*Scomberomorus commerson*) in Western Australia (FRDC Report No. 1999/151). Department of Fisheries, Perth.

Mackie, M., Nardi, A., Lewis, P., Newman, S., 2007. Small pelagic fishes of the north-west marine region. Department of Fisheries, Perth.

Marsh, H., Penrose, H., Eros, C., Hughes, J., 2002. Dugong: status report and action plans for countries and territories, Early warning and assessment report series. United Nations Environment Programme, Nairobi.

Marshall, A., Bennett, M., Kodja, G., Hinojosa-Alvarez, S., Galvan-Magana, F., Harding, M., Stevens, G., Kashiwaga, T., 2011. *Manta birostris* (Chevron Manta Ray, Giant Manta Ray, Oceanic Manta Ray, Pacific Manta Ray, Pelagic Manta Ray) [WWW Document]. The IUCN Red List of Threatened Species. URL http://www.iucnredlist.org/details/198921/0. Accessed 12-Jun-2018.

Marshall, A.D., Compagno, L.J., Bennett, M.B., 2009. Redescription of the genus Manta with resurrection of *Manta alfredi* (*Chondrichthyes; Myliobatoidei; Mobulidae*). Zootaxa 2301, 1–28.

Martin, S.B., K.A. Kowarski, E.E. Maxner, and C.C. Wilson. 2019. Acoustic Monitoring During Scotian Basin Exploration Project: Summer 2018. Document Number 01687, Version 2.0. Technical report by JASCO Applied Sciences for BP Canada Energy Group ULC. https://www.bp.com/content/dam/bp-country/en_ca/canada/documents/NS_Drilling_Pgm/Acoustic-Monitoring-During-Scotian-Basin-Exploration-Project-Summer-2018.pdf.

Matkin, C.O., Saulitis, E.L., Ellis, G.M., Olesiuk, P., Rice, S.D., 2008. Ongoing population-level impacts on killer whales *Orcinus orca* following the ‘Exxon Valdez’ oil spill in Prince William Sound, Alaska. Marine Ecology Progress Series 356: 269–281.

Matsuura, H., Sugimoto, T., Nakai, M., Tsuji, S., 1997. Oceanographic conditions near the spawning ground of southern bluefin tuna; northeastern Indian Ocean. Journal of Oceanography 53, 421–434.

McCauley, R., 1998. Radiated underwater noise measured from the drilling rig *Ocean General*, rig tenders *Pacific Ariki* and *Pacific Frontier*, fishing vessel *Reef Venture* and natural sources in the Timor Sea, Northern Australia. (Report No. C98–20). Centre for Marine Science and Technology, Curtin University of Technology, Perth.

McCauley, R., 2005. Underwater sea noise in the Otway Basin – drilling, seismic and blue whales, Oct-Dec 2003, in: Howell, E. (Ed.), A Compilation of Recent Research into the Marine Environment. Australian Petroleum Exploration Association, Canberra, pp. 18–19.

McCauley, R., Duncan, A., 2011. Sea noise logger deployment, Wheatstone and Onslow, April 2009 to November 2010 (Technical Report No. R2011–23). Centre for Marine Science and Technology, Curtin University of Technology, Perth.

McCauley, R., Jenner, C., 2010. Migratory patterns and estimated population size of pygmy blue whales (*Balaenoptera musculus brevicauda*) traversing the Western Australian coast based on passive acoustics (International Whaling Commission Report No. SC/62/SH26). International Whaling Commission.

McCauley, R., Salgado Kent, C., 2008. Pile driving underwater noise assessment, proposed Bell Bay pulp mill wharf developmnet (CMST Report). Centre for Marine Science and Technology, Curtin University of Technology, Perth

McCauley, R., Jenner, C., 2001. The underwater acoustic environment in the vicinity of Vincent and Enfield petroleum leases, North West Cape, Exmouth WA (Report No. R2001–22). Centre for Marine Science and Technology, Curtin University of Technology, Perth.

McCauley, R.D., 2011. Woodside Kimberley sea noise logger program, September 2006 to June 2009: whales, fish and man made noise (Report No. R2010–50_3). Curtin University, Perth.

McLean, D.L., Partridge, J.C., Bond, T., Birt, M.J., Bornt, K.R., Langlois, T.J., 2017. Using industry ROV videos to assess fish associations with subsea pipelines. Continental Shelf Research 141: 76–97. Doi:10.1016/j.csr.2017.05.006.

McLean, D.L., Taylor, M.D., Partridge, J.C., Gibbons, B., Langlois, T.J., Malseed, B.E., Smith, L.D., Bond, T., 2018. Fish and habitats on wellhead infrastructure on the north west shelf of Western Australia. Continental Shelf Research 164:10–27.

McIntyre, A.D., Johnston, R., 1975. Effects of Nutrient Enrichment from Sewage in the Sea, in: Discharge of Sewage from Sea Outfalls: Proceedings of an International Symposium Held at Church House, London, 27 August to 2 September 1974. Elsevier.

McPherson, C.R, J.E. Quijano, M.J. Weirathmueller, K.R. Hiltz, and K. Lucke. 2019. Browse to North West Shelf Noise Modelling Study: Assessing Marine Fauna Sound Exposures. Document 01824, Version 2.0. Technical report by JASCO Applied Sciences for Jacobs.

McPherson, C., Zykov, M., Matthews, M., 2013. Underwater Noise Assessment: Deepwater Millennium – Malaguti A, JASCO Document 00643, Version 1.0, Techncial report by JASCO Applied Sciences for Woodside Energy Limited. (No. 00643). Woodside Energy Limited.

Meekan, M., Radford, B., 2010. Migration patterns of whale sharks: A summary of 15 satellite tag tracks from 2005 to 2008. Australian Institute of Marine Science, Perth.

Meekan, M.G., Bradshaw, C.J., Press, M., McLean, C., Richards, A., Quasnichka, S., Taylor, J.G., 2006. Population size and structure of whale sharks *Rhincodon typus* at Ningaloo Reef, Western Australia. Marine Ecology Progress Series 319, 275–285.

Meyers, G., Bailey, R., Worby, A., 1995. Geostrophic transport of Indonesian Throughflow. Deep Sea Research Part I: Oceanographic Research Papers 42, 1163–1174.

Milton, S.L., Lutz, P.L., 2003. Physiological and genetic responses to environmental stress, in: Lutz, P.L., Musick, J.A., Wyneken, J. (Eds.), The Biology of Sea Turtles. CRC Press, Boca Raton, pp. 164–198.

Mollet, H., Cliff, G., Pratt Jr, H., Stevens, J., 2000. Reproductive biology of the female shortfin mako, *Isurus oxyrinchus Rafinesque*, 1810, with comments on the embryonic development of lamnoids. Fishery Bulletin 98.

Molony, B., Lai, E., Jones, R., 2015. Mackerel managed fishery report: Statistics only, in: Fletcher, W., Santoro, K. (Eds.), Status Reports of the Fisheries and Aquatic Resources of Western Australia 2014/2015: The State of the Fisheries. Department of Fisheries, Perth, pp. 207–210.

Morgan, D., Whitty, J., Phillips, N., 2010a. Endangered sawfishes and river sharks in Western Australia. Centre for Fish and Fisheries Research, Murdoch University, Perth.

Morgan, D., Whitty, J., Phillips, N., 2010b. Endangered sawfishes and river sharks in Western Australia. Centre for Fish and Fisheries Research, Murdoch University, Perth.

Morrice, M.G., Gill, P.C., Hughes, J., Levings, A.H., 2004. Summary of aerial surveys conducted for the Santos Ltd EPP32 seismic survey, 2–13 December 2003. Deakin University, Warnambool.

Myrberg, A.A., 2001. The acoustical biology of elasmobranchs, in: The Behavior and Sensory Biology of Elasmobranch Fishes: An Anthology in Memory of Donald Richard Nelson. Springer, pp. 31.

National Oceanic and Atmospheric Administration, 1996. Aerial observations of oil at sea (HAZMAT Report No. 96–7). National Oceanic and Atmospheric Administration, Seattle.

National Oceanic and Atmospheric Administration, 2010. Oil and sea turtles: Biology, planning and response. National Oceanic and Atmospheric Administration, Washington.

National Oceans Office, Geoscience Australia, 2005. 2005 National Marine Bioregionalisation of Australia. Geoscience Australia, Canberra.

National Research Council, 2005. Oil spill dispersants: efficacy and effects. The National Academies Press, Washington, D.C.

Nedwed, T., Smith, J.P., Melton, R., 2006. Fate of nonaqueous drilling fluid cuttings discharged from a deepwater exploration well. Presented at the SPE International Health, Safety & Environment Conference, Society of Petroleum Engineers, Abu Dhabi.

Neff, J., McKelvie, S., Ayers Jr., R., 2000. Environmental impacts of synthetic based drilling fluids (OCS Study No. MMS 2000-064). United States Department of the Interior, New Orleans.

Neff, J.M., 2008. Estimation of bioavailability of metals from drilling mud barite. Integrated Environmental Assessment and Management 4, 184–193.

Newman, S., Wakefield, C., Skepper, C., Boddington, D., Jones, R., Smith, E., 2018. North coast demersal fisheries status report, in: Fletcher, W., Santoro, K. (Eds.), Status Reports of the Fisheries and Aquatic Resources of Western Australia 2016/17: The State of the Fisheries. Department of Fisheries, Perth.

NOPSEMA., 2015. NOPSEMA briefing and MODU mooring systems in cyclonic conditions briefing. https://www.nopsema.gov.au/assets/Presentations/Presentation-NOPSEMA-briefing-and-MODU-mooring-systems-in-cyclonic-conditions-Sept–2015.pdf.

Normandeau Associates, Inc., 2012. Effects of noise on fish, fisheries, and invertebrates in the U.S. Atlantic and Arctic from energy industry sound-generating activities. U.S. Department of the Interior Bureau of Ocean Energy Management, Bedford.

Nowacek, D.P., Thorne, L.H., Johnston, D.W., Tyack, P.L., 2007. Responses of cetaceans to anthropogenic noise. Mammal Review 37, 81–115.

Offshore: Risk & Technology Consulting Inc., 2002. Post mortem failure assessment on MODUs during Hurricane Lili (MMS Order No. 0103PO72450). Minerals Management Service, Houston.

Oil and Gas UK, 2014. Guidance on risk related decision making (Issue No. 2). United Kingdom Offshore Operators Association, London.

Olsen, P., Marples, T.G., 1993. Geographic variation in egg size, clutch size and date of laying of Australian raptors (*Falconiformes* and *Strigiformes*).

OSPAR, 2010. Quality Status Report 2010. OSPAR Commission, London.

Owens, E.H., Humphrey, B., Sergy, G.A., 1994. Natural cleaning of oiled coarse sediment shorelines in Arctic and Atlantic Canada. Spill Science & Technology Bulletin 1, 37–52.

Patterson, D. L., Woehler, E.J., Croxall, J.P., Cooper, J., Poncet, S., Fraser, W.R., 2008. Breeding distribution and population status of the Northern Giant Petrel *Macronectes halli* and Southern Giant Petrel *M. giganteus*. *Marine Ornithology* 36: 115–124.

Patterson, H., Stephan, M., 2014. Western tuna and billfish fishery, in: Georgeson, L., Stobutzki, I., Curtotti, R. (Eds.), Fishery Status Reports 2013–2014. Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra.

Patterson, H., Stobutzki, I., Curtotti, R., 2017. Southern bluefin tuna fishery, in: Patterson, H., Noriega, R., Georgeson, L., Stobutzki, I., Curtotti, R. (Eds.), Fisheries Status Reports 2017. Department of Agriculture and Water Resources, Canberra, pp. 394–405.

Pearce, A., Buchan, S., Chiffings, T., D'Adamo, N., Fandry, C., Fearns, P., Mills, D., Phillips, R., Simpson, C., 2003. A review of the oceanography of the Dampier Archipelago, Western Australia, in: Wells, F., Walker, D., Jones, D. (Eds.), The Marine Flora and Fauna of Dampier, Western Australia. Western Australian Museum, Perth, pp. 13–50.

Petroleumstilsynet, 2014. Anchor line failures Norwegian continental shelf 2010–2014 (Report No. 992081). Petroleumstilsynet, Stavanger.

Popper, A.N., A.D. Hawkins, R.R. Fay, D.A. Mann, S. Bartol, T.J. Carlson, S. Coombs, W.T. Ellison, R.L. Gentry, et al. 2014. Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. ASA S3/SC1.4 TR-2014. SpringerBriefs in Oceanography. ASA Press and Springer. https://doi.org/10.1007/978-3-319-06659-2.

Potemra, J.T., Hautala, S.L., Sprintall, J., 2003. Vertical structure of Indonesian Throughflow in a large-scale model. Deep Sea Research Part II: Topical Studies in Oceanography 50, 2143–2161. Doi:10.1016/S0967-0645(03)00050-X.

Preen, A., 2004. Distribution, abundance and conservation status of dugongs and dolphins in the southern and western Arabian Gulf. Biological Conservation 118, 205–218.

Preen, A., Marsh, H., Lawler, I., Prince, R., Shepherd, R., 1997. Distribution and abundance of dugongs, turtles, dolphins and other megafauna in Shark Bay, Ningaloo Reef and Exmouth Gulf, Western Australia. Wildlife Research 24, 185–208.

Prieto, R., Janiger, D., Silva, M.A., Waring, G.T., Gonçalves, J.M., 2012. The forgotten whale: a bibliometric analysis and literature review of the North Atlantic sei whale *Balaenoptera borealis*. Mammal Review 42, 235–272. Doi:10.1111/j.1365–2907.2011.00195.x.

Rainer, S., 1991. High species diversity in demersal polychaetes of the North West Shelf of Australia. Ophelia 5: 497–505.

Rees, M., Heyward, A., Cappo, M., Speare, P., Smith, L., 2004. Ningaloo Marine Park – initial survey of seabed biodiversity in intermediate and deep waters (March 2004). Australian Institute of Marine Science, Townsville.

Richardson, W.J., Greene Jr, C.R., Malme, C.I., Thomson, D.H., 1995. Marine Mammals and Noise. Academic Press, San Diego.

Robertson, A., Duke, N., 1987. Mangroves as nursery sites: comparisons of the abundance and species composition of fish and crustaceans in mangroves and other nearshore habitats in tropical Australia. Marine Biology 96, 193–205.

Rosser, N., Gilmour, J., 2008. New insights into patterns of coral spawning on Western Australian reefs. Coral Reefs 27, 345–349.

RPS Bowman Bishaw Gorham, 2007. Gorgon development on Barrow Island: Intertidal habitats (Report No. R03208). RPS Bowman Bishaw Gorham, Subiaco.

RPS APASA (Asia-Pacific Applied Science Associates), 2016. Greater Enfield Development Drill Cuttings and Fluids Discharge Modelling Report, Prepared for Woodside Energy Limited by APASA.

RPS, 2011. Sediment quality surveys March-April 2011, Greater Western Flank Marine Environmental Baseline Studies, RPS Planning and Environment Pty Ltd, Perth, WA.

Salgado-Kent, C., Jenner, C., Jenner, M., Bouchet, P., Rexstad, E., 2012. Southern Hemisphere breeding stock D humpback whale population estimates from North West Cape, Western Australia. Journal of Cetacean Research and Management 12, 29–38.

Salmon, M., Reiners, R., Lavin, C., Wyneken, J., 1995a. Behaviour of loggerhead sea turtles on an urban beach. I. Correlates of nest placement. Journal of Herpetology 560–567.

Salmon, M., Tolbert, M.G., Painter, D.P., Goff, M., Reiners, R., 1995b. Behaviour of loggerhead sea turtles on an urban beach. II. Hatchling orientation. Journal of Herpetology 568–576.

Salmon, M., Witherington, B.E., 1995. Artificial lighting and seafinding by loggerhead hatchlings: evidence for lunar modulation. Copeia 931–938.

Scandpower, Blowout and well relase frequencies based on SINTEF offshore blowout database 2012, 2013, Scandpower AS, Norway

Schianetz, K., Jones, T., Kavanagh, L., Walker, P.A., Lockington, D., Wood, D., 2009. The practicalities of a Learning Tourism Destination: a case study of the Ningaloo Coast. International Journal of Tourism Research 11, 567–581. Doi:10.1002/jtr.729.

Sepulveda, C., Kohin, S., Chan, C., Vetter, R., Graham, J., 2004. Movement patterns, depth preferences, and stomach temperatures of free-swimming juvenile mako sharks, *Isurus oxyrinchus*, in the Southern California Bight. Marine Biology 145, 191–199.

SGS Economics & Planning, 2012. Economic development opportunities for the Gascoyne region associated with resource sector investment and expansion. Gascoyne Development Commission, Fortitude Valley.

Shell, 2014. Shell GTL Saraline 185V Safety Data Sheet.

Sheppard, J.K., Preen, A.R., Marsh, H., Lawler, I.R., Whiting, S.D., Jones, R.E., 2006. Movement heterogeneity of dugongs, *Dugong dugon* (Müller), over large spatial scales. Journal of Experimental Marine Biology and Ecology 334, 64–83.

Simmonds, M., Dolman, S., Weilgart, L., 2004. Oceans of noise, WDCS Science Report. Whale and Dolphin Conservation Society, Chippenham.

Simpson, C.J., Cary, J.L., Masini, R.J., 1993. Destruction of corals and other reef animals by coral spawn slicks on Ningaloo Reef, Western Australia. Coral Reefs 12, 185–191. Doi:10.1007/BF00334478.

Sinclair Knight Merz (SKM), 2006. Marine Survey for Proposed Angel Pipeline Route. Report for Woodside Energy Ltd 26 pp.

Sinclair Knight Merz, 2007. North West Shelf Venture Cumulative Environmental Impact Study – cumulative environmental assessment report. Sinclair Knight Merz, Perth.

SINTEF, 2018. SINTEF Offshore Blowout Database. Available at https://www.sintef.no/en/projects/sintef-offshore-blowout-database/. Accessed 02-Dec-2018.

Sleeman, J.C., Meekan, M.G., Wilson, S.G., Jenner, C.K.S., Jenner, M.N., Boggs, G.S., Steinberg, C.C. and Bradshaw, C.J.A., 2007. Biophysical correlates of relative abundances of marine megafauna at Ningaloo Reef, Western Australia, Marine and Freshwater Research 58: 608–623.

Sleeman, J.C., Meekan, M.G., Fitzpatrick, B., Steinberg, C., Ancel, R., Bradshaw, C., 2010. Oceanographic and atmospheric phenomena influence the abundance of whale sharks at Ningaloo Reef, Western Australia. Journal of Experimental Marine Biology and Ecology 382, 77–81.

Slijper, E.J., Van Utrecht, W. L., Naaktgeboen, C., 1964. Remarks on the distribution and migration of whales observations from Netherlands ships. *Bijdr. Dierkunde,* 34, 93 pp.

Smallwood, C.B., Beckley, L.E., Moore, S.A., Kobryn, H.T., 2011. Assessing patterns of recreational use in large marine parks: A case study from Ningaloo Marine Park, Australia. Ocean & Coastal Management 54, 330–340. Doi:10.1016/j.ocecoaman.2010.11.007.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene, C.R., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A., Tyack, P.L., 2007. Marine mammal noise exposure criteria: Initial scientific recommendations. Aquatic mammals 33, 411–414.

Southall, B.L., J.J. Finneran, C. Reichmuth, P.E. Nachtigall, D.R. Ketten, A.E. Bowles, W.T. Ellison, D.P. Nowacek, and P.L. Tyack. 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Aquatic Mammals 45(2): 125-232. https://doi.org/10.1578/AM.45.2.2019.125.

Spaulding, M.L., Li, Z., Mendelsohn, D., Crowley, D., French-McCay, D., Bird, A., 2017, 'Application of an integrated blowout model system, OILMAP DEEP, to the Deepwater Horizon (DWH) Spill', Marine Pollution Bulletin, vol. 120, no. 1-2, pp. 37–50.

Stevens, J.D., Pillans, R.D., Salini, J.P., 2005. Conservation assessment of *Glyphis glyphis* (speartooth shark), *Glyphis garricki* (northern river shark), *Pristis microdon* (freshwater sawfish) and *Pristis zijsron* (green sawfish). Report to Department of Environment and Heritage, Canberra, Australia.

Stevens, J., McAuley, R., Simpfendorfer, C., Pillans, R., 2008. Spatial distribution and habitat utilisation of sawfish (*Pristis* spp.) in relation to fishing in northern Australia. CSIRO Marine and Atmospheric Research, Hobart.

Stevens, J., Pillans, R., Salini, J., 2005. Conservation assessment of *Glyphis sp. A* (speartooth shark), *Glyphis sp. C* (northern river shark), *Pristis microdon* (freshwater sawfish) and *Pristis zijsron* (green sawfish). CSIRO Marine Research, Hobart.

Stevens, J.D., Bradford, R.W., West, G.J., 2010. Satellite tagging of blue sharks (*Prionace glauca*) and other pelagic sharks off eastern Australia: depth behaviour, temperature experience and movements. Marine biology 157, 575–591.

Storr, G.M., Smith, L.A., Johnstone, R.E., 2002. Snakes of Western Australia. Western Australian Museum, Perth, WA.

Strain, L., Brown, J., Walters, S., 2018. West Coast Roe's Abalone Resource Status Report 2017. In: *Status Reports of the Fisheries and Aquatic Resources of Western Australia 2016/17: The State of the Fisheries* eds. D.J. Gaughan and K. Santoro. Department of Primary Industries and Regional Development, Western Australia. pp. 36–40.

Swan, J.M., Neff, J.M., Young, P.C., 1994. Environmental implications of offshore oil and gas development in Australia: the findings of an independent scientific review. Australian Petroleum Exploration Association, Sydney.

Terrens, G.W., Gwyther, D., Keough, M.J., Tait, R.D., 1998. Environmental Assessment of Synthetic-Based Drilling-Mud Discharges to Bass Strait, Australia. Presented at the International Conference on Health, Safety, and Environment in Oil and Gas Exploration and Production, Society of Petroleum Engineers, Caracas, p. SPE-46622-MS. Doi:10.2118/46622-MS.

TGS, 2011. Exmouth Plateau Northern Extension MC3D Marine Seismic Survey Environment Plan: Public Summary. Available at http://www.nopsema.gov.au/assets/epsummaries/EP-Summary-Exmouth-Plateau-Northern-Extension-MC3D-EP-Rev0.pdf.

Thiele, D., Gill P.C., 1999. Cetacean observations during a winter voyage into Antarctic sea ice south of Australia. Antarctic Science 11, 48–53.

Thorburn, D.C., Morgan, D.L., Rowland, A.J., Gill, H.S., Paling, E., 2008. Life history notes of the critically endangered dwarf sawfish, *Pristis clavata*, Garman 1906 from the Kimberley region of Western Australia. Environmental Biology of Fishes 83, 139–145.

Threatened Species Scientific Committee, 2008a. Approved conservation advice for *Dermochelys coriacea* (Leatherback Turtle). Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Threatened Species Scientific Committee, 2008b. Approved conservation advice for green sawfish. Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Threatened Species Scientific Committee, 2009. Approved conservation advice for *Pristis clavata* (dwarf sawfish). Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Threatened Species Scientific Committee, 2015a. Conservation advice *Balaenoptera borealis* sei whale. Threatened Species Scientific Committee, Canberra.

Threatened Species Scientific Committee, 2015b. Conservation advice *Balaenoptera physalus* fin whale. Threatened Species Scientific Committee, Canberra.

Threatened Species Scientific Committee, 2015c. Conservation advice *Megaptera novaeangliae* humpback whale. Department of the Environment, Canberra.

Threatened Species Scientific Committee, 2015d. Conservation advice *Rhincodon typus* whale shark. Department of the Environment, Canberra.

Threatened Species Scientific Committee, 2015f. Conservation advice *Calidris ferruginea* curlew sandpiper. Threatened Species Scientific Committee, Canberra.

Threatened Species Scientific Committee, 2015g. Conservation Advice *Pterodroma Mollis* soft-plumaged petrel. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1036-conservation-advice-01102015.pdf. In effect under the EPBC Act from 01-Oct-2015.

Threatened Species Scientific Committee, 2015h. Conservation Advice Papasula abbotti Abbott's booby. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/59297-conservation-advice-01102015.pdf. In effect under the EPBC Act from 01-Oct-2015.

Threatened Species Scientific Committee, 2016a. Conservation advice *Calidris canutus* red knot. Threatened Species Scientific Committee, Canberra.

Tomajka, J., 1985. The influence of petroleum hydrocarbons on the primary production of the Danube River plankton. Acta Hydrochimica et Hydrobiologica 13, 615–618.

Truax, B. (Ed.), 1978. Handbook for Acoustic Ecology. Simon Fraser University, Burnaby.

United States Environmental Protection Agency, 2000. Development document for final effluent limitations guidelines and standards for synthetic-based drilling fluids and other non-aqueous drilling fluids in the oil and gas extraction point source category (Report No. EPA-821-B-00-013). United States Environmental Protection Agency, Washington, DC.

Vanderlaan, A.S.M., Taggart, C.T., 2007. Vessel collisions with whales: the probability of lethal injury based on vessel speed. Marine Mammal Science 23, 144–156. Doi:10.1111/j.1748-7692.2006.00098.x.

Waayers, D., Smith, L., Malseed, B., 2011. Inter-nesting distribution of green turtles (*Chelonia mydas*) and flatback turtles (*Natator depressus*) at the Lacepede Islands, Western Australia. Journal of the Royal Society of Western Australia 94, 359–364.

Weng, K.C., Boustany, A.M., Pyle, P., Anderson, S.D., Brown, A., Block, B.A., 2007a. Migration and habitat of white sharks (*Carcharodon carcharias*) in the eastern Pacific Ocean. Marine Biology 152, 877–894. Doi:10.1007/s00227-007-0739-4.

Weng, K.C., O’Sullivan, J.B., Lowe, C.G., Winkler, C.E., Dewar, H., Block, B.A., 2007b. Movements, behaviour and habitat preferences of juvenile white sharks *Carcharodon carcharias* in the eastern Pacific. Marine Ecology Progress Series 338, 211–224.

White, H.K., Hsing, P.-Y., Cho, W., Shank, T.M., Cordes, E.E., Quattrini, A.M., Nelson, R.K., Camilli, R., Demopoulos, A.W., German, C.R., 2012. Impact of the Deepwater Horizon oil spill on a deep-water coral community in the Gulf of Mexico. Proceedings of the National Academy of Sciences 109, 20303–20308.

Whittock, P., Pendoley, K., Hamann, M., 2014. Internesting distribution of flatback turtles *Natator depressus* and industrial development in Western Australia. Endangered Species Research 26, 25–38. Doi:10.3354/esr00628.

Williams, A., Patterson, H., Bath, A., 2017. Western tuna and billfish fishery, in: Patterson, H., Noriega, R., Georgeson, L., Stobutzki, I., Curtotti, R. (Eds.), Fisheries Status Reports 2017. Department of Agriculture and Water Resources, Canberra, pp. 406–423.

Wilson, S., Carleton, J., Meekan, M., 2003. Spatial and temporal patterns in the distribution and abundance of macrozooplankton on the southern North West Shelf, Western Australia. Estuarine, Coastal and Shelf Science 56, 897–908.

Wilson, S., Polovina, J., Stewart, B., Meekan, M., 2006. Movements of whale sharks (*Rhincodon typus*) tagged at Ningaloo Reef, Western Australia. Marine Biology 148, 1157–1166.

Wilson, S.K., Depczynski, M., Fisher, R., Holmes, T.H., O'Leary, R.A., Tinkler, P., 2010. Habitat associations of juvenile fish at Ningaloo Reef, Western Australia: The importance of coral and algae. PloS ONE 5, e15185. Doi:10.1371/journal.pone.0015185.

Woodhams, J., Bath, A., 2017a. North west slope trawl fishery, in: Patterson, H., Noriega, R., Georgeson, L., Stobutzki, I., Curtotti, R. (Eds.), Fisheries Status Reports 2017. Department of Agriculture and Water Resources, Canberra, pp. 85–91.

Woodside Energy Limited, 2006. Pluto LNG development draft Public Environment Report/Public Environment Review (EPBC Act Referral No. 2006/2968). Woodside Energy Limited, Perth.

Woodside Energy Limited, 2011. Browse LNG Development Draft Upstream Environmental Impact Statement (No. EPBC Referral 2008/4111). Woodside Energy Limited, Perth.

Yender, R., Michel, J., Lord, C., 2002. Managing seafood safety after an oil spill. National Oceanic and Atmospheric Administration, Seattle.

9 GLOSSARY AND ABBREVIATIONS

9.1 Glossary

Term	Meaning
(the) Regulator	The Government Agency (State or Commonwealth) that is the decision maker for approvals and undertakes ongoing regulation of the approval once granted.
3D seismic data	A set of numerous closely-spaced seismic lines that provide a high spatially sampled measure of subsurface reflectivity and 3D image.
Acceptability	The EP must demonstrate that the environmental impacts and risks of an activity will be of an acceptable level as per Regulation 10A(c).
ALARP	A legal term in Australian safety legislation, it is taken here to mean that all contributory elements and stakeholdings have been considered by assessment of costs and benefits, and which identifies a preferred course of action.
API (gravity)	A measure of how heavy or light a petroleum liquid is compared to water.
Australian Standard	An Australian Standard which provides criteria and guidance on design, materials, fabrication, installation, testing, commissioning, operation, maintenance, re-qualification and abandonment.
Ballast	Extra weight taken on to increase a ship's stability to prevent rolling and pitching. Most ships use seawater as ballast. Empty tank space is filled with inert (non-combustible) gas to prevent the possibility of fire or explosion.
Bathymetry	Related to water depth, a bathymetry map shows the depth of water at a given location on the map.
Benthos/Benthic	Relating to the seabed, and includes organisms living in or on sediments/rocks on the seabed.
Biodiversity	Relates to the level of biological diversity of the environment. The EPBC Act defines biodiversity as: "the variability among living organisms from all sources (including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part) and includes: (a) diversity within species and between species; and (b) diversity of ecosystems".
Biota	The animal and plant life of a particular region, habitat or geological period.
Cetacean	Whale and dolphin species.
Consequence	The worst case credible outcome associated with the selected event assuming some controls (prevention and mitigation) have failed. Where more than one impact applies (e.g. environmental and legal/compliance), the consequence level for the highest severity impact is selected.
Coral	Anthozoa that are characterised by stone like, horny, or leathery skeletons (external or internal). The skeletons of these animals are also called coral.
Coral Reef	A wave-resistant structure resulting from skeletal deposition and cementation of hermatypic corals, calcareous algae, and other calcium carbonate-secreting organisms.
Crustacean	A large and variable group of mostly aquatic invertebrates which have a hard external skeleton (shell), segmented bodies, with a pair of often very modified appendages on each segment, and two pairs of antennae (e.g. crabs, crayfish, shrimps, wood lice, water fleas and barnacles).
Cyclone	A rapidly-rotating storm system characterised by a low-pressure centre, strong winds, and a spiral arrangement of thunderstorms that produce heavy rain.
Datum	A reference location or elevation which is used as a starting point for subsequent measurements.
dB	Decibel – this is a measure of the overall noise level of sound across the audible spectrum with a frequency weighting (that is, 'A' weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.

Term	Meaning
dB re 1 µPa²	Measure of underwater noise, in terms of sound pressure. Because the dB is a relative measure, rather than an absolute measure, it must be referenced to a standard 'reference intensity', in this case one micro Pascal (1 mPa), which is the standard reference that is used. The dB is also measured over a specified frequency, which is usually either a one Hertz bandwidth (expressed as dB re 1 mPa²/Hz), or over a broadband which has not been filtered. Where a frequency is not specified, it can be assumed that the measurement is a broadband measurement.
dB re 1 µPa².s	Normal unit for sound exposure level.
Demersal	Living close to the floor of the sea (typically of fish).
Drill casing	Tubing that is set inside the drilled well to protect and support the well stream.
Drilling fluids	The main functions of drilling fluids include providing hydrostatic pressure to prevent formation fluids from entering into the well bore, keeping the drill bit cool and clean during drilling, carrying out drill cuttings, and suspending the drill cuttings while drilling is paused and when the drilling assembly is brought in and out of the hole. The drilling fluid used for a particular job is selected to avoid formation damage and to limit corrosion. The three main categories of drilling fluids are water-based muds (which can be dispersed and non-dispersed), non-aqueous muds, usually called oil-based mud, and gaseous drilling fluid, in which a wide range of gases can be used.
DRIMS	Woodside's internal document management system.
Dynamic positioning	In reference to a marine vessel that uses satellite navigation and radio transponders in conjunction with thrusters to maintain its position.
EC_{50}	the concentration of a drug, antibody or toxicant which induces a response halfway between the baseline and maximum after a specified exposure time.
Echinoderms	Any of numerous radially symmetrical marine invertebrates of the phylum Echinodermata, which includes the starfishes, sea urchins, and sea cucumbers, which have an internal calcareous skeleton and often covered with spines.
Endemic	A species that is native to, or confined to a certain region.
Environment	The surroundings in which an organisation operates, including air, water, land, natural resources, flora, fauna, humans and their interrelations (Source: ISO 14001).
Environment Plan	Prepared in accordance with the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009, which must be assessed and accepted by the Designated Authority (NOPSEMA) before any petroleum-related activity can be performed.
Environment Regulations	OPGGS (Environment) Regulation 2009.
Environmental approval	The action of approving something, which has the potential to have an adverse impact on the environment. Environmental impact assessment is generally required before environmental approval is granted.
Environmental Hazard	The characteristic of an activity or event that could potentially cause damage, harm or adverse effects on the environment
Environmental impact	Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's activities, products or services (Source: HB 203:2006).
Environmental impact assessment	An orderly and systematic process for evaluating a proposal or scheme (including its alternatives), and its effects on the environment, and mitigation and management of those effects (Source: Western Australian *Environmental Impact Assessment Administrative Procedures 2010*).
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*. Commonwealth legislation designed to promote the conservation of biodiversity and protection of the environment.
Epifauna	Benthic animals that live on the surface of a substrate.
Fauna	Collectively, the animal life of a particular region.
Flora	Collectively the plant life of a particular region.

Term	Meaning
IC_{50}	A measure of the effectiveness of a compound in inhibiting biological or biochemical function.
Infauna	Aquatic animals that live in the substrate of a body of water, especially in a soft sea bottom.
ISO 14001	ISO 14001 is an international standard that specifies a process (called an Environmental Management System or EMS) for controlling and improving a company's environmental performance. An EMS provides a framework for managing environmental responsibilities so that they become more efficient and more integrated into overall business operations.
Jig Fishing	Fishing with a jig, which is a type of fishing lure. A jig consists of a lead sinker with a hook moulded into it and usually covered by a soft body to attract fish.
LC_{50}	The concentration of a substance that is lethal to 50% of the population exposed to it for a specified time.
Likelihood	The description that best fits the chance of the selected consequence actually occurring, assuming reasonable effectiveness of the prevention and mitigation controls.
MARPOL (73/78)	The International Convention for the Prevention of Pollution from Ships 1973, as modified by the Protocol of 1978. MARPOL 73/78 is one of the most important international marine environmental conventions. It was designed to minimise pollution of the seas, including dumping, oil and exhaust pollution. Its stated object is to preserve the marine environment through the complete elimination of pollution by oil and other harmful substances and the minimization of accidental discharge of such substances.
Meteorology	The study of the physics, chemistry, and dynamics of the earth's atmosphere, including the related effects at the air–earth boundary over both land and the oceans.
Mitigation	Management measures which minimise and manage undesirable consequences.
NOHSC (1008:2004)	National Occupational Health and Safety Commission – Approved Criteria for Classifying Hazardous Substances.
Oligotrophic	Low in plant nutrients and having a large amount of dissolved oxygen throughout.
pH	measure of the acidity or basicity of an aqueous solution.
Protected Species	Threatened, vulnerable or endangered species which are protected from extinction by preventive measures. Often governed by special federal or state laws.
Putrescible	Refers to food scraps and other organic waste associated with food preparation that will be subject to decay and rot (putrefaction).
Risk	The combination of the consequences of an event and its associated likelihood. For guidance see Environmental Guidance on Application of Risk Management Procedure.
S-BRUVS	Stereo-baited remote underwater video systems.
Sessile	Organism that is fixed in one place; immobile.
Syngnathids	Family of fish which includes the seahorses, the pipefishes, and the weedy and leafy sea dragons.
Teleost	A fish belonging to the Teleostei or Teleostomi, a large group of fishes with bony skeletons, including most common fishes. The teleosts are distinct from the cartilaginous fishes such as sharks, rays, and skates.
Thermocline	A temperature gradient in a thermally stratified body of water.
XC Polymer	A polysaccharide secreted by the bacteria genus *Xanthomonas campestris*.
Zooplankton	Plankton consisting of small animals and the immature stages of larger animals.

Abbreviation	Meaning
μm	Micrometer
AHS	Australian Hydrographic Service
AHO	Australian Hydrographic Office
AHV	Anchor handling vessel
AIMS	Australian Institute of Marine Science
ALARP	As low as reasonably practicable
AMP	Australian Marine Park
AMSA	Australian Maritime Safety Authority
API	American Petroleum Institute
APPEA	Australian Petroleum Production and Exploration Association
AS/NZS	Australian Standard (New Zealand Standard)
ATSB	Australian Transport Safety Bureau
AusSAR	Australian Search and Rescue
bbl	Oil barrel
BIA	Biologically important areas
BoM	Bureau of Meteorology
BOP	Blowout preventer
BP	Boiling point
CALM	Department of Conservation and Land Management
CCP	Cyclone Contingency Plan
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CICC	Corporate Incident Communication Centre
CV	Company values
DAWR	Department of Agriculture and Water Resources
DEWHA	Department of Environment, Water, Heritage and the Arts
DGPS	Differential global positioning system
DMIRS	Department of Mines, Industry Regulation and Safety
DMP	Department of Mines and Petroleum
DNP	Director of National Parks
DoD	Department of Defence
DoEE	Department of Environment and Energy
DoT	Department of Transport
DP	Dynamically positioned
DPaW	Department of Parks and Wildlife
DPIRD	Department of Primary Industries and Regional Development
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EC_{50}	Half maximal effective concentration
EDS	Emergency disconnect sequence
EEZ	Exclusive Economic Zone

Abbreviation	Meaning
EFL	Electrical flying lead
EHU	Electro-hydraulic umbilical
EMBA	Environment that may be affected
EMS	Environmental Management System
ENVID	Environmental hazard identification
EP	Environment Plan
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPO	Environmental Performance Outcome
EPS	Environmental Performance Standard
ERP	Emergency Response Plans
ESD	Emergency shutdown
FCGT	Flood, clean and gauge testing
FEWD	Formation evaluation while drilling
FPSO	Floating production, storage and offtake vessel
g/m^2	Grams per square metre
GP	Good practice
HAZID	Hazard identification
HFL	Hydraulic flying lead
HLV	Heavy lift vessel
HOCNF	Harmonised Offshore Chemical Notification Format
HQ	Hazard quotient
HSE	Health, safety and environment
Hz	Hertz
IC	Incident Controller
IC_{50}	Half maximal inhibitory concentration
IMO	International Maritime Organization
IMS	Invasive marine species
IOGP	International Association of Oil and Gas Producers
ITF	Indonesian Through Flow
IUCN	International Union for Conservation of Nature
JRCC	Joint Rescue Coordination Centre
JSA	Job safety assessment
KEF	Key ecological feature
kHz	Kilohertz
km	Kilometre
kPa	Kilopascal
L	Litres
LAT	Lowest astronomical tide
LC_{50}	Lethal concentration, 50%

Abbreviation	Meaning
LBL	Long baseline transponder
LCS	Legislation, codes and standards
LNG	Liquefied natural gas
LWI	Light well intervention
LWIV	Light well intervention vessel
MBES	Multi-beam echo sounder
MC	Measurement criteria
MEG	Monoethylene glycol
MFO	Marine Fauna Observers
scf	Standard cubic feet
MNES	Matters of National Environmental Significance
MOC	Management of Change
MODU	Mobile offshore drilling unit
MPA	Marine Protected Area
ms^{-1}	Metres per second
MSIN	Maritime Safety Information Notifications
NIMS	Non-indigenous marine species
nm	Nautical mile (1852 m), a unit of distance on the sea
NOAA	National Oceanic and Atmospheric Administration
NOECs	No-observed-effect concentrations
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NTM	Notice to Mariners
NWBM	Non water-based mud
NWMR	North West Marine Region
NWSTF	North West Slope Trawl Fishery
OCNS	Offshore Chemical Notification Scheme
OIW	Oil in water
OOC	Oil on cuttings
OPEP	Oil Pollution Emergency Plan
OPGGS Act	*Offshore Petroleum and Greenhouse Gas Storage Act*
OSPAR	Oslo and Paris Commission for the Convention for the Protection of the Marine Environment of the North-East Atlantic
HSPU	Hydrocarbon Spill Preparedness Unit
OVID	Offshore Vessel Inspection Database
OVMSA	Offshore Vessel Safety Management System assessment
PAH	Polycyclic aromatic hydrocarbons
Permit Area	Petroleum Activities Area
PJ	Professional judgement
PLONOR	OSPAR definition of a substance ‘poses little or no risk’ to the environment

Abbreviation	Meaning
PPA	Pearl Producers Association
ppb	Parts per billion
ppm	Parts per million
psi	Pounds per square inch
PS	Performance standards
PTW	Permit to Work
PW	Produced water
RBA	Risk based analysis
RCC	Rescue Co-ordination Centre
RMR	Riserless mud recovery
RMS	Root mean square
ROV	Remotely operated vehicle
SCE	Solids control equipment
SDU	Subsea distribution unit
SIMAP	Spill Impact Mapping and Analysis Program
SIMOPS	Simultaneous operations
SMPEP	Spill Monitoring Programme Execution Plan
SOPEP	Ship Oil Pollution Emergency Plan
SPL	Sound pressure levels
SV	Societal values
TD	Total depth
TSS	Total suspended solids
TTS	Temporary threshold shift
USBL	Ultra short baseline transponder
UTA	Umbilical termination assembly
UK	United Kingdom
VLS	Vertical lay system
VOC	Volatile organic compounds
WA	Western Australia
WAF	Water accommodated fractions
WAFIC	Western Australian Fishing Industry Council
WBM	Water based mud
WCBD	Well Control Bridging Document
WCC	Woodside Communication Centre
WHA	World Heritage Area
WMS	Woodside Management System
WOMP	Well Operation Management Plan
Woodside	Woodside Energy Ltd
wt%	Weight per cent

APPENDIX A: WOODSIDE ENVIRONMENT & RISK MANAGEMENT POLICIES

WOODSIDE POLICY

Health, Safety, Environment and Quality Policy

OBJECTIVES

Strong health, safety, environment and quality (HSEQ) performance is essential for the success and growth of our business. Our aim is to be recognised as an industry leader in HSEQ 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, incorporating a right first time approach to quality.

PRINCIPLES

Woodside will achieve this by:

- implementing a systematic approach to HSEQ 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 HSEQ performance
- embedding HSEQ considerations in our business planning and decision making processes
- integrating HSEQ requirements when designing, purchasing, constructing and modifying equipment and facilities
- maintaining a culture in which everybody is aware of their HSEQ obligations and feels empowered to speak up and intervene on HSEQ issues
- undertaking and supporting research to improve our understanding of HSEQ 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 HSEQ expectations in a mutually beneficial manner
- publicly reporting on HSEQ 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.

This policy will be reviewed regularly and updated as required.

December 2015

WOODSIDE POLICY woodside

Risk Management Policy

OBJECTIVES

Woodside recognises that risk is inherent to its business and that effective management of risk is vital to delivering on our objectives, our success and our continued growth. We are committed to managing all risk in a proactive and effective manner.

Our approach to risk enhances opportunities, reduces threats and sustains Woodside's competitive advantage.

The objective of our risk management system is to provide a consistent process for the recognition and management of risks across Woodside's business. The success of our risk management system lies in the responsibility placed on everyone at all levels to proactively identify, manage, review and report on risks relating to the objectives they are accountable for delivering.

PRINCIPLES

Woodside achieves these objectives by:

- Applying a structured and comprehensive risk management system across Woodside which establishes common risk management understanding, language and methodology
- Identifying, assessing, monitoring and reporting risks to provide management and the Board with the assurance that risks are being effectively identified and managed
- Ensuring risks consider impacts across the following key areas of exposure: health and safety, environment, finance, reputation and brand, legal and compliance, and social and cultural
- Understanding our exposure to risk and applying this to our decision making
- Embedding risk management into our critical business activities and processes
- Assuring the effectiveness of risk controls and of the risk management process
- Building our internal resilience to the effects of adverse business impacts in order to sustain performance.

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.

December 2012

APPENDIX B: RELEVANT REQUIREMENTS

This appendix refers to Commonwealth Legislation related to the project. Western Australian State Legislation relevant to an accidental release of hydrocarbons in WA State waters is outlined in the Julimar Phase 2 Drilling and Subsea Installation Oil Pollution Emergency Plan.

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.

Commonwealth Legislation	Legislation Summary
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.
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

Australian Government
Department of the Environment and Energy

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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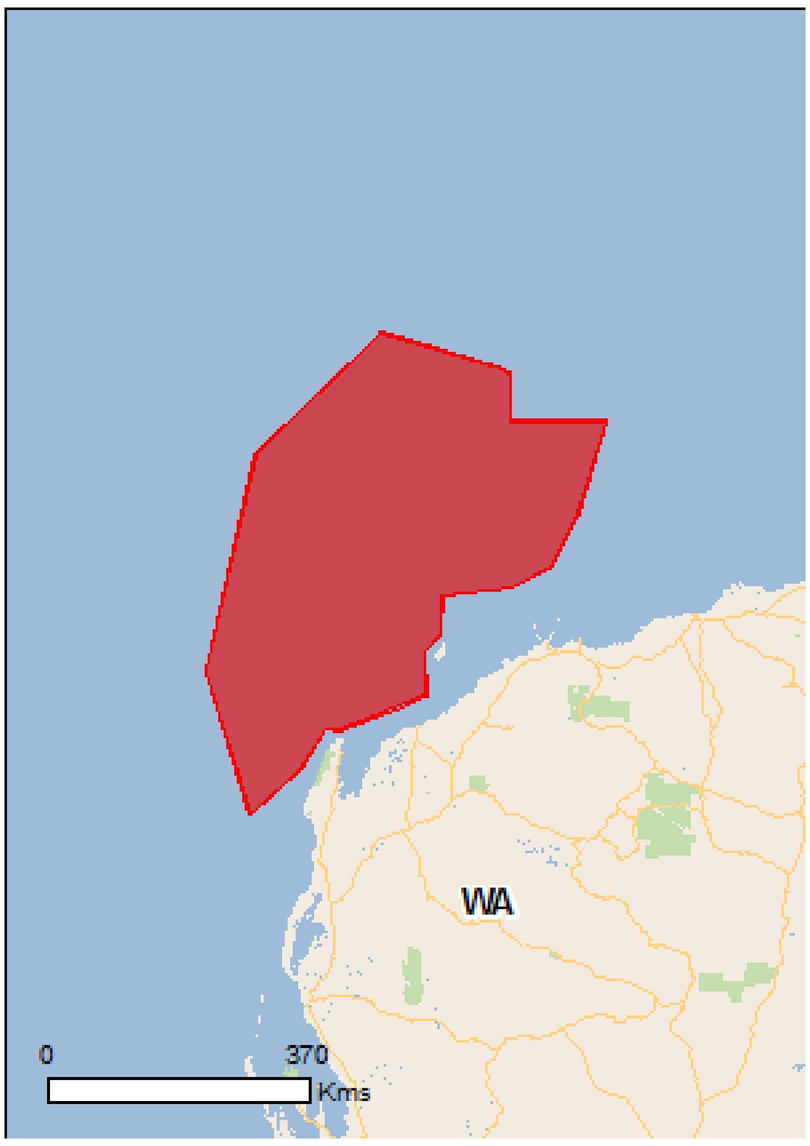

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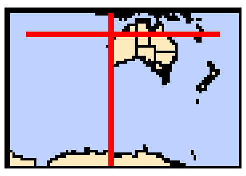

Summary

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:	1
National Heritage Places:	1
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	25
Listed Migratory Species:	45

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:	82
Whales and Other Cetaceans:	29
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	4

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

World Heritage Properties [Resource Information]

Name	State	Status
The Ningaloo Coast	WA	Declared property

National Heritage Properties [Resource Information]

Name	State	Status
Natural		
The Ningaloo Coast	WA	Listed place

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea
Extended Continental Shelf

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
North-west

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
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
Rostratula australis Australian Painted-snipe, Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Sternula nereis nereis		
Australian Fairy Tern [82950]	Vulnerable	Breeding known to occur within area
Thalassarche impavida		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may 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	Species or species habitat known to occur within area
Reptiles		
Aipysurus apraefrontalis		
Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Congregation or aggregation known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Congregation or aggregation known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata		
Hawksbill Turtle [1766]	Vulnerable	Congregation or aggregation known to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Congregation or aggregation known to occur within area
Sharks		
Carcharias taurus (west coast population)		
Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat 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
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
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
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
Sterna dougallii Roseate Tern [817]		Breeding likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may 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
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Congregation or

Name	Threatened	Type of Presence
		aggregation known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Congregation or aggregation known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Dugong dugon Dugong [28]		Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Congregation or aggregation known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat known to occur within area
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	Species or species habitat 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 Terrestrial Species		
Hirundo rustica Barn Swallow [662]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat 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		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		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
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 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]		Species or species habitat likely to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Sterna bengalensis Lesser Crested Tern [815]		Breeding known to occur within area
Sterna dougallii Roseate Tern [817]		Breeding likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed	Vulnerable	Species or species

Name	Threatened	Type of Presence
Albatross [64459]		habitat may occur within area
Fish		
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within area
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area
Campichthys 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

Name	Threatened	Type of Presence
		habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
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

Name	Threatened	Type of Presence
		habitat known to occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake [1114]		Species or species habitat may occur within area
Aipysurus apraefrontalis Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus duboisii Dubois' Seasnake [1116]		Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake [1117]		Species or species habitat may occur within area
Aipysurus 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	Congregation or aggregation known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Congregation or aggregation known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat 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	Congregation or aggregation known to occur within area
Hydrelaps darwiniensis Black-ringed Seasnake [1100]		Species or species habitat may occur within area
Hydrophis czeblukovi Fine-spined Seasnake [59233]		Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake [1104]		Species or species

Name	Threatened	Type of Presence
		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
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
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
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 known to occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin [50]		Species or species habitat may occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks [Resource Information]

Name	Label
Gascoyne	Habitat Protection Zone (IUCN IV)
Gascoyne	Multiple Use Zone (IUCN VI)

Name	Label
Montebello	Multiple Use Zone (IUCN VI)
Ningaloo	Recreational Use Zone (IUCN IV)

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
Commonwealth waters adjacent to Ningaloo Reef	North-west
Continental Slope Demersal Fish Communities	North-west
Exmouth Plateau	North-west
Glomar Shoals	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

-22.6881849747 112.991579705,-22.6873762818 112.98933694,-22.6859053585 112.98701865,-22.6839288915 112.98472169,-22.681560849 112.982547298,-22.6788794927 112.980607729,-22.6759328925 112.979033325,-22.6727430498 112.977980087,-21.0074941116 112.430587029,-21.0033625608 112.429309162,-20.9987554686 112.428482269,-20.9940046147 112.428011142,-20.9894327072 112.427806801,-20.98535702 112.427785757,-20.9793552244 112.428007085,-18.3995818268 113.044622459,-18.3980275354 113.045214462,-16.9478896927 114.631878431,-16.9460164963 114.634251014,-16.9451228166 114.636724596,-16.9453449835 114.639043976,-17.3861631754 116.186599585,-17.3873266394 116.190491293,-17.3888050583 116.194410654,-17.390508647 116.198351371,-17.3923711558 116.202308369,-17.4299265531 116.280495099,-18.0053550149 116.28114493,-18.0058550727 117.479522954,-18.0074197478 117.481173275,-18.0097703289 117.481946312,-18.0126658363 117.481863764,-18.0159310702 117.481145448,-19.1215419769 117.135709763,-19.1251811981 117.134370804,-19.128818512 117.132871628,-19.1323852539 117.131296158,-19.1417655945 117.126848221,-19.1455726624 117.124895096,-19.7343559265 116.794755936,-19.9959069695 116.310453625,-20.0845499437 115.408619834,-20.5523223877 115.37793541,-20.7641334534 115.187059402,-21.2774620056 115.20423317,-21.3712310791 114.970716476,-21.688451767 114.112737656,-21.6672344208 113.928182602,-22.1513271332 113.616506577,-22.6869140089 112.995583971,-22.6881235205 112.993648227,-22.6881849747 112.991579705

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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APPENDIX D: OIL SPILL PREPAREDNESS AND RESPONSE STRATEGY SELECTION AND EVALUATION

Oil Spill Preparedness and Response Mitigation Assessment for the WA-34-L Pyxis Drilling and Subsea Installation Environment Plan

Security & Emergency Management

Hydrocarbon Spill Preparedness Unit

Revision 2

November 2019

TABLE OF CONTENTS

FIGURES

TABLES

EXECUTIVE SUMMARY

Woodside Burrup Ltd (Woodside) has developed its oil spill preparedness and response position for the WA-34-L Pyxis Drilling and Subsea Installation Activities Program, 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

Key details of assessment	Summary	Reference to additional detail
Worst Case Credible Scenarios	**Hydrocarbon release of Pyxis Condensate caused by loss of well containment (five day surface, 62 day subsea).** Well loss of containment of 147,755 m^3 over 67 days. The residual volume of hydrocarbon remaining post weathering is ~ 29,255 m^3 over 67 days (~436.6 m^3/day). **Instantaneous hydrocarbon release of marine diesel caused by vessel collision**. Instantaneous release of 1000 m^3. The residual volume of hydrocarbon remaining post weathering is ~ 50 m^3	Section 2.2
Hydrocarbon Properties and weathering	**Pyxis Condensate (API 41)** Contains a moderate proportion (19.8% by mass) of hydrocarbon compounds that will not evaporate at atmospheric temperatures. These compounds are expected to persist in the marine environment. The unweathered mixture has a dynamic viscosity of 0.994 cP. The pour point of the whole oil (<36°C) ensures that it will remain in a liquid state over the annual temperature range observed on the North West Shelf. The Pyxis condensate (surface and subsea) mixtures are composed of hydrocarbons that have a wide range of boiling points and volatilities at atmospheric temperatures, and which will begin to evaporate at different rates on exposure to the atmosphere. Evaporation rates will increase with temperature, but in general about 11.4% of the Pyxis condensate (surface) mass has the capacity to evaporate within the first 12 hours (BP <180 °C); a further 38.3% could evaporate within the first 24 hours (180 °C <BP <265 °C); and a further 30.5% could evaporate over several days (265 °C <BP <380 °C). For the Pyxis condensate (subsea) oil, 76.1% of the mass has the capacity to evaporate within the first 12 hours (BP <180 °C); a further 13.5% could evaporate within the first 24 hours (180 °C <BP <265 °C); and a further 10.3% could evaporate over several days (265 °C <BP <380 °C) **Marine Diesel (API 37.2)** In general, about 6% of the oil mass should 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	Section 6.7.1 and 6.7.3 of the EP Appendix A of the First Strike Response Plan

	over several days (265 °C < BP < 380 °C). Approximately 5% of the oil is shown to be persistent (50 m^3). Under calm conditions the majority of the remaining oil on the water surface will weather at a slower rate due to being comprised of the longer-chain compounds with higher boiling points. Evaporation of the residual compounds will slow significantly, and they will then be subject to more gradual decay through biological and photochemical processes.	
Modelling Results	A quantitative, stochastic assessment has been undertaken for credible spill scenarios to help assess the environmental risk of a hydrocarbon spill. A total of 100 replicate simulations were completed for each scenario 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 (25 simulations per quarter). Woodside uses a series of triggers from the stochastic modelling to inform whether deterministic modelling is required to inform response strategy implementation. For this PAP the stochastic modelling did not trigger any of the criteria, therefore deterministic modelling was not required to inform response strategy implementation.	Section 2.3
Net Environmental Benefit Analysis	Monitor and Evaluate, Source Control (relief well drilling) and Oiled Wildlife Response, are all response strategies 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 strategies	The evaluation of the selected response strategies 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 7

1 INTRODUCTION

1.1 Overview

Woodside Burrup Ltd (Woodside) has developed its oil spill preparedness and response position for the WA-34-L Pyxis Drilling and Subsea Installation Activities Program, hereafter known as the Petroleum Activities Program (PAP). This document outlines Woodside's decisions and strategies 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 WA-34-L Pyxis Drilling and Subsea Installation Environment Plan (EP)
- Oil Pollution Emergency Arrangements (OPEA) (Australia)
- The WA-34-L Pyxis Drilling and Subsea Installation Oil Pollution Emergency Plan (OPEP) including:
    - First Strike Response Plan (FSRP)
    - relevant Operations Plans
    - relevant Tactical Response Plans (TRPs)
    - relevant Supporting Plans
    - Data Directory.

1.3 Scope

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 risks and impacts resulting from an unplanned loss of hydrocarbon containment associated with the PAP described in the EP. This content of 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 3-2 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 FSRP contains a pre-operational Net Environmental Benefit Analysis (NEBA) summary, outlining the selected response strategies for this PAP. Relevant Operational Plans to be initiated for associated response strategies are identified in the FSRP and relevant forms to initiate a response are appended to the FSRP.

The process to develop an Incident Action Plan (IAP) begins once the Oil Pollution FSRP 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 (see Section 4). The response will continue as described in Section 5 until the response termination criteria have been met as set out in ANNEX B: Operational Monitoring Activation and Termination Criteria.

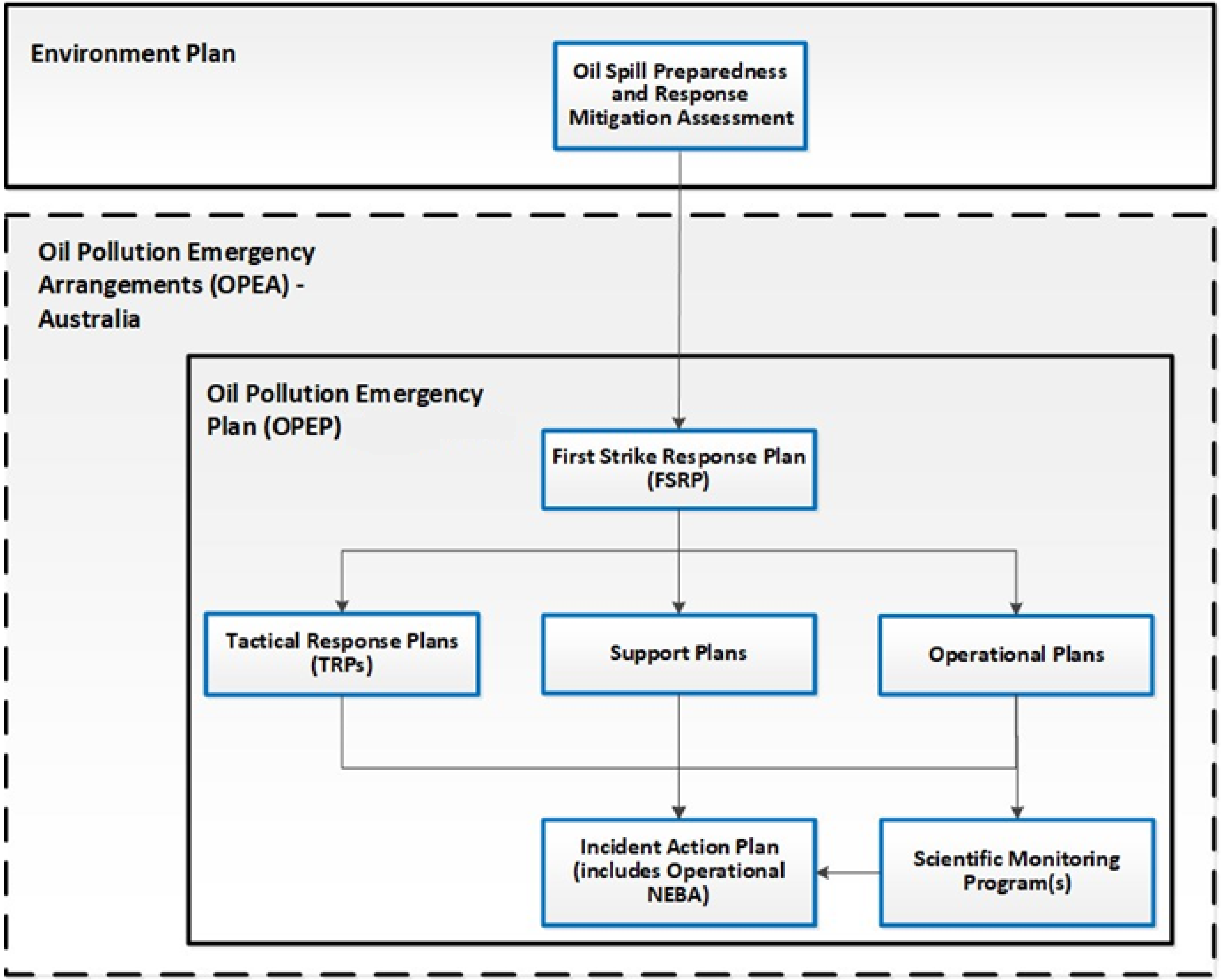


Figure 1-1: Woodside hydrocarbon spill document structure

Table 1-1: Hydrocarbon Spill preparedness and response – document references

Document	Document overview	Stakeholders	Relevant information	Document subsections (if applicable)
WA-34-L Pyxis Drilling and Subsea Installation Environment Plan (EP)	Demonstrates that potential adverse impacts on the environment associated with the PAP (during both routine and non-routine operations) are mitigated and managed to As Low As Reasonably Practicable (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 7 (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 WA-34-L Pyxis Drilling and Subsea Installation (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.	
WA-34-L Pyxis Drilling and Subsea Installation 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 Incident Action Plan (IAP) specific to the event is developed.	Site-based IMT for initial response, activation and notification. CICC for initial response, activation and notification.	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.	

Document	Document overview	Stakeholders	Relevant information	Document subsections (if applicable)
	Oil Pollution First Strike Response Plans are intended to be the first document used to provide immediate guidance to the responding Incident Management Team (IMT).	CICC: Control function in an ongoing spill response for activity-specific response information.	Details and forms for use in immediate response. Activation process for oil spill 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 First Strike Response Plan on the Oil Pollution; 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 Source Control & Well Intervention Oiled Wildlife Scientific Monitoring
Tactical Response Plans	Provides options for response techniques in selected Response Protection Areas (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 strategies. Access requirements and/or permissions. Relevant information for undertaking a response at that site. Where applicable, may include equipment deployment locations and site layouts.	There are no tactical response plans for this activity.

Document	Document overview	Stakeholders	Relevant information	Document subsections (if applicable)
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.	Strategy 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 (First Strike Response) IT (Extended Response) Communications (First Strike Response) Communications (Extended Response) Stakeholder Engagement Accommodation & Catering Waste Management Guidance for Oil Spill Claims Management (Land based) 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 WA-34-L Pyxis Drilling and Subsea Installation Oil Pollution 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.

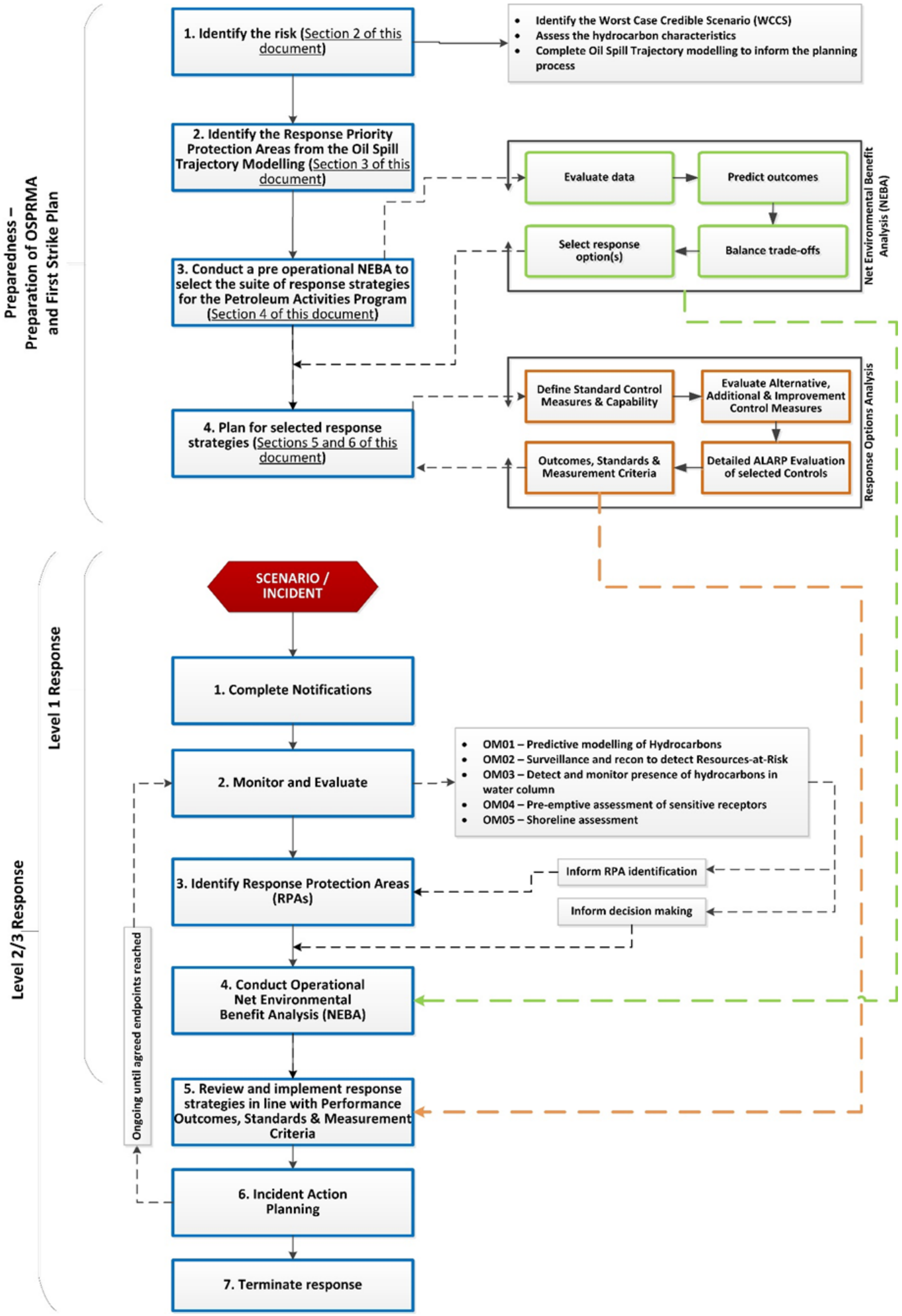


Figure 2-1: Response planning and selection process

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 strategies 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 the 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 strategy 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 STRATEGIES

- Evaluation of impacts and risks from implementing selected response options.

Section 8. ALARP CONCLUSION

Section 9. ACCEPTABILITY CONCLUSION

2.1.1 Response Planning Assumptions – Timing, Resourcing and Effectiveness

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 Assumptions – Timing, Resourcing and Effectiveness

For the purpose of defining terms related to response planning and timing, the following definitions have been developed;

- Activation - Is the time taken to activate the appropriate contract and/or arrangements by the IMT once the IMT has mobilised to the Incident Control Centre (ICC). For planning purposes, this is expected to be two-four hours post IMT mobilisation to ICC (where the IMT mobilisation is two-four hours).
- Mobilisation - Is the time taken following contract activation to mobilise the resources/equipment from its home location (e.g., Dampier, Singapore, Perth, etc.) to the staging area/laydown area (expected to be a nearby seaport or airport). Mobilisation time includes movement of resources from primary storage location to the designated deployment location/staging area in Dampier, inclusive of all required access, loading, permits/approvals, transit and unloading activities. If a resource is comprised of multiple components (i.e., vessel with fuel, crew, supplies, hoses, pumps, powerpacks, etc.), the mobilisation time is calculated from the longest lead time item that must be present for the resource to be safely and effectively deployed.
- Deployment - Is the time taken to deploy the required resource(s) from the staging area/laydown area (expected to be a nearby seaport or airport) to the required location in the field (offshore, nearshore, shoreline) where the resource will be utilised.

2.2 Environment plan risk assessment (credible spill scenarios)

Potential hydrocarbon release scenarios from the PAP have been identified during the risk assessment process (presented in Section 2.5 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 hydrocarbon 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.

A loss of well integrity is an uncontrolled release of reservoir hydrocarbon or other well fluids to the marine environment, resulting from an over-pressured reservoir. Woodside has identified a blowout as the scenario with the worst case credible environmental outcome, caused by a loss of well integrity. The loss of well containment scenario has been modelled and considered to determine the WCCS for response planning purposes. The PAP credible spill scenarios are presented in Table 2-1

Table 2-1: PAP credible spill scenarios

Scenarios	Scenario selected for planning purposes	Scenario description	Maximum credible volume released (liquid m^3)	Incident Level	Hydrocarbon type	Residual proportion	Residual volume (liquid m^3)	Key credible scenarios informing response planning
Scenario one	Yes	67-day hydrocarbon release of Pyxis Condensate caused by loss of well containment (5-day surface, 62 days subsea).	147,755 m^3	Three	Pyxis Condensate	19.8%	436.6 m^3 per day	Well loss of containment of 147,755 m^3 over 67 days
Scenario two	Yes	Instantaneous hydrocarbon release caused by vessel collision.	1000 m^3	Two	Marine Diesel	5%	50 m^3	Loss of marine diesel from vessel collision of 1000 m^3
Scenario three	No	Hydrocarbon Release during diesel fuel bunkering	8 m^3	One	Marine Diesel	5%	0.4 m^3	The WCCS for a marine diesel spill is described in Scenario two.

2.2.1 Hydrocarbon characteristics

Hydrocarbon characteristics, including modelled weathering data and ecotoxicity, are included in Section 6.7.2 and 6.7.3 of the EP.

Pyxis Condensate

Pyxis Condensate (API 41) contains a moderate proportion (19.8% by mass) of hydrocarbon compounds that will not evaporate at atmospheric temperatures. These compounds are expected to persist in the marine environment.

The unweathered mixture has a dynamic viscosity of 0.994 cP. The pour point of the whole oil (<36°C) ensures that it will remain in a liquid state over the annual temperature range observed on the North West Shelf.

The properties of Pyxis condensate differ for the surface and seabed release to account for the pressure and temperature differentials between the water surface and the seabed release phases.

The Pyxis condensate (surface and subsea) mixtures are composed of hydrocarbons that have a wide range of boiling points and volatilities at atmospheric temperatures, and which will begin to evaporate at different rates on exposure to the atmosphere. Evaporation rates will increase with temperature, but in general about 11.4% of the Pyxis condensate (surface) mass has the capacity to evaporate within the first 12 hours (BP <180 °C); a further 38.3% could evaporate within the first 24 hours (180 °C <BP <265 °C); and a further 30.5% could evaporate over several days (265 °C <BP <380 °C). For the Pyxis condensate (subsea) oil, 76.1% of the mass has the capacity to evaporate within the first 12 hours (BP <180 °C); a further 13.5% could evaporate within the first 24 hours (180 °C <BP <265 °C); and a further 10.3% could evaporate over several days (265 °C <BP <380 °C), once exposed to the atmosphere. The whole oils have low asphaltene contents (0.05%), indicating a low propensity for the mixtures to take up water to form water-in-oil emulsion over the weathering cycle.

The Pyxis condensate (surface and subsea) mixtures are composed of hydrocarbons that have a wide range of boiling points and volatilities at atmospheric temperatures, and which will begin to evaporate at different rates on exposure to the atmosphere. Evaporation rates will increase with temperature, but in general about 11.4% of the Pyxis condensate (surface) mass has the capacity to evaporate within the first 12 hours (BP <180 °C); a further 38.3% could evaporate within the first 24 hours (180 °C <BP <265 °C); and a further 30.5% could evaporate over several days (265 °C <BP <380 °C).

Marine Diesel

Marine Diesel is typically classed as an International Tanker Owners Pollution Federation (ITOPF) Group two oil. Group two oils are a mixture of volatile and persistent hydrocarbons, with approximately 40-50% by mass predicted to evaporate over the first day or two, depending upon the prevailing conditions, with further evaporation slowing over time.

Modelling shows about 6% of the oil mass should 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. 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.

It is predicted only 50 m^3 of product would remain after weathering from the WCC marine diesel scenario. No predicted shoreline contact or accumulation above response thresholds specified in Table 2-2.

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 both used for stochastic and deterministic trajectory modelling 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. 2007; 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, 2018). 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 has been completed for the following scenarios outlined in Table 2-1 (Scenarios one and two). A quantitative, stochastic assessment has been undertaken for credible spill scenarios to help assess the environmental consequences of a hydrocarbon spill.

A total of 100 replicate simulations were completed for each of 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 (25 simulations per quarter). Further details relating to the assessments for the scenarios can be found in Section 6.7.1 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 the Environment that May Be Affected (EMBA) and is discussed further in Section 6.7 of the EP. As the weathering of different fates of hydrocarbons (surface, entrained, dissolved and accumulated) 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. Woodside recognises that hydrocarbons may be present beyond the ecological impact EMBA at low concentrations that may be visible, but are not expected to cause ecological impacts. The threshold for visible surface oil (1 g/m^2) has therefore been 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, 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;
- Fisheries.

These hydrocarbon thresholds are presented in Table 2-2 below and described in Section 6.7.1.1 of the EP.

Table 2-2: Summary of thresholds applied to the stochastic hydrocarbon spill modelling to determine Environment that May Be Affected and environmental impacts

Hydrocarbon Type	Surface hydrocarbon (g/m^2)	Entrained hydrocarbon (ppb)	Dissolved aromatic hydrocarbon (ppb)	Accumulated hydrocarbon (g/m^2)
Condensate	10	100	50	100
Diesel	10	500	500	100

2.3.2 Deterministic modelling

Woodside uses deterministic modelling results to evaluate risks and impacts and response capability requirements. Thresholds to determine the EMBA are used to predict environmental effects and inform the Scientific Monitoring Program (SMP), however they do not appropriately represent the thresholds at which an effective response can be implemented. Additional thresholds are used for response planning and to determine areas where response strategies would be most effective. The deterministic modelling is then used to assess the nature and scale of a response.

As per the Woodside Hydrocarbon Spill Modelling Guideline, Woodside uses a series of triggers from the stochastic modelling to inform whether deterministic modelling is required to inform response strategy implementation. The triggers are based on response planning thresholds described in Section 2.3.2.1 and informs whether deterministic modelling is required for response planning.

For this PAP the stochastic modelling did not trigger any of the above criteria, therefore deterministic modelling has not been required to inform response strategy implementation.

Woodside is committed to a realistic, scalable response capability that is commensurate to the level of risk and able to be practically implemented and feasibly sustained.

2.3.2.1 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 strategies would be most effective.

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 deterministic spill modelling outputs are presented at response planning thresholds for surface hydrocarbons for the WCCS. Hydrocarbon spill concentrations are expressed as grams per square metre (g/m^2). The thresholds used are derived from oil spill response planning literature and industry guidance and are summarised below in Table 2-3.

Table 2-3: Hydrocarbon thresholds for response planning

Hydrocarbon concentration (g/m^2)	Description	Bonn Agreement Oil Appearance Code (BAOAC)	Mass per area (g/m^2)
>10	Predicted minimum threshold for commencing operational monitoring	Code three – Dull metallic colours	5 to 50

Hydrocarbon concentration (g/m²)	Description	Bonn Agreement Oil Appearance Code (BAOAC)	Mass per area (g/m²)
50	Predicted minimum floating oil threshold for containment and recovery and surface dispersant application [1]	Code four – Discontinuous true oil colour	50 to 200
100	Predicted optimum floating oil threshold for containment and recovery and surface dispersant application	Code five – Continuous true oil colour	>200
Shoreline hydrocarbon	**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 three - Thin Coating	200 - 1000

The surface thickness of oil at which dispersants are typically effective is approximately 100 g/m². However, substantial variations occur in the thickness of the oil within the slick, and most fresh crude oils spread within a few hours, so that overall the average thickness is 0.1 mm (or approx. 100 g/m²) (ITOPF 2011). 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 one 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 two 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. five – 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 two 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 four and five. Spraying areas of oil designated as BAOAC Code four (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 five 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 Strategies: A Guide for Spill Response Planning in Marine Environments 2013 (NOAA 2013).* This guide outlines advice for response planning across

[1] At 50 g/m², 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.

all common strategies, 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 50 g/m^2 was chosen as an average / equilibrium thickness (50 g/m^2 is an average is 50% coverage of 0.1mm Bonn Agreement Code 4 - discontinuous true oil colour, or 25% coverage of 0.2 mm Bonn Agreement Code five – continuous true oil colour which would represent small patches of thick oil or wind-rows.

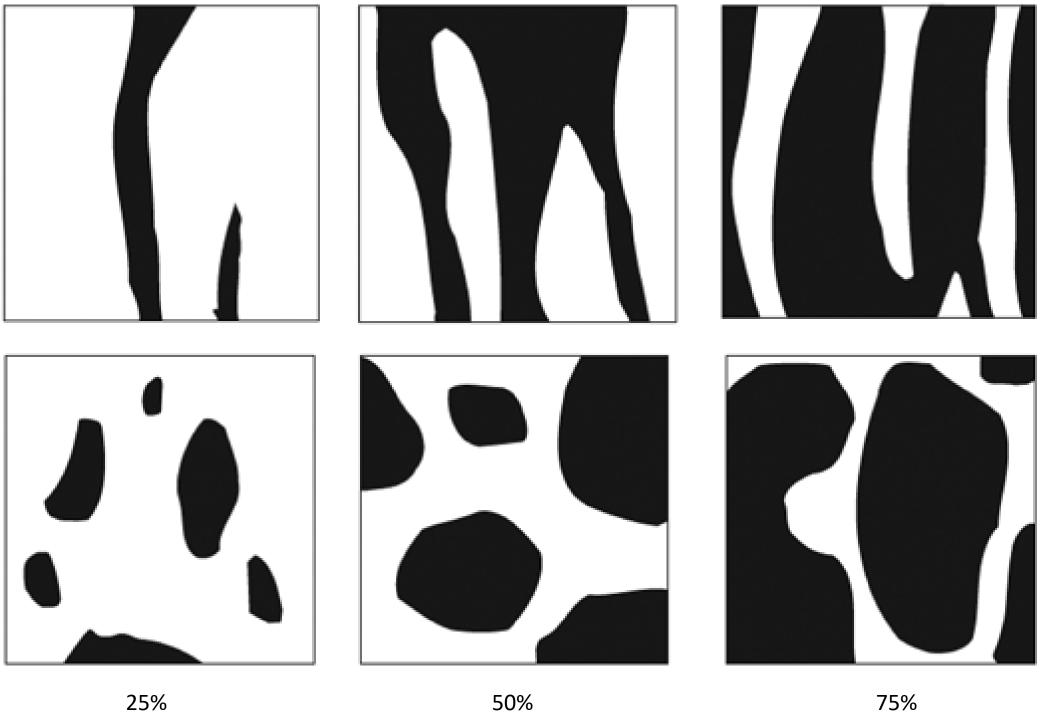


Figure 2-3: Proportion of total area coverage (AMSA, 2014)

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.

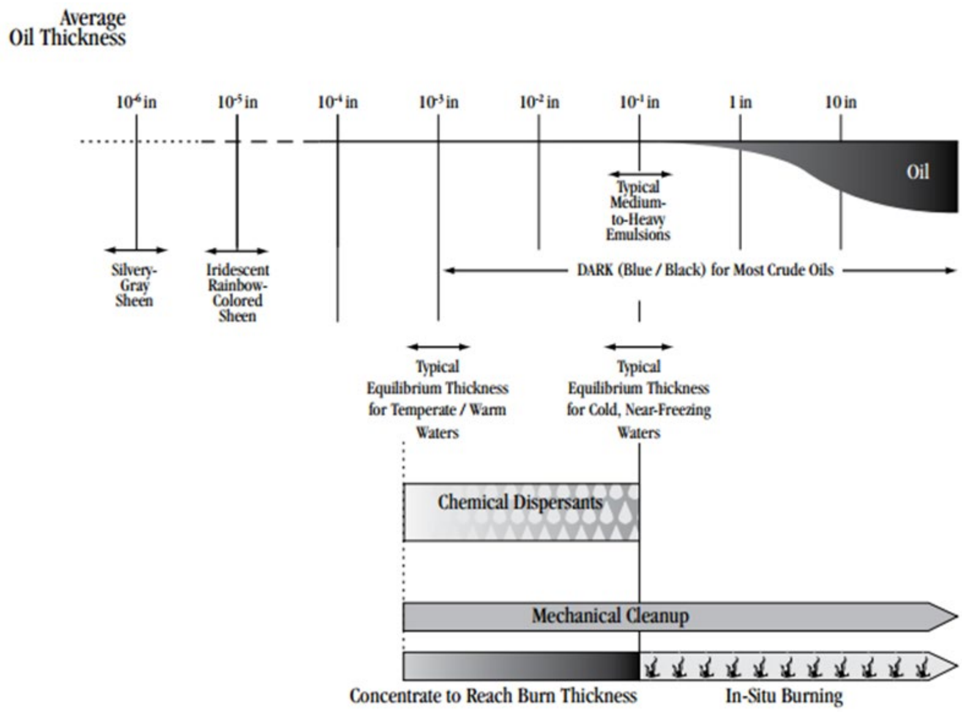


Figure 2-4: Oil thickness versus potential response options (from Allen & Dale 1996)

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.

2.3.2.2 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 strategies. 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 France’s Centre for Documentation, Research and Experimentation on Accidental Water Pollution (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.

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).

2.3.3 Spill modelling results

Details of the scenario and modelling inputs are included in Table 2-5.

Table 2-5: Worst case credible scenario modelling results

Scenario description	Results
Pyxis Condensate	
Worst-case credible scenario(s) (WCCS) Total volume released	**Surface/subsurface Well loss of containment of over 67 days (WCCS)** Subsurface – 145, 049 m^3 over 62 days Surface – 2, 706 m^3 over five days
Worst-case credible scenario(s) (WCCS) Residual volume remaining post-weathering	**Surface/subsurface Well loss of containment of over 67 days (WCCS)** The residual volume of hydrocarbon remaining post weathering is ~ 29,255 m^3 over 67 days (~436.6 m^3/day). These hydrocarbons will persist in the environment for longer period and be subject to relatively slow degradation.
Marine Diesel	
Worst-case credible scenario(s) (WCCS) Total volume released	**Instantaneous hydrocarbon release caused by vessel collision**. Loss of marine diesel from vessel collision of 1000 m^3
Worst-case credible scenario(s) (WCCS) Residual volume remaining post-weathering	**Instantaneous hydrocarbon release caused by vessel collision**. The residual volume of hydrocarbon remaining post weathering is ~ 50 m^3

The modelling results have been used to inform the response planning. The results show surface concentration of oil at 0-50 g/m^2 (BAOAC Code one to three sheen - light grey) in close vicinity of the release location 30 km. No concentrations above 50 g/m^2 are expected (BAOAC Code 4 – discontinuous true oil colour - brown).

- There is a very small, daily area where surface oil concentration is adequate for dispersant and/or containment recovery (50 g/m^2 concentration), one km from release location
- The scale of hydrocarbon present at sufficient concentrations and the proximity to the facility, coupled with the volatile nature of fresh hydrocarbon, are likely to prevent effective surface response operations within two-five kilometres of the release location. This will be validated using actual readings if an event were to occur.
- The associated gas from a loss of well containment may also limit opportunities for recovery or treatment of surface hydrocarbons. Response operations cannot be implemented if the safety of response personnel cannot be guaranteed. Safety circumstances that limit the execution of this control measure include volatile concentrations of hydrocarbons in the atmosphere, high winds (>20 knots), waves and/or sea states (>1.5m waves) and high ambient temperatures.

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.

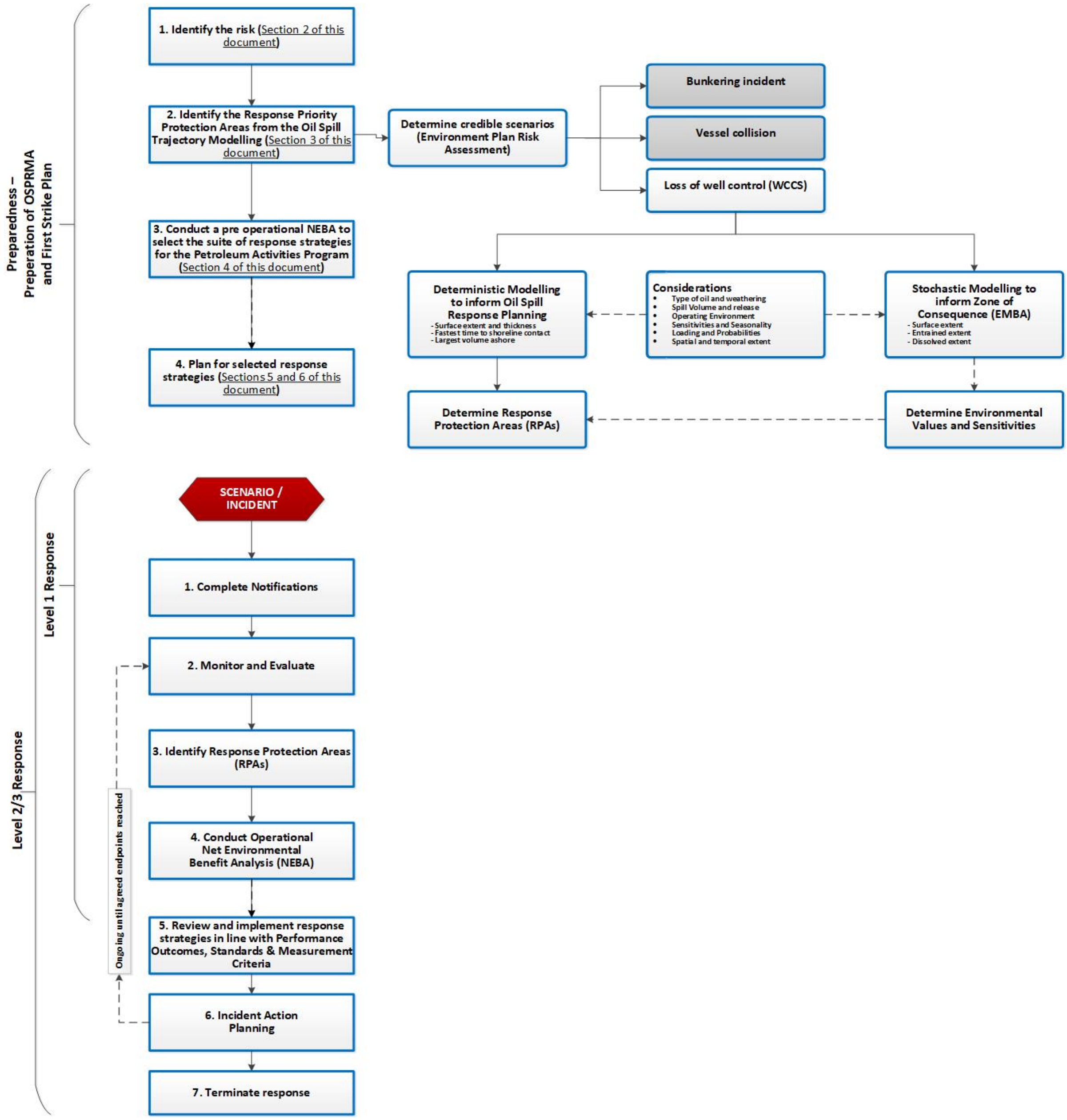


Figure 3-1: Identify Response Protection Areas (RPAs) flowchart

3.1 Identified sensitive receptor locations

Section 6.7.2 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
  - 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 6.7.2 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) have been selected for response planning purposes.

Contact from floating hydrocarbons above 10 g/m^2 concentration is not predicted for any shoreline receptor from the stochastic modelling. Additionally, accumulation >100 g/m^2 is not predicted on any shoreline receptor, with only minimal accumulation volumes below the 100 g/m^2 concentration (six metres cubed). Consequently, no RPAs have been selected for response planning.

4 NET ENVIRONMENTAL BENEFIT ANALYSIS (NEBA)

A Net Environmental Benefit Analysis (NEBA) is a structured process to consider which response strategies 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.

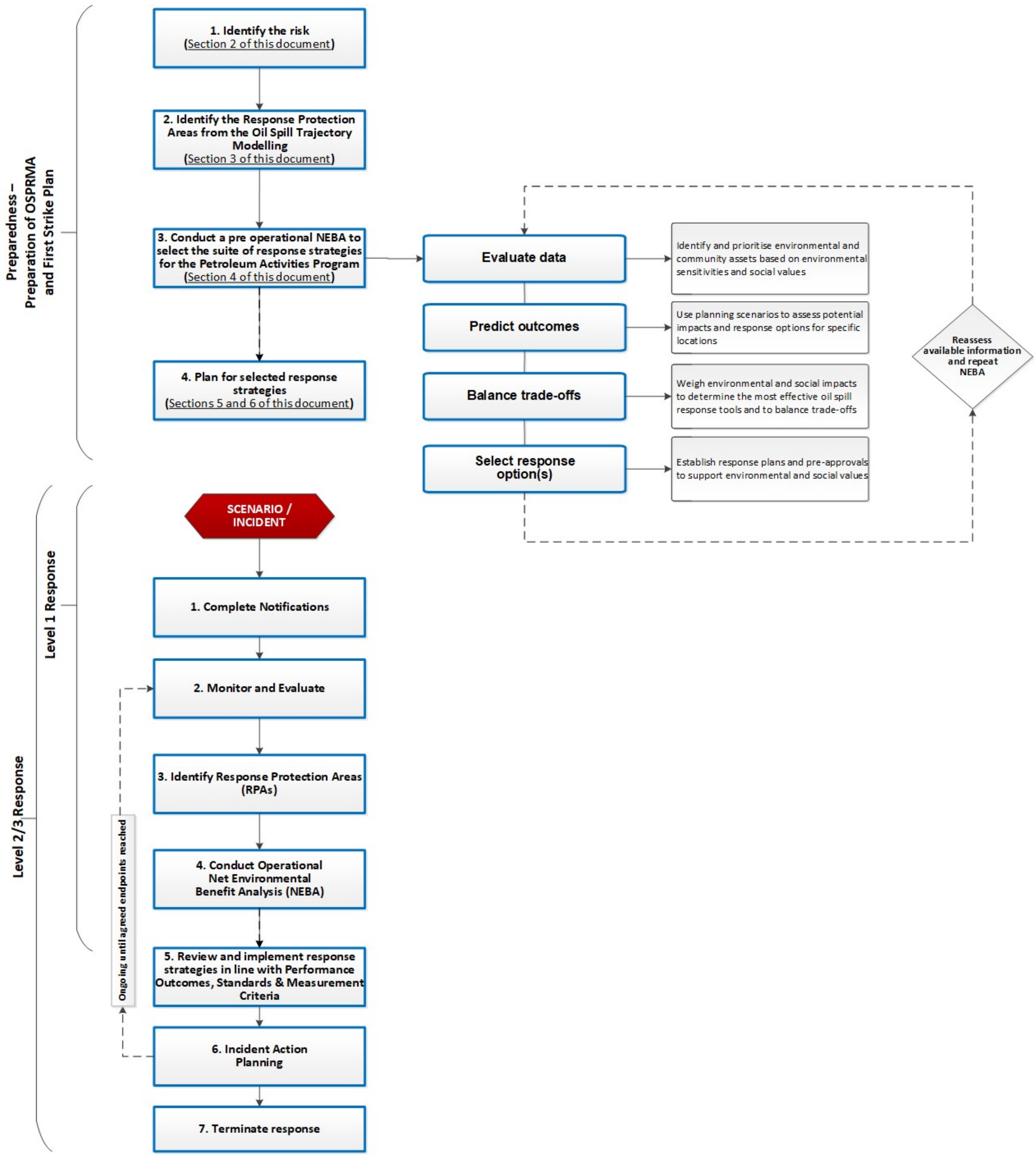


Figure 4-1: Net Environmental Benefit Analysis (NEBA) flowchart

4.1 Pre-operational / Strategic NEBA

The pre-operational NEBA identifies positive and negative impacts to sensitive receptors from implementing the response strategies. Feasibility is considered by assessing the receptors potentially impacted above response thresholds and the surface concentrations from the modelling (Section 2.3.3).

Completing a pre-operational NEBA is a key response planning control that reduces the environmental risks and impacts of implementing the selected response strategies. 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 scenarios

Woodside uses scenarios identified from the risk assessment in the EP to assess potential impacts and response options for specific locations. Response thresholds and modelling are then used to assess the feasibility/effectiveness and scale of the response.

Table 4-1: Scenario summary information (WCCS)

Scenario summary information (condensate WCCS)	
Scenario	Hydrocarbon release caused by well loss of containment
Location	Pyxis PYA-01 well (19° 49' 40.37" S, 115° 10' 34.96" E),
Oil Type	Condensate
Fate and Weathering	Subsea Release phase 76.1% of the mass should evaporate over the first 12 hours (BP < 180 °C) 13.5% should evaporate within the first 24 hours (180 °C < BP < 265 °C); 10.3% could evaporate over several days (265 °C < BP < 380 °C). Surface Release phase 11.4% of the mass should evaporate over the first 12 hours (BP < 180 °C) 38.3% should evaporate within the first 24 hours (180 °C < BP < 265 °C); 30.5% could evaporate over several days (265 °C < BP < 380 °C).
Volume and duration of release	147,755 m^3 over 67 days
Scenario summary information (marine diesel – WCCS)	
Scenario	Hydrocarbon release caused by vessel collision
Location	19° 59’ 46.476” S, 115° 22’ 05.582” E
Oil Type	Marine Diesel
Fate and Weathering	6% of the oil mass should evaporate within the first 12 hours (BP < 180 °C); 35% should evaporate within the first 24 hours (180 °C < BP < 265 °C); 54% should evaporate over several days (265 °C < BP < 380 °C).
Volume and duration of release	1, 000 m^3 (instantaneous)

4.2.1.1 Hydrocarbon characteristics

Marine Diesel

Marine Diesel Oil is typically classed as an ITOPF Group I/II oil. It is a mixture of volatile and persistent hydrocarbons with low proportions of highly volatile and residual components.

Pyxis Condensate

Pyxis Condensate (API 41) contains a moderate proportion (19.8% by mass) of hydrocarbon compounds that will not evaporate at atmospheric temperatures. These compounds are expected to persist in the marine environment

Selective evaporation of the lower boiling-point components will lead to a shift in the physical properties of the remaining mixture, including an increase in the viscosity and pour point.

The results of the modelled simulation predict that the discharge will generate a cone of rising gas that will entrain the oil droplets and ambient sea water up to a trapping depth (where the gas plume becomes neutrally buoyant and its vertical velocity drops to zero) ranging from 694 m above the seabed (ASB) in week one to 660 m ASB in week 9. The mixed plume is forecast to initially jet towards the water surface with a vertical velocity of around 4.4-4.8 m/s, gradually slowing and increasing in plume diameter as more ambient water is entrained. The radius of the central cone of rising water and oil at the neutral buoyancy point is predicted to be approximately 179 m in Week one and 149 m by Week 9.

The discharge velocity and turbulence generated by the expanding gas plume is predicted to generate oil droplet sizes between 56-263 µm with an associated rise velocity of up to 480 cm/s. These droplets will be subject to mixing due to turbulence generated by the lateral displacement of the rising plume, as well as vertical mixing induced by wind and breaking waves. The largest droplets have the potential to reach the surface a few hours after the release, in the absence of turbulence or strong stratification of the water column. Floating slicks are likely to be formed under typical wind conditions.

The ongoing nature of the release combined with the potential for the plume to breach the water surface may present other hazards, including conditions that may lead to high local concentrations of atmospheric volatiles. These issues should be considered when evaluating the practicality of the response operations at or near the blowout site.

Table 4-2: Oil fate, behaviour and impacts

Modelling results WCCS (Condensate)	
Surface area of hydrocarbons >50g/m² concentration	Surface hydrocarbon concentration >50 g/m² within one km of the release location.
Minimum time to shoreline contact from floating hydrocarbons (above 100 g/m² concentration)	Floating hydrocarbons do not contact shorelines above 100 g/m² concentration (no contact >10 g/m²)
Largest volume ashore at any single RPA (above 100g/m²)	No shoreline accumulation above 100 g/m²
Largest total shoreline accumulation (above 100g/m²)	No shoreline accumulation above 100 g/m²
Modelling results WCCS (Diesel)	
Surface area of hydrocarbons >50g/m² concentration	Surface hydrocarbon concentration >50 g/m² within 60 km of the release location.
Minimum time to shoreline contact from floating hydrocarbons (above 100 g/m² concentration)	Floating hydrocarbons do not contact shorelines above 100 g/m² concentration (no contact >10 g/m²)
Largest volume ashore at any single RPA (above 100g/m²)	No shoreline accumulation above 100 g/m²
Largest total shoreline accumulation (above 100g/m²)	No shoreline accumulation above 100 g/m²

4.2.2 Determining potential response options

The available response strategies based on current technology can be summarised under the following headings:

- Monitor and evaluate (including operational monitoring)
- Source control
  - Remotely operated vehicle (ROV) intervention
  - debris clearance and/or removal
  - capping stack
  - containment dome
  - relief well drilling
- Subsea dispersant injection
- Containment and recovery
- In-situ burning
- Surface dispersant application:
  - aerial dispersant application
  - vessel dispersant application
- Shoreline protection and deflection:

    - protection
    - deflection
- Shoreline clean-up:
    - Phase one – Mechanical clean-up
    - Phase two – Manual clean-up
    - Phase three – Final polishing
- In-situ burning
- Oiled wildlife response (including hazing)

Support functions may include:

- Waste management
- Post spill monitoring/scientific monitoring

An assessment of which response options are feasible for the scenarios is included below in Table 4-3 for Pyxis Condensate and Table 4-4 for marine diesel. 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 strategies 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 4-3: Response strategy evaluation – Loss of well containment

Response Strategy	Effectiveness	Feasibility	Decision	Rationale for the decision
Hydrocarbon: Condensate				
Monitor and evaluate	Will be effective in informing other response techniques and 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 Pyxis condensate spill is a feasible response technique and an essential element of all spill response incidents. Outputs will be used to guide decision making on the use of other monitoring/response techniques and whether the spill passes into State Waters and thus control of the incident moves to WA DoT (if a Level 2/3 event).	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 state of the slick. • Provide forecasts of spill trajectory. • Determine appropriate response techniques. • Determine effectiveness of response techniques. • Confirm impact pathways to receptors. • Determine when the spill crosses into State Waters and control of the spill passes to WA DoT.
Source control via BOP intervention using ROV and hot stab	Controlling a loss of well containment at source through BOP intervention using ROV and hot stab would be the most effective way to limit the quantity of hydrocarbon entering the marine environment.	In the event of the worst-case scenario with a loss of well containment during drilling operations, ROV operations to locally operate the BOP would be attempted.	Yes	The use of source control through BOP intervention using ROV and hot stab may be feasible (depending on local concentration of atmospheric volatiles) and may reduce or stop quantity of hydrocarbons entering the marine environment.
Source control via debris clearance and capping stack	Controlling a loss of well containment at source via capping stack installation would cap the quantity of hydrocarbon entering the marine environment. Debris clearance using the SFRT would be implemented prior to capping stack installation.	Depending on blowout rates (see section 6.2), capping stack is feasible at this depth.	Yes	No shoreline accumulation >100 g/m^2 is predicted, therefore successful Capping Stack deployment will contribute minor environmental reduction to total hydrocarbon volume in open water. The environmental benefit gained from implementing source control outweigh the risks. Capping stack will be deployed if the conditions are appropriate (blowout rates within safe operating limits, see section 6.2), informed through operational monitoring.
Source control via relief well drilling	A relief well is the primary method of regaining control of the well and therefore stopping the flow of oil. Drilling a relief well introduces the normal planned impacts associated with drilling a well such as cuttings discharges, small chemical discharges, and low levels of continuous noise discharges.	Relief well drilling is feasible for this PAP	Yes	The additional impacts introduced from drilling a relief well are comprehensively understood and are low in comparison to an ongoing release of hydrocarbons. Therefore, the environmental benefit for implementing relief well drilling outweighs the risk of implementing the response strategy.
Containment and Recovery	Predicted to be ineffective on the hydrocarbon due to rapid spreading, entrainment and evaporation leading to inadequate rapid reduction of surface hydrocarbons. Likely to provide no further benefit over natural attrition and evaporation.	Highly volatile hydrocarbon likely to weather, spread and evaporate quickly. Only concentrations for feasible containment recovery are within one km of the release location. In this area it is likely containment and recovery is not safe due to the potential for the plume to breach the water surface presenting other hazards, including conditions that may lead to high local concentrations of atmospheric volatiles.	No	In addition to low effectiveness and potential safety issues from predicted high local concentrations of atmospheric volatiles, the modelling results show that the non-persistent characteristics and fate/trajectory of Pyxis condensate would make containment and recovery an unsuitable response technique.
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 strategy is of limited benefit in an open ocean environment where wind and wave action are likely to deliver similar advantages.	Although the strategy is feasible, highly volatile hydrocarbons are likely to weather, spread and evaporate quickly. Volatile nature of the oil likely to lead to unsafe conditions in the vicinity of fresh hydrocarbon.	No	Given the poor effectiveness of mechanical dispersion and the associated risk of implementing the response for this activity, this strategy is unsuitable for the Pyxis activity.

Subsea Dispersant Injection	Dispersant modelling indicated only minor reduction in shoreline loading, with increased entrained and dissolved hydrocarbons around sensitive receptors (APASA, 2019). Not predicted to be effective on the subsea hydrocarbon release due to oil properties and predicted gas release volumes.	Subsea dispersant application is feasible, however the environmental benefit gained is minimal, potentially impacting marine environment through the dispersant toxicity.	No	The predicted low effectiveness associated with implementing a SSDI response outweigh the potential environmental benefit gained.
Surface dispersant application	Predicted to be ineffective on the hydrocarbon due to rapid spreading, entrainment and evaporation leading to inadequate rapid reduction of surface hydrocarbons. Likely to provide no further benefit over natural attrition and evaporation.	Highly volatile hydrocarbon likely to weather, spread and evaporate quickly. Volatile nature of the oil likely to lead to unsafe conditions in the vicinity of fresh hydrocarbon. Only concentrations for feasible containment recovery are within one km of the release location.	No	The safety concerns associated, and the predicted low effectiveness associated with implementing a dispersant response outweigh the potential environmental benefit.
In-situ Burning	Due to the surface concentration/thickness and the gas/volatiles close to the release location prior to the oil thinning and spreading in situ burning is not considered a feasible response strategy.	Due to the surface concentration/thickness and the gas/volatiles close to the release location prior to the oil thinning and spreading, in situ burning is not considered a feasible response strategy.	No	The safety concerns and the predicted low effectiveness associated with implementing an in-situ burning response outweigh the potential environmental benefit.
Shoreline Protection and Deflection	No surface slicks above 10 g/m^2 are expected to contact the shorelines, therefore this strategy will not protect or deflect any hydrocarbons from sensitive receptors.	Although the response strategy may be feasible, the effectiveness at reducing hydrocarbons reaching sensitive receptors is limited given no hydrocarbon contact > 10 g/m^2. No environmental benefit is predicted.	No	Rejected due to shoreline protection and deflection offering no environmental benefit.
Shoreline Clean-up	No accumulation >100 g/m^2. Implementing a shoreline response below this accumulation is ineffective. Implementing shoreline cleanup for thresholds below 100 g/m^2 may result in further damage sensitive receptors from presence of personnel and equipment.	A shoreline cleanup response is feasible, however due to the lack of hydrocarbon accumulation >100 g/m^2 there is no environmental benefit.	No	Rejected due to inadequate hydrocarbon accumulation above the recommended response threshold of 100 g/m^2
Oiled wildlife	May lead to ensuring the survival of vulnerable wildlife populations. Potential to be effective depending on collection method and wildlife treatment method. Wildlife response typically has a very high mortality rate for seabirds and waders.	Oiled wildlife may be prevented through the initiation of preventative measures (i.e. hazing or pre-emptive capture). The level of oiled wildlife response can be scalable based on the predicted number of animals oiled. No shoreline contact from floating hydrocarbon above 10 g/m^2 concentration is predicted, however, an open water oiled wildlife response may be conducted.	Yes	This response may prevent or treat oiled wildlife in open water providing net environmental benefit.

Table 4-4: Response strategy evaluation – Marine Diesel

Response Technique	Effectiveness	Feasibility	Decision	Rationale for the decision
Hydrocarbon: Marine Diesel				
Monitor and Evaluate	Will be effective in informing other response techniques and 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 diesel spill is a feasible response technique and outputs can be used to guide decision making on the use of other response techniques and whether the spill passes into State Waters and thus control of the incident moves to WA DoT. Techniques include predictive modelling, surveillance and reconnaissance, monitoring of hydrocarbon presence in water, pre-emptive assessment of sensitive receptors at risk, and monitoring of contaminated resources.	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 state of the slick. • Provide forecasts of spill trajectory. • Determine appropriate response techniques. • Determine effectiveness of response techniques. • Confirm impact pathways to receptors. Determine when the spill crosses into State Waters and control of the spill passes to WA DoT.
Source Control	Vessel source control will be managed under the vessel SOPEP. 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 or facility 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.
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.	Marine diesel is non-persistent, prone to rapid spreading and evaporation, and does not tend to form emulsions thus reducing the feasibility of containment and recovery as a response technique.	No	Containment and recovery would be an inappropriate response technique as it requires the spilled hydrocarbon to be BAOAC four or five with a 50-100% coverage of 100 g/m^2 to 200 g/m^2 which a spill of marine diesel would not achieve. In addition, most of the spilled diesel would have been subject to rapid evaporation 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 strategy is of limited benefit in an open ocean environment where wind and wave action are likely to deliver similar advantages.	Although the strategy is feasible, highly volatile hydrocarbons are likely to weather, spread and evaporate quickly. Volatile nature of the oil likely to lead to unsafe conditions in the vicinity of fresh hydrocarbon.	No	Given the poor effectiveness of mechanical dispersion and the associated risk of implementing the response for this activity, this strategy is unsuitable for the Pyxis activity.
Surface Dispersant Application	Dispersants are not considered effective when applied on thin surface films such as diesel as the dispersant droplets tend to pass through the surface films without binding to the hydrocarbon.	Marine diesel is non-persistent and 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 expose marine fauna to hydrocarbons unnecessarily.
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 and evaporation. 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 and would unnecessarily cause an increase 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.	No	In addition to the rapid spreading and evaporation of the diesel, the modelling undertaken predicts that no shoreline receptors would be contacted by floating oil concentrations at any of the assessed thresholds.

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.	Use of shoreline clean-up 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. In addition, coverage from marine diesel on a shoreline would not be high enough to allow effective hydrocarbon removal.	No	In addition to the rapid spreading and evaporation of the diesel and lack of optimum coverage, the modelling undertaken predicts that no shoreline receptors would be contacted by floating oil concentrations at any of the assessed thresholds.
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 fauna from being contaminated and through rehabilitation of fauna 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.	Yes	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 fauna are at risk of contamination, oiled wildlife response will be undertaken as and where required.

4.2.3 Exclusion of response strategies

4.2.3.1 Subsea dispersant injection

The discharge velocity and turbulence generated by the expanding gas plume is predicted to generate oil droplet sizes between 56-263 µm. These droplets will be subject to mixing due to turbulence generated by the lateral displacement of the rising plume, as well as vertical mixing induced by wind and breaking waves. The largest droplets have the potential to reach the surface a few hours after the release. Floating slicks that form on the water surface will be subject to evaporation, 76.1% of the mass has the capacity to evaporate within the first 12 hours. The radius of the central cone of rising water and oil at the neutral buoyancy point is predicted to be approximately 179 m in Week 1 and 149 m by Week 9.

Modelling of the surface hydrocarbon concentration >50 g/m^2 and 10 g/m^2 indicate untreated hydrocarbons remain in the vicinity of the release location spreading up to 1 km and 30 km respectively. No floating hydrocarbon contact to shoreline receptors is predicted at any threshold. Additionally, no shoreline accumulation of hydrocarbons above the concentration threshold 100 g/m^2 are expected.

Based on the Stochastic modelling outputs no thresholds were reached that triggered the need to conduct further modelling (Deterministic). Furthermore, the stochastic modelling outputs and predicted impacts did not provide an indication that SSDI would be a feasible response strategy or provide an overall new benefit for the Pyxis spill scenario, therefore modelling was not required to further establish the effectiveness of the technique. However, as an exploratory investigation into SSDI and condensate releases and as a prudent response planning measure, Woodside undertook new modelling to examine the effectiveness of SSDI at reducing hydrocarbon droplet size in the water column. (APASA, 2019). The effect of SSDI on Pluto Condensate was estimated based on surface dispersant test data and a review of contemporary SSDI literature.

The blowout simulations indicate that untreated oil droplets would follow a size distribution ranging from 56 µm to 263 µm (**Figure 4-2**). The application of dispersant in this scenario is forecast to result in the production of a larger proportion of smaller droplets, ranging in size from 35 µm to 158 µm (**Figure 4-2**). The smaller droplets will display slower vertical migration and will be subject to greater horizontal dispersion and increased vertical mixing influence in the surface mixed layer, resulting in increased entrainment and dissolution of hydrocarbons in the water column. There would be a reduced tendency for these smaller droplets to generate floating slicks; however, the tendency for the larger droplets to surface would be unchanged. The SSDI modelling indicated there be some effectiveness at reducing droplet size. However, once the SSDI modelling was incorporated into the NEBA it was determined that while SSDI modelling indicates a marginal reduction in floating oil could be achieved, the introduction of dispersant into the water column does not provide an overall net benefit. This is based on the following, which need to be considered for response planning:

- The low quantities of floating oil and the low accumulation on shorelines in limited quantities (3 m^3);
- The modelling does not hit thresholds which would necessitate the use of SSDI (no need to reduce surface VOCs for a response, and shoreline loading is below thresholds) thus the thresholds/triggers for utilising SSDI are not met); and
- There is no reduction in mass-balance.

The environmental benefit of conducting an SSDI response is minimal, if at all, given the additional predicted entrained and dissolved hydrocarbons expected near shoreline receptors with only a slight reduction in shoreline loading. This additional entrainment would also increase exposure of subsea species and habitats to hydrocarbons, which, under normal conditions would evaporate on not impact these receptors. Additionally, the use of subsea dispersant injection would unnecessarily introduce additional chemical substances to the marine environment.

With the considerations above, the SSDI response strategy is excluded based on the lack of environmental benefit associated with response implementation. The predicted reduction in accumulation volumes are minor (<3 m^3) and below the minimum concentration from shoreline clean-up (100 g/m^2). It would unnecessarily introduce additional chemical substances to the marine environment and increase exposure of subsea species and habitats to hydrocarbons which would potentially evaporate on the surface.

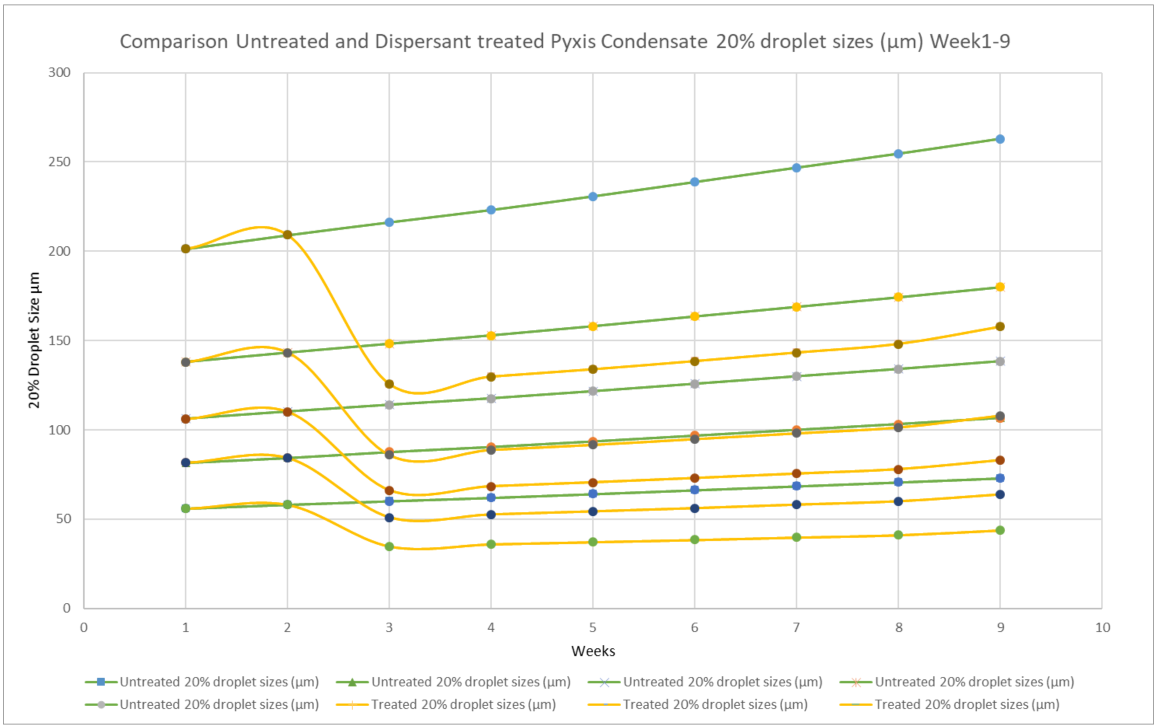


Figure 4-2: Droplet size comparison for hydrocarbons treated with SSDI, weeks 1-9 (APASA, 2019).

4.2.3.2 Surface dispersant application

Modelling results for a hydrocarbon release caused by a well loss of containment from pyxis condensate indicate that surface thresholds required for surface dispersant application are limited to within one km of the release location. Additionally, no shoreline accumulation above threshold 100 g/m^2 are expected. Therefore, surface application of dispersant is unlikely to be effective in preventing isolated incidents of accumulation. Therefore, any application of surface dispersant would be unlikely to have any appreciable effect on the behaviour or extent of the oil plume.

The effectiveness of the application of surface dispersants is predicted to be very low based on the light, volatile nature of the Pyxis condensate. Therefore, any application of surface dispersant would be unlikely to have any appreciable effect on the behaviour or extent of the oil plume, with no incremental benefit over natural weathering.

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 strategy is of limited benefit in an open ocean environment where wind and wave action are likely to deliver similar advantages.

4.2.3.4 In-situ Burning

This strategy requires calm sea state conditions as is required for containment and recovery operations, which limits its feasibility in the Dampier region. Optimum weather conditions are <20 knot wind speed and waves <one to 1.5 m with oil collected to a minimum 3mm thick layer. Due to the conditions in Dampier region 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.

Until further operational and environmental information becomes available, Woodside will not consider this option.

4.2.3.5 Containment and Recovery

Modelling results for a hydrocarbon release caused by a well loss of containment from Pyxis condensate indicate that surface thresholds required for containment and recovery (>50g/m^2) are found only within one km of the release location. Additionally, no shoreline accumulation, above the 100 g/m^2 concentration threshold is anticipated. Therefore, containment and recovery are unlikely to be effective in preventing impact from floating hydrocarbons.

The effectiveness of containment and recovery is predicted to be very low based on Dampier met-ocean conditions, the inherent inefficiency of containment and recovery operations, and the light, volatile nature of the Pyxis condensate.

4.2.3.6 Shoreline Protection and Deflection

Shoreline surface contact above thresholds is not expected to occur. Therefore, shoreline protection and deflection is not considered effective. Localised instances of accumulated hydrocarbons below threshold concentrations (100 g/m^2) are likely to be the result of surface hydrocarbons contacting below threshold concentrations (10 g/m^2) or entrained hydrocarbons resurfacing and becoming stranded on shorelines.

4.2.3.7 Shoreline Cleanup

No accumulation is predicted above the recommended threshold to commence shoreline assessment operations (100 g/m^2), therefore this strategy is unlikely to reduce environmental impact to sensitive receptors, potentially impacting shoreline environments through clean-up activities.

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 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 strategies carried forward to the ALARP assessment (**ANNEX A**: Net Environmental Benefit Analysis detailed outcomes).

4.5 Stage 4: Select Best Response Options

To select the response strategy, 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 strategies 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 strategy and supports decisions on whether they are feasible and of net environmental benefit. Response strategies 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 4-5: Selection and prioritisation of response strategies

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 strategies									Outline response strategy
		Monitor and evaluate	Subsea dispersant injection	Surface dispersant application	Source control	Source control – relief well drilling	Containment and recovery	Shoreline protection and deflection	Shoreline cleanup	Oiled wildlife response	
Release of up to 8 m^3 marine diesel from a bunkering incident	No contact above impact assessment or response thresholds	Yes Primary Strategy	No	No	Yes	No	No	No	No	Yes	Monitor and evaluate. Initiate source control if feasible. Plan for oiled wildlife response and implement if oiled wildlife is observed.
Release of up to 1000 m^3 marine diesel from a vessel collision	No contact above impact assessment or response thresholds	Yes Primary Strategy	No	No	Yes	No	No	No	No	Yes	Monitor and evaluate. Initiate source control if feasible. Plan for oiled wildlife response and implement if oiled wildlife is observed.
Hydrocarbon release caused by a well loss of containment of 147,755 m^3 of Pyxis Condensate for 67 days (residual 436.6 m^3/day)	No contact above impact assessment or response thresholds	Yes Primary Strategy	No	No	Yes	Yes (Relief Well) Primary Strategy	No	No	No	Yes	Monitor and evaluate. Initiate relief well drilling. Plan for oiled wildlife response and implement if oiled wildlife is observed.

From the NEBA undertaken on the WCCS identified (WA-34-L Pyxis Drilling and Subsea Installation, well loss of containment), the primary response strategies are;

- Monitor and evaluate (ME)
- Source control (Relief Well)

Additional response strategies would be considered based on ME inputs and field reports. This may include:

- Oiled wildlife response
- Source control (capping stack, well intervention)
- Scientific monitoring programs

Support functions may include:

- Waste management
- Scientific Monitoring programs

5 HYDROCARBON SPILL ALARP PROCESS

Woodside's hydrocarbon spill ALARP process is aligned with guidance provided by NOPSEMA in *Guideline N-04750-GL1687* (2016) 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, 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 strategy/control measure by providing an initial and, if required, detailed evaluation of;
   - Predicted cost associated with adopting the control measure,
   - Predicted change/environmental benefit, and
   - Predicted effectiveness/feasibility of the control measure.
3. Evaluates the risks and impacts of implementing the proposed response strategies, 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 strategy;
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 strategy 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 strategies selected in the pre-operational NEBA is informed through the assessment of modelling results.

For the purpose of the ALARP assessment, the following terms and definitions have been used:

- Response strategies are considered the control measures that reduce consequences from hydrocarbon spill events. The terms 'response strategy' 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.

The table below provides the operations monitoring plans that support the successful execution of this response strategy.

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, behavior and weathering in water
OM04	Pre-emptive assessment of sensitive receptors at risk
OM05	Shoreline assessment

Woodside maintains an *Operational Monitoring Operational Plan* (W0000AH9329605). If shoreline contact is predicted, Response Protection Areas (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 Dampier 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 Dampier. However, in the event of an extended spill with potential to impact receptors further afield, monitoring activities may also be mobilised from Exmouth.

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:

- Floating surface oil in sufficient concentrations for effective operational monitoring is expected to be present with surface concentrations of 50 g/m^2 up to one km from the well location, and 10g/m^2 up to 30 km from the well location for the WCCS subsea release.
- Shoreline contact from floating hydrocarbons >10 g/m^2 is not expected.
- The time to contact for oil at concentrations of entrained hydrocarbons greater than 500 ppb at shoreline receptors is 54 hours at Montebello MP.
- 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.
- The duration of the spill may extend up to 67 days.
- No shoreline hydrocarbon accumulation expected above the shoreline assessment threshold of 100 g/m^2 (as per Table 2-3).

5.1.2 Environmental performance based on need

Table 5-2: Environmental Performance - Monitor and Evaluate

Environmental Performance		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.		
Control measure		**Performance Standard**		**Measurement Criteria (Section 5.7)**
1	Oil spill trajectory modelling	1.1	Initial modelling available within six hours using the Rapid Assessment Tool	1, 3B, 3C, 4
		1.2	Detailed modelling available within four hours of APASA receiving information from Woodside	
		1.3	Detailed modelling service available for the duration of the incident upon contract activation	
2	Tracking buoy	2.1	Tracking buoy located on facility/vessel and ready for deployment 24/7	1, 3A, 3C, 4
		2.2	Deploy tracking buoy from facility within two hours as per the First Strike Response Plan.	1, 3A, 3B, 4
		2.3	Contract in place with service provider to allow data from tracking buoy to be received 24/7 and processed.	1, 3B, 3C, 4
		2.4	Data received to be uploaded into Woodside Close of Play (COP) daily to improve the accuracy of other monitor and evaluate strategies.	1, 3B, 4
3	Satellite imagery	3.1	Contract in place with third party provider to enable access and analysis of satellite imagery. Imagery source/type requested on activation of service.	1, 3C, 4
		3.2	3rd party provider will confirm availability of an initial acquisition within two hours	1, 3B, 3C, 4
		3.3	First image received with 24 hours of Woodside confirming to 3rd party provider its acceptance of the proposed acquisition plan.	1
		3.4	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.	1
		3.5	Data received to be uploaded into Woodside COP daily to improve accuracy of other monitor and evaluate strategies.	1, 3B, 4
		3.6	Satellite Imagery services available and employed during response	1, 3C, 4
4	Aerial surveillance	4.1	Two trained aerial observers available to be deployed by day one from resource pool.	1, 2, 3B, 3C, 4
		4.2	One aircraft available for two sorties per day, available for the duration of the response from day one.	1, 3C, 4
		4.3	Observer to compile report during flight as per First Strike Response Plan. Observers report available to the IMT within two hours of landing after each sortie.	1, 2, 3B, 4
		4.4	Unmanned Aerial Vehicles/Systems (UAV/UASs) to support SCAT, and pre-emptive assessments as contingency if required.	1, 2
5	Hydrocarbon detections in water	5.1	Activate third party service provider as per First Strike Response Plan. Deploy resources within 2.5 days: • Three specialists in water quality monitoring • Two monitoring systems and ancillaries • One vessel for deploying the monitoring systems with a dedicated winch, A-frame or Hiab and ancillaries to deploy the equipment.	1, 2, 3C, 3D, 4
		5.2	Water monitoring services available and employed during response	1, 3C, 4
		5.3	Preliminary results of water sample as per contractor's implementation plan within seven days of receipt of samples at the accredited lab	
		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 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	Shoreline assessment	7.1	10 days prior to predicted impact, in agreement with WA DoT (for Level 2/3 incidents), deployment of 1 specialist(s) in SCAT from resource pool for each of the Response Protection Areas (RPAs) with predicted impact.s ~~at greater than 100 g/m2.~~	1, 2, 3B, 3C, 4
		7.2	SCAT reports provided to IMT daily detailing the assessed areas to maximise effective utilisation of resources	1, 3B, 4

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 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 and well intervention

The worst-case credible scenario for a subsea loss of containment would be as a result of a loss of well integrity. This scenario would result in an uncontrolled flow from the well as outlined in the EP.

The Woodside Source Control Emergency Response Planning Guideline includes the process for the IMT to mobilise resources for BOP intervention, Subsea First Response Toolkit (SFRT) support, and capping support. This plan has pre-identified vessel specifications and contracts required for SFRT debris clearance work and Woodside monitors the availability and location of these vessels.

Woodside is a signatory to a MoU between Australian offshore operators to provide mutual aid to facilitate and expedite mobilising a MODU and drilling a relief well, if a subsea loss of containment incident were to occur. The MoU commits the signatories to share rigs, equipment, personnel and services to assist another operator in need.

5.2.1 Response need based on predicted consequence parameters

The following statements identify the key parameters upon which a response need can be based:

- The duration of the spill may extend up to 67 days with no shoreline cleanup operations expected (no accumulation above 100 g/m^2).
- Hydrocarbons will flow from the well until one of the following interventions can be made:
  - BOP intervention using ROV and hot stab
  - A relief well is drilled and first attempt at well kill within 67 days
  - Capping stack, if flow rate is appropriate (see 6.2.2), and if deemed safe to do so (Table 5-3).
- Prior to any source control activities, Woodside will implement protocols to ensure that the site is safe including subsea ROV surveys and surface air monitoring.
- Arrangements for support organisations who provide specialist services or resources will 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.

In addition, a number of assumptions are required to estimate the response need for source control. These assumptions have been described in the table below.

Table 5-3: Response Planning Assumptions – Source Control

Response planning assumptions	
Safety considerations	Source control operations cannot be implemented if the safety of response personnel cannot be guaranteed. This requires an initial and ongoing risk assessment of health and safety hazards and risks at the site, in accordance with the Woodside Management Systems (WMS). Personnel safety issues may include: • hydrocarbon gas and/or liquid exposure • high winds, waves and/or sea states • high ambient temperatures.
Feasibility considerations	Woodside's primary source control option would be ROV intervention followed by relief well drilling for the WA-34-L Pyxis Drilling and Subsea Installation activity. The following approaches outline Woodside's hierarchy for relief well drilling: • Primary – Review internal drilling programs and MODU availability to source an appropriate rig operating within Australia with an approved Safety Case. • Alternate – Source and contract a MODU through APPEA MOU that is operating within Australia with an approved Safety Case. • Contingency – Source and contract a MODU outside Australia with an approved Australian Safety Case.

5.2.2 Environmental performance based on need

Table 5-4: Environmental Performance - Source Control

Environmental Performance Outcome		To stop the flow of hydrocarbons into the marine environment		
Control measure		**Performance Standard**		**Measurement Criteria (Section 5.7)**
8	Well intervention	8.1	Frame agreements with ROV providers in place to be mobilised upon notification. ROV equipment deployed within nine days	1, 3B, 3C
		8.2	Frame agreements for ISVs require vessels to maintain/enforce regulatory approvals and provide support in the event of an emergency	
		8.3	BOP intervention using ROV and hot stab attempted within nine days	
		8.4	Source control vessel will have the following minimum specifications: • Active Heave Compensated crane, rated to at least 125T minimum. • At least 90 m in length • Deck has water/electricity supply • Deck capacity to hold at least 110T of capping stack	
		8.5	Identify source control vessel availability within 24 hours and begin contracting process.	
		8.6	Capping stack on suitable vessel mobilised to site within 16 days. Well intervention attempt will be made if safety and metocean conditions are suitable.	
		8.7~~6~~	Wild Well Control staff available all year round, via contract, to assist with the mobilization, deployment, and operation of the Capping Stack and Well intervention equipment.	
		8.8~~7~~	Contract in place with Wild Well Control and Oceaneering to provide trained personnel	1, 3B, 3C, 4
		8.9~~8~~	MODU mobilised to location for relief well drilling within 21 days	1, 3C
		8.10~~9~~	First well kill attempt within 67 days	1, 3B, 3C
		8.11~~10~~	Open communication line(s) to be maintained between IMT and infield operations to ensure awareness of progress against plan(s)	1, 3A, 3B
		8.12~~11~~	Monthly monitoring of the availability of MODUs through existing market intelligence including current Safety Case history, to meet specifications for relief well drilling.	3C
		8.13	Relief Well Peer review undertaken during well design which includes screening and identification of suitable MODU(s) with in-force Australian safety cases for relief well drilling.	1, 3A, 3C
		8.14	Prior to entering the reservoir reconfirm that pre-identified/screened MODU(s) remain available for relief well drilling and engage titleholder.	1, 3C
	SFRT	8.15	Oceaneering support staff available all year round, via contract, to assist with the mobilization, deployment, and operation of the SFRT (Subsea First Response Toolkit) equipment.	1, 3B, 3C
		8.16	Intervention vessel with minimum requirement of a working class ROV and operator.	1, 3C
		8.17	Mobilised to site for deployment within 11 days	1, 3B, 3C
		8.18	Open communication line to be maintained between IMT and infield operations to ensure awareness of progress against plan(s)	1, 3A, 3B
9	Support vessels	9.1	At least two communication methods, one of which will include the capability to communicate with aviation.	1, 3A
		9.2	Monthly monitoring of the availability of larger vessels through existing Frame Agreements and market intelligence to meet specifications for source control.	3C

		9.3	Frame agreements for installation support vessels (ISVs) require vessels to maintain in-force safety case approvals covering ROV operations and provide support in the event of an emergency.	1, 3B, 3C
		9.4	MODU and vessel contracts include clause outlining requirement for support in the event of an emergency	1, 3C
		9.5	Quarterly monitoring of Registered Operators and Woodside will maintain minimum safe operating standards that can be provided to MODU and vessel operators for Safety Case guidance.	1, 3B, 3C
10	Safety Case	10.2	Woodside will prioritize MODU or vessel(s) for intervention work(s) that have an existing safety case	1, 3C
		10.2	Woodside Planning, Logistics, and Safety Officers (on roster/Call 24/7) to assist in expediting the safety case assessment process as far as practicable.	1, 3C
		10.3	MODU and vessel contracts include clause outlining requirement for support in the event of an emergency	1, 3C
		10.4	Woodside will maintain minimum safe operating standards that can be provided to MODU and vessel operators for Safety Case guidance.	
		10.5	The development of a generic Safety Case Revision that contemplates a capping stack deployment is anticipated under the commitments in the 2019 Julimar Drilling Environment Plan. Woodside will adopt the learnings from this process in establishing representative timeframes for safety case approval for the Pyxis Drilling activity.	1, 3C

The resulting source control capability has been assessed against the WCCS. The range of strategies provide a feasible and viable approach to relief well drilling operations to stop the well flowing.

- 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 disproportionate to the insignificant environmental benefit gained and/or not reasonably practicable for this PAP.
- 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 6.2.
- 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 limited scale and timeframe for deployment of this strategy does not justify the excessive costs of identified additional, alternative and improved control measures.

5.3 Oiled wildlife response (including hazing)

Woodside would implement a response in accordance with the *Oiled Wildlife Operational Plan* (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 Department of Biodiversity, Conservation and Attractions (DBCA).

Oiled wildlife response is undertaken in accordance with the Western Australian Oiled Wildlife Response Plan (WAOWRP) 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 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 Dampier. 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:

- modelling predicts no shoreline impact from floating hydrocarbons >10 g/m^2
- No shoreline accumulation > 100 g/m^2 threshold is expected.
- the offshore location of the release site is expected to initially result in small numbers of at-risk or impacted wildlife.
- Given there is no potential for shoreline accumulation >100 g/m^2 and surface concentrations above 10 g/m^2 are only expected within 50 km of the release location, it is estimated that an oiled wildlife response would be between Level two and four, as defined in the West Australian Oiled Wildlife Response Plan WAOWRP (Table 5-7).

Table 5-5: Key at-risk species potentially in the open ocean

Species	Open ocean
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	√
Dugongs	
Sea snakes	√

The oiled wildlife response strategy targets key wildlife populations at risk within Commonwealth open waters and the nearshore waters as described in Section 4 of the EP. Responding to oiled wildlife consists of eight key stages, as described in Table 5-6 below.

Table 5-6: 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 Dampier 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. The shoreline assessments would be done in accordance with OM05, which would be used as a further tool to identify fauna and habitats contacted by hydrocarbons.

Staging sites would be established as forward bases for shoreline- or 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 Dampier 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 WAOWRP, with additional capability if required (e.g. volunteers) accessible through Woodside’s *People & Global Capability Surge Labour Requirement Plan* (Woodside doc. W0000AH9420020).

The WAOWRP provides indicative oiled wildlife response levels (Table 5-7) and the resources likely to be needed at each increasing level of response.

Table 5-7: 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	Pinnipeds	Dugongs
Level one	6	< three days	One – two/day < 5 total	None	None	None	None	None
Level two	26	> four – 14 days	One –five /day < 20 total	None	< 20 hatchlings No juv/adults	None	None	None
Level three	59	> four – 14 days	Five – 10/day	one–five/day < 10 total	< five juv/adults < 50 hatchlings	None	< five	None
Level four	77	> four – 14 days	Five – 10/day < 200 total	five–10/day	< 20 juv/adults < 500 hatchlings	< 5, or known habitats affected	five–50	Habitat affected only
Level five	116	> four – 14 days	10–100/ day > 200 total	10–50/day	> 20 juv/adults > 500 hatchlings	< five dolphins	> 50	Dugongs oiled
Level six	122	> four – 14 days	> 100/day	10–50/day	> 20 juv/adults > 500 hatchlings	> five dolphins	> 50	Dugongs oiled

5.3.2 Environmental performance based on need

Table 5-8: Environmental Performance – Oiled Wildlife Response

Environmental Performance Outcome		Oiled Wildlife Response is conducted in accordance with the Western Australian Oiled Wildlife Response Plan (WAOWRP) 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**
11	Wildlife response equipment	11.1	Contracted capability to treat 100 individual fauna for immediate mobilisation.	1, 3A, 3B, 3C, 4
		11.2	Contracted capability to treat up to an additional 250 individual fauna within a five-day period.	
		11.3	National plan access to additional resources under the guidance of the DoT (up to a Level five oiled wildlife response as specified in the OWRP), with the ability to treat about 600 individual fauna by the time hydrocarbons contact the shoreline.	1, 3C, 4
		11.4	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
		11.5	Facilities for the rehabilitation of oiled wildlife are operational 24/7 as per WAOWRP.	1, 3A, 4
12	Wildlife responders	12.6	3 wildlife divisional commanders to lead the oiled wildlife operations who have completed an Oiled Wildlife Response Management course	1, 2, 3B
		12.7	Wildlife responders to be accessed through resource pool and additional agreements with specialist providers	1, 2, 3A, 3B, 3C, 4
		12.8	Oiled wildlife operations (including hazing) would be implemented with advice and assistance from the Oiled Wildlife Advisor from the DBCA.	1
		12.9	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. No RPA's are contacted above response thresholds of hydrocarbons.

Under optimal conditions, during the subsea or 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 one central wildlife treatment and rehabilitation locations at Dampier in accordance with WAOWRP.

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 Dampier.

5.4 Waste Management

Waste management is considered a support strategy to wildlife response, containment and recovery and shoreline clean-up. The last two are unlikely to be required. 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, containment and recovery and shoreline clean-up, and/or
- Solids/semi-solids (oily solids, garbage, contaminated materials) and debris (e.g. seaweed, sand, woods, and plastics) collected during wildlife response, containment and recovery and shoreline clean-up.

Expected waste volumes during an event are likely to vary depending on oil type, volume released, response strategies employed and how 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 strategies 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 5-9: Response Planning Assumptions – Waste Management

Response planning assumptions: Waste management	
Waste loading per m^3 oil recovered (multiplier)	Containment & Recovery – Not adopted for this activity.
	Shoreline clean-up (manual) – Not adopted for this activity.
	Oiled wildlife response – approx. 1m^3 of oily liquid waste generated for each wildlife unit cleaned ~10 m^3 per day (based on the predicted oiled wildlife response).

5.4.2 Environmental performance based on need

Table 5-10: 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**
13	Waste Management	13.1	Contract with waste management services for transport, removal, treatment and disposal of waste	1, 3A, 3B, 3C, 4
		13.2	Access to at least 70 m^3 of solid and liquid waste storage available within seven days upon activation of 3rd party contract.	
		13.3	Access to up to 300 m^3 by end of Month one.	
		13.4	Decanting in accordance with National Plan guidelines to occur in daylight hours into the apex of the boom once hydrocarbon/water has settled in storage container.	
		13.5	Recovered hydrocarbons and wastes will be transferred to licensed treatment facility for reprocessing or disposal.	
		13.6	Teams will segregate liquid and solid wastes at the earliest opportunity.	
		13.7	Waste management provider support staff available year-round to assist in the event of an incident with waste management as detailed in contract.	
		13.8	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
		13.9	Waste management to be conducted in accordance with Australian laws and regulations	1, 3A, 3B, 3C, 4
		13.10	Waste management services available and employed during response	

The resulting waste management capability has been assessed against the WCCS. The range of strategies provide an ongoing approach to waste management.

Given no shoreline accumulation is expected >100 g/m^2, a shoreline cleanup operation is not required. Therefore, waste management strategies are only required for waste associated with the oiled wildlife response.

It indicates that the waste management capability has the following expected performance:

- Offshore operations may generate up to an additional 70 m^3 for one week off offshore operations.
- 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 6.3.

The waste management requirements are within Woodside's and its service providers existing capacity.

5.5 Scientific monitoring

A scientific monitoring program (SMP) would be activated following a Level two or three 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 operational activities (refer to Table 2-1: PAP 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 worst-case credible spill scenarios 1 and 2 define the EMBAs and are the basis of the SMP approach presented in this section

It should be noted that the resulting SMP receptor locations differ from the Response Protection Areas (RPAs) presented and 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) for operational monitoring overview).

Key objectives of the Woodside oil spill SMP are:

- Assess the extent, severity and persistence of the environmental impacts from the spill event;

  and

- 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 physico-chemical (water and sediment) and biological (species and habitats) receptors including EPBC Act listed, 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 Scenario 1 and therefore represents the largest spatial boundaries of 100 scenario 1 oil spill combinations, not the spatial extent of a single Scenario 1 spill.

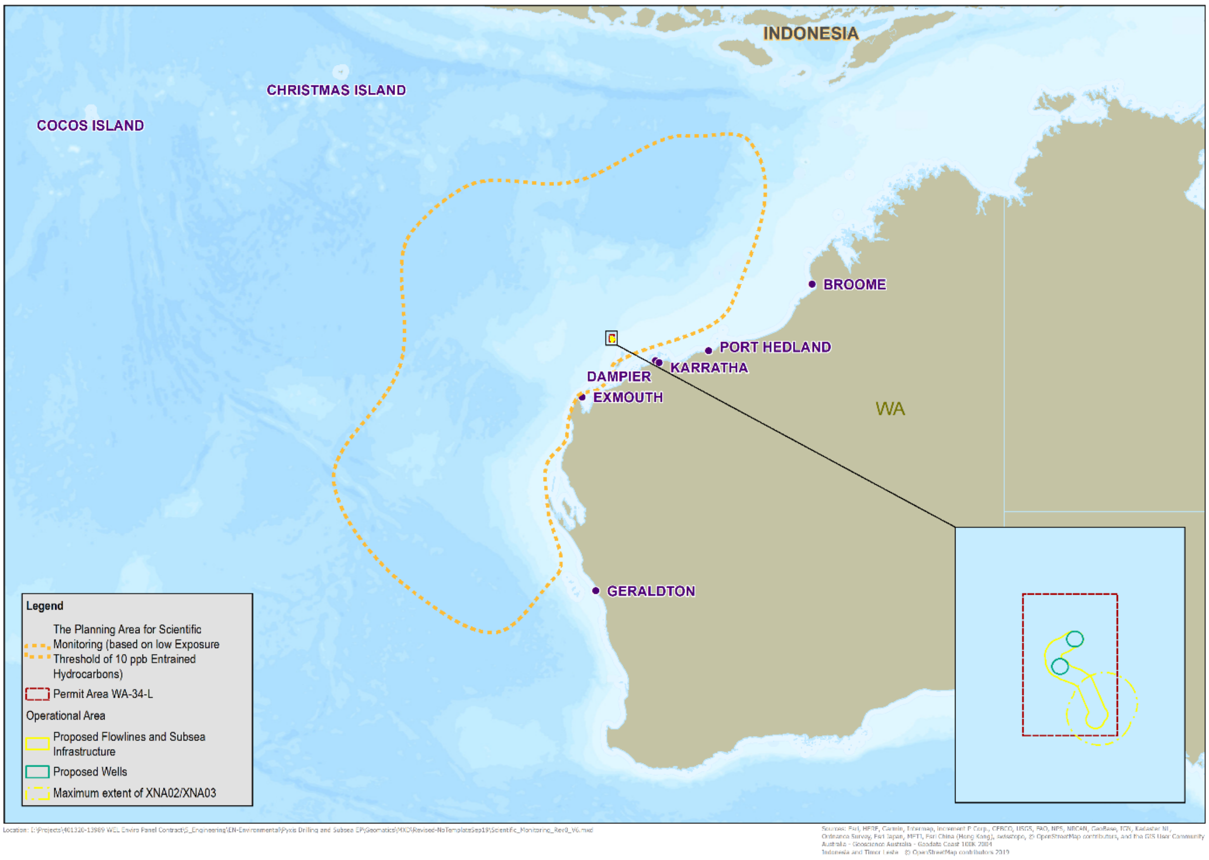


Figure 5-1: The planning area for scientific monitoring based on the area potentially contacted by the low (below ecological impact) entrained hydrocarbon threshold of 10 ppb in the event of the worst-case credible spill scenario (Scenario 1).

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 Scenario 1 and therefore represents the largest spatial boundaries of 100 Scenario 1 oil spill combinations, not the spatial extent of a single Scenario 1 spill.

5.5.1 Scientific Monitoring Deployment Considerations

Table 5-11: 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: The approach is to conduct a desktop review of available and appropriate baseline data for key receptors for locations (if any) that are potentially impacted within 10 days of a spill and look to conduct baseline data collection to address data gaps and demonstrate spill response preparedness. 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 >10 days' time to predicted hydrocarbon contact in the event of an unplanned hydrocarbon release (from the facility operational activities). SMP activation (as per the WA-34-L Pyxis Drilling and Subsea Installation FSRP) 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 (as documented in ANNEX C).
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 to implement SMPs: • Waves <one 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

Table 5-12: Scientific monitoring 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 are planned for and data collection may commence pre-PAP (≤ 10 days minimum time to contact), where identified as a gap. • PBAs (> 10 days minimum time to contact) for which baseline data may be collected in the event of an unplanned hydrocarbon release. Response phase PBAs are prioritised for SMP activities due to vulnerability (i.e. time to contact and environmental sensitivity) to potential impacts from hydrocarbon contact and an 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 WA-34-L Pyxis Drilling and Subsea Installation. Pre-emptive Baseline Areas for WA-34-L Pyxis Drilling and Subsea Installation 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	WA-34-L Pyxis Drilling and Subsea Installation A review of existing baseline data for receptor locations with potential to be contacted by floating or entrained hydrocarbons at environmental thresholds within ≤10 days has identified the following. • Rankin Bank [2] (note: modelling confirmed contact at depth for submerged feature) • Montebello AMP • Gascoyne AMP All the Australian Marine Parks (AMPs) are located in offshore waters where hydrocarbon exposure is possible on surface waters and in the water column.
In the Event of a Spill	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 worste-case credible spill scenario(s) (Table 2-1). To address the initial focus in a response phase SMP planning situation, receptor locations predicted to be contacted between >10 days and 20 days have been identified as follows: • Ningaloo Coast WHA, North and Middle • Ningaloo AMP (note modelling did not identify contact with Ningaloo State Marine Park, but assume contact for SMP response planning assumptions) • Barrow Island • Montebello Islands*[3] • Lowendal Islands*[3] For example, adequate baseline data are available for Glomar Shoals as last surveyed (benthic communities and fish assemblages) in November 2018 (AIMS, 2019). 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). With reference to the WA-34-L Pyxis Drilling and Subsea Installation facility, priority would be focused on Ningaloo Coast WHA and Ningaloo AMP.

[2] Floating oil will not accumulate on submerged features and at open ocean locations, therefore, no surface contact is possible with only entrained hydrocarbon contact predicted at Rankin Bank ≤10 days.
[3] ≥10 days time to contact is specifically applicable to Barrow Island; however, Montebello Islands and the Lowendal Islands are being included as a precautionary approach, given the spill modelling does not encompass the complex hydrographic processes for these islands groups.

	ii. Highly sensitive and/or valued habitats and communities in coastal waters will be prioritised for pre-emptive baseline surveys over open water areas of AMPs e.g. Ningaloo AMP. iii. 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 EMBAs for the PAP worst case credible spill scenarios 1 and 2, is presented in the WA-34-L Pyxis Drilling and Subsea Installation EP (Section 6). The key receptors at risk by location and corresponding SMPs based on the EMBAs for the PAP are presented in ANNEX D, as per the PAP credible spill scenarios one and two. This matrix maps the receptors at risk with their location and the applicable SMPs that may be triggered in the event of a Level two or three 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 locations identified as PBAs. 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 IGEM (Industry-Government Environmental Metadata database) (refer to ANNEX C).

5.5.3 Summary – scientific monitoring

The resulting scientific monitoring capability has been assessed against the PAP 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 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 Standby SMP 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:

- Ningaloo Coast WHA, North and Middle
- Ningaloo Australian Marine Park (AMP)
- Barrow Island
- Montebello Islands
- Lowendal Islands

Documented baseline studies are available for certain sensitive receptor locations including the Ningaloo Coast, Barrow Island, Montebello Islands and Lowendal Islands (ANNEX D, Table D-2). The SMP approach in the response phase would still deploy SMP teams to maximise the opportunity to collect pre-emptive baseline data at sensitive receptor locations, i.e., the sections of the Ningaloo Coast not immediately exposed to hydrocarbons. As the exact locations where hydrocarbon contact occurs may be unpredictable, 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 option analysis in Section 6.5 considers ways to reduce the gap by considering alternate, additional, and/or improved control measures on each selected response strategy.

5.5.5 Environmental performance based on need

Table 5-13: Environment Performance - 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**
14	• Woodside has an established and dedicated SMP team comprising the Environmental Science Team and additional Environment Advisers within the Health Safety Environment and Quality (HSEQ) Function.	14.1	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.
15	• Woodside have 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.	**15.1**	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.

16	• 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 control 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 Information System (IMIS) 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 FSRP. • Step by step process to activation of individual SMPs provided in the SMP Operational Plan. • All decisions made regarding SMP logged in the online IMIS (SMP team members trained in using Woodside's online Incident Management System). • SMP component input to the ICC Incident Action Plan (IAP) as per the identified ICC timed sessions and the SMP IAP logged on the online IMIS. • Woodside Environmental Science Team provide 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 provide awareness training on the activation and stand-up of the Scientific Monitoring Programme (SMP) for the SMP Standby provider. • Woodside Environmental Science Team co-ordinates an annual SMP arrangement testing exercise which the Standby SMP contractor SMP team participates in since 2016 (report on 2016 SMP simulation: and Standby SMP contractor SMP arrangements (people and equipment availability) tested annually since 2016.	**16.1**	• 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.

17	• 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 one marine sampling equipment companies and one analytical laboratory (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.	**17.1**	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 Standby SMP standby contractor, as detailed within the SMP Implementation Plan.	• OSPU 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.
18	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:	**18.1**	• Annual reviews of environmental baseline data. • PAP specific Pre-emptive Baseline Area baseline gap analysis.	• Annual review/update of Woodside Baseline Environmental Studies Database.

	• Documentation annual reviews of the Woodside Baseline Environmental Studies Database, and specific activity baseline gap analyses. • Industry-Government Environmental Meta-database (IGEM) Baseline Studies Database: http://www.igem.com.au/landing/ (Note – the IGEM password is documented in the SMP Operational Plan).			• 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 data achieved.		
Control measure		**Performance Standard**		**Measurement Criteria**
19	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.	19.1	**Pre-emptive Baseline Area (PBA) baseline data acquisition in the response phase** If baseline data gaps are identified for PBAs that has predicted hydrocarbon contact (contact time >10 days), there will be a response phase effort to collect baseline data with priority in implementing SMPs 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.

		19.2	**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**
20	• 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 IAP to trigger operational logistic support services. Methodology documents for each of the ten SMPs 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.	20.1	**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.
		20.2	**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.

		20.3	**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 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 strategies 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 strategies 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 strategy through the operational NEBA process. This process manages the environmental risks and impacts of response strategies 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 strategies.

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. 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 5-14: Environmental Performance – Incident Management System

<table>
<tr><th colspan="2">Environmental Performance Outcome</th><td colspan="3">To support the effectiveness of all other control measures and monitor/record the performance levels achieved.</td></tr>
<tr><th colspan="2">Control measure</th><th colspan="2">Performance Standard</th><th>Measurement Criteria</th></tr>
<tr><td rowspan="3">21</td><td rowspan="3">Operational NEBA</td><td>21.1</td><td>Confirm that the response strategies adopted at the time of acceptance remain appropriate to reduce the consequences of the spill within 24 hours.</td><td rowspan="6">1, 3A</td></tr>
<tr><td>21.2</td><td>Record the evidence and justification for any deviation from the planned response activities.</td></tr>
<tr><td>21.3</td><td>Record the information and data from operational and scientific monitoring activities used to inform the NEBA.</td></tr>
<tr><td rowspan="3">22</td><td rowspan="3">Stakeholder engagement</td><td>22.1</td><td>Prompt and record all notifications (including government notifications) for stakeholders in the region are made</td></tr>
<tr><td>22.2</td><td>In the event of a response, identification of relevant stakeholders will be re-assessed throughout the response period.</td></tr>
<tr><td>22.3</td><td>Undertake communications in accordance with:
• Woodside Crisis Management Functional Support Team Guideline – Reputation
• External Communication Operating Standard;
• External Stakeholder Engagement Operating Standard</td></tr>
<tr><td rowspan="8">23</td><td rowspan="8">Personnel required to support any response</td><td>23.1</td><td>Action planning is an ongoing process that involves continual review to ensure strategies to control the incident are appropriate to the situation at the time.</td><td>1, 3B</td></tr>
<tr><td>23.2</td><td>A duty roster of trained and competent people will be maintained to ensure that minimum manning requirements are met all year round.</td><td>3C</td></tr>
<tr><td>23.3</td><td>Immediately activate the IMT with personnel filling one or more of the following roles:
• Operations Duty Manager;
• Drilling and Completions (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; and
• Finance Coordinator.</td><td rowspan="4">1, 2, 3B, 3C, 4</td></tr>
<tr><td>23.4</td><td>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.</td></tr>
<tr><td>23.5</td><td>Security and Emergency Management (S&EM) advisors will be integrated into ICC to monitor performance of all functional roles.</td></tr>
<tr><td>23.6</td><td>Continually communicate the status of the spill and support Woodside to determine the most appropriate response by delivering on the responsibilities of their role.</td></tr>
<tr><td>23.7</td><td>Follow the OPEA, Operational Plans, FSRPs, support plans and the IAPs developed.</td><td>1, 2, 3A, 4</td></tr>
<tr><td>23.8</td><td>Contribute to Woodside’s response in accordance with the aims and objectives set by the Duty Manager.</td><td>1, 2, 3B, 3C, 4</td></tr>
</table>

5.7 Measurement criteria for all response strategies

Woodside ensures compliance with environmental performance outcomes and standards through four primary mechanisms. The performance tables aforementioned 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 & 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 & 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 strategies (defined during response planning); and
- The effectiveness of response strategies.

The information captured in the IMS (including information from personal logs and assigned tasks/close outs) confirms the response strategies 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

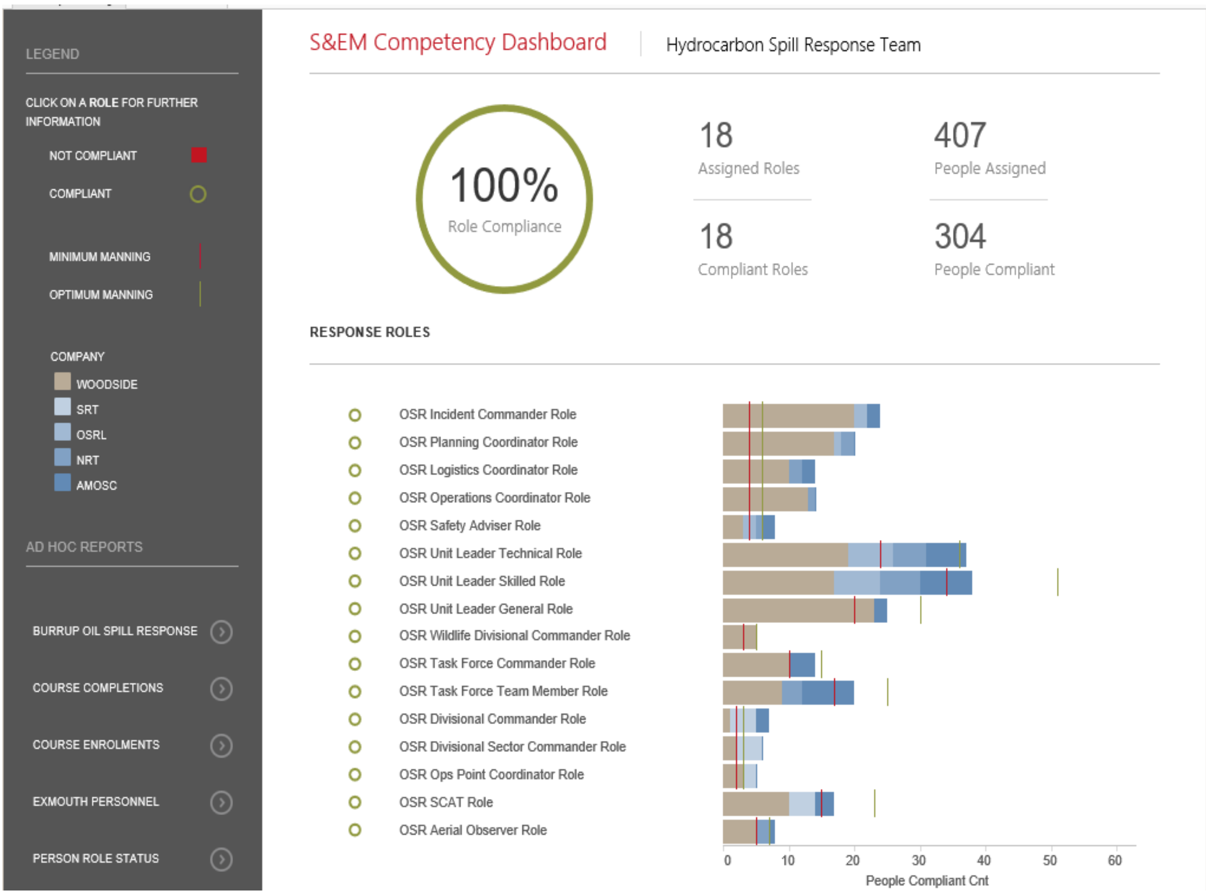


Figure 5-2: Example screen shot of the HSP competency dashboard

The Dashboard is one of Woodside's key means of monitoring its readiness to respond. It also and 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.

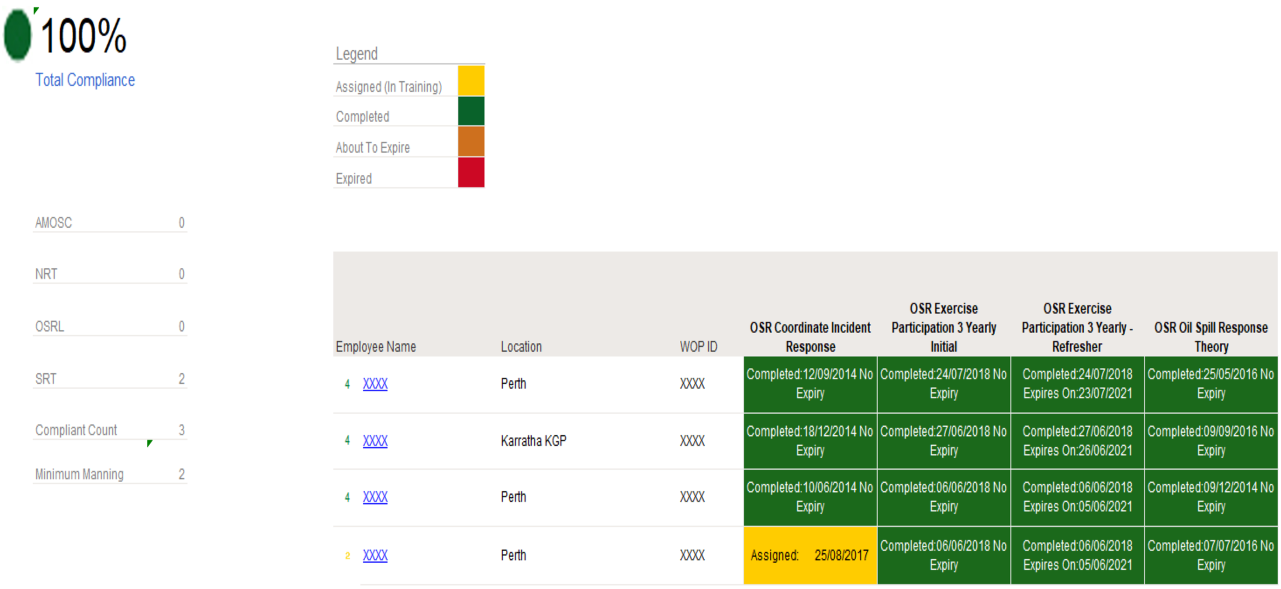


Figure 5-3: Example screen shot for the Ops Point Coordinator role

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[1] vessel schedule, dispersant availability, rig/vessels monitoring, equipment stockpiles, tracking buoy locations and the CICC duty roster.
d) **Compliance & 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 & Compliance System (WiRCs) and subject to the requirements of the Woodside Assurance process.

[1] 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

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; and
- 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
- 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

Table 6-1: Monitor and Evaluate – Alternative Control Measure Options considered

Option considered	Environmental consideration	Feasibility	Cost	Implemented
Aerostat (or similar inflatable observation platform) for localised aerial surveillance	The system provides a very limited field of visibility around the vessel it is deployed from reducing any environmental benefits compared to standard aerial surveillance.	Long lead time to access (>10 days). Each system would require an operator to interpret data and direct vessels accordingly.	Purchase cost per system is approximately $300,000 and multiple systems would be required in a response	No
Dedicated aviation platform on standby for aerial surveillance and operational monitoring	Woodside has access to helicopters as required at short notice from the operational fleet from day one. Additional platforms can be sourced as per the Aviation Support Plan. Therefore, current capability meets need and this strategy offers no additional environmental benefit.	A dedicated aviation platform would have to be located at Dampier airport, with trained observers living locally and able to mobilise at short notice. This option is feasible.	The approximate cost would be approx. $3M per annum, $15 Million over the life of the Petroleum Activities Program.	No
Use of Autonomous Underwater Vehicles (AUVs) for hydrocarbon presence and detection.	Use of AUVs may be feasible and may provide an environmental benefit in assessing inaccessible areas for presence of hydrocarbons in the water. Given the low proportion of Hydrocarbons predicted close to shorelines for this activity, the effectiveness is considered low.	AUVs may be considered as an additional method of monitoring, should remote systems be required for health and safety reasons.	The approximate cost $10,000 for mobilisation and $15,000 a day when deployed.	Yes

Table 6-2: Monitor and Evaluate – Additional Control Measure Options considered

Option considered	Environmental consideration	Feasibility	Cost	Implemented
Additional oil spill modelling system	The additional oil spill modelling system provides no environmental benefit above already adopted assessment and modelling arrangements.	While feasible, Woodside has an internal rapid assessment tool available for short notice trajectory modelling, and a contract in place for an external provider to produce additional more detailed and complex models. Additional modelling is available as per current participant's agreement with OSRL.	Cost for training in-house staff would be approximately $25,000.	No
Additional personnel trained to use systems.	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 approximately. $25,000.	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 on location at manned facility, additional needs are met from WEL owned stocks in King Bay Support Facility (KBSF) and Exmouth or can be provided by service provider.	The approximate cost for an additional satellite tracking buoy would be $200 per day or $6,000 to purchase.	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 & 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.	The approximate cost for additional trained aerial observers would be $2,000 per person per day.	No

Table 6-3: Monitor and Evaluate – Improved Control Measure Options considered

Option considered	Environmental consideration	Feasibility	Cost	Implemented
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 $50,000 for 24hr access plus an initial $5,000 per modelling run.	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 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.	No
Faster mobilisation time for water quality monitoring – Support vessel on standby in Dampier	Operations are not feasible on day one as the hydrocarbon will take time to surface, and 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 three. Shortening the timeframes for vessel availability would require dedicated response vessels on standby in KBSF and would accelerate the initiation of monitoring by one day.	The strategy would offer faster mobilisation by having support vessels on standby to conduct water quality monitoring from start of day 2. However, the minimum contact time at sensitive receptors is 54 hours. Current Woodside arrangements allow for water quality monitoring to commence by day 32, which meets the need. Therefore, decreasing the mobilisation time by one day, would provide no environmental benefit over standard mobilisation time.	The cost and organisational complexity of employing a dedicated response vessel is approximately M$7/year, $35 M over the life of the Petroleum Activities Program. Dedicated equipment and personnel, living locally and on short notice to mobilise would further increase the cost by approx. $1M per annum, five million dollars over the life of the Petroleum Activities Program.	No

6.1.2 Selected Control Measures

Following review of alternative, additional and improved control measures, the following controls were selected for implementation for the PAP.

- Alternative
  - Use of Autonomous Underwater Vehicles (AUVs) for hydrocarbon presence and detection.
- Additional
  - None selected
- Improved
  - None selected

6.2 Source Control - ALARP Assessment

Woodside has based its response planning on the worst-case credible scenario (as described in Section 2.2.1). This includes the following selection of source control and well intervention strategies which would be conducted concurrently;

- BOP intervention using ROV and hot stab
- Debris clearance and/or removal
- Capping stack
- Relief well drilling

6.2.1 ROV Intervention

Following confirmation of an emergency event, Woodside would mobilise work class ROVs through existing frame agreements. It is not expected that any additional regulatory approvals would be required as inspection, maintenance and repair is within the scope of activities for the WA-34-L Pyxis Drilling and Subsea Installation Activities Program Operations Safety Case as well as the scope of activities for contracted Frame Agreement vessels.

As Woodside holds Frame Agreements for vessels along with contracts for ROV providers and pilots, inspection and intervention activities using ROVs are expected to commence within nine days.

6.2.1.1 Safety Case considerations

Woodside has assessed against the NOPSEMA safety case guidance (NOPSEMA N-09000-GN1161), confirming that vessels conducting subsea intervention operations are not classified as an “associated offshore place” but as a facility and therefore require the appropriate Safety Case arrangements to be in place. In the event of an emergency, Woodside has access to suitable vessels (infield support vessels (ISVs)) for well intervention through existing frame agreements. The frame agreements for ISV vessels require the vessels to maintain in-force safety case approval covering a range of subsea activities. This would cover the requirement for intervention operations such as subsea manifold installation, maintenance and repair, commissioning, cargo transfer (including bulk liquids) and ROV operations. With frame agreements in place, the credible Safety Case Scenario from those presented in Figure 6-3 for implementing this response would be “no safety case revision required”. Timeframes for ROV intervention are presented in Table 6-4 and Figure 6-2 and would be implemented concurrently to the actions required by the “no Safety Case” revision scenario detailed in Figure 6-3. Therefore, the Safety Case scenario will have no impact on the delivery of the strategy.

Table 6-4: ROV timings

Estimate ROV intervention duration for WA-34-L Pyxis Drilling and Subsea Installation Activities Program **(days)**	
Source and mobilise vessel and re-supply	Two days
Source and mobilise ROV and pilot to port	Three days
Liaise with Regulator regarding risks and impacts*	Four days
Undertake BOP intervention using ROV and hot stab	One day
Total	Nine days

** Based on timings from the Report into the Montara Commission of Enquiry, submission and discussion of revised documentation for limited activities inside the Petroleum Safety Zone (water deluge operations) to manage personnel risks and impacts was up to 20 days.*

6.2.2 Debris clearance and/or removal

The Woodside Source Control Response Procedure details the mobilisation and resource requirements for implementing this strategy. Debris clearance may be required as a prerequisite to deployment of the capping stack. The AMOSC SFRT would be mobilised from Fremantle. The mobilisation of the SFRT would take place in parallel with mobilisation of the capping stack to ensure initial ROV surveys and debris clearance have commenced before the arrival of the capping stack. The SFRT comprises ROV-deployed cutters and tools that are used to remove damaged or redundant items from the wellhead and allow improved access to the well. The SFRT can be mobilised and deployed with well intervention attempted within 11 days.

6.2.2.1 Safety Case considerations

Woodside has assessed against the NOPSEMA safety case guidance (NOPSEMA N-09000-GN1161) and can confirm that vessels conducting debris clearance and removal operations are not classified as an "associated offshore place" but as a facility and therefore require the appropriate Safety Case arrangements in place. In the event of an emergency, Woodside has access to suitable ISVs for these operations through existing frame agreements. The frame agreements for ISVs require the vessels to maintain in-force safety case approval covering a range of subsea activities. This would cover the requirement for debris clearance and removal operations such as subsea manifold installation, commissioning, cargo transfer (including bulk liquids) and ROV operations. With frame agreements in place, the credible Safety Case Scenario from those presented in Figure 6-3 for implementing this response would be "no safety case revision required". Timeframes for SFRT presented in Figure 6-2 would be implemented concurrently to the actions required by the "no Safety Case" revision scenario detailed in Figure 6-3. Therefore, the Safety Case scenario will have no impact on the delivery of the strategy.

6.2.3 Capping stack

The Source Control Emergency Response Planning Guideline details the mobilisation and resource requirements for implementing this strategy. A capping stack is designed to be installed on a subsea well and provides a temporary means of sealing the well, until a permanent well kill can be performed through either a relief well or well re-entry.

Recent Literature, specifically the IOGP Report 594 – Source Control Emergency Response Planning Guide for Subsea Wells (2019), outlines the operating boundaries for Capping Stack deployment. The Operating boundaries are summarised below:

- Safe operating pressure for capping stack deployment is <15,000 psi.
- Suitable water depth range across global capping stack capability between 75 – 3, 800 m.
- Capping stack compatibility and configuration.

In the event of a hydrocarbon release, depending on the blowout rates (confirmed through operational monitoring), capping stack has been deemed feasible for the depth range for this PAP, and the well configuration (using the capping stack arrangements through WWC). Based on the depth, vertical linear deployment is feasible.

Woodside assumes conventional capping stack deployment sourcing vessels as per the Source Control Emergency Response Planning Guideline. This plan has pre-identified vessel specifications for the capping stack deployment and Woodside monitors the availability and location of these vessels on a monthly basis. Woodside maintain several frame agreements with various vessel service providers and maintains the ability to call off services with a capping stack and debris clearance agreement. Capping stack will be mobilised to a staging area within 16 days near the incident well location ready for deployment should conditions permit. Woodside will monitor the conditions around the wellsite, and should conditions be suitable, a capping stack can be mobilised and deployed with well intervention attempted.

6.2.3.1 Safety Case considerations

Woodside has assessed against the NOPSEMA safety case guidance (NOPSEMA N-09000-GN1161) and can confirm that vessels conducting capping stack are not classified as an "associated offshore place" but as a facility and therefore require the appropriate Safety Case arrangements in place.
The 16-day timeframe to mobilise the vessel is based on the following assumptions:

- Existing frame agreement vessel, located outside the region with approved Australian Safety Case.
- A safety case revision and scope of validation is required (16 days as per Figure 6-3) .
- Vessel has an active heave compensated crane, rated for deployment of capping stack.

Timeframes for capping stack deployment detailed in Table 6-5 and Figure 6-2 would be implemented concurrently with the actions required by the Safety Case revision scenarios detailed in Figure 6-3 and Table 6-7. To reduce uncertainty in regulatory approval timeframe, Woodside is collaborating with The Drilling Industry Steering Committee (DISC) and a contracted IMR Vessel Operator to develop a generic Safety Case Revision that contemplates a capping stack deployment. This Safety Case Revision will be used for early engagement with NOPSEMA before entering the reservoir for the 2019 Julimar Drilling Environment Plan. The learnings from this process will be applied for the Pyxis Drilling campaign to reduce uncertainty in permissioning timeframes in the event a capping stack deployment is required (see EPS 10.5). Woodside will execute the capping stack response in the fastest possible timeframe, provided the required safety and metocean conditions allow. Woodside has considered a broad range of alternate, additional, and improved options as outlined in Section 6.2.7.

Table 6-5: Capping Stack timings

Estimate Capping stack timings for WA-34-L Pyxis Drilling and Subsea Installation Activities Program **(days)**	
Identify Local Frame Agreement Vessel with appropriate specifications (as per EPS 8.4 Table 5-4~~)~~ and mobilise to Singapore	Three days
Build up and test Capping stack in Singapore*	Two days*
Prepare and load capping stack to vessel.	One day
Mobilise capping stack to deployment site (contingency for bad weather). Well intervention attempt will be made if safety and metocean conditions are suitable.	12 days
Total	16 days

**This operation is run simultaneously to identifying the frame agreement vessel. Therefore, the timing is not considered in the total duration of the response.*

6.2.4 Relief Well drilling

The options analysis detailed in this section considers options to source, contract and mobilise a MODU and ensure necessary regulatory approvals are in place to meet timelines for relief well drilling. The screening for relief well drilling MODUs is based on the following and the process used for Pyxis is illustrated in Figure 6-1:

- Primary – Review internal Woodside drilling programs and MODU availability to source an appropriate rig operating within Australia with an approved Safety Case;
- Alternate – Source and contract a MODU through APPEA MOU that is operating within Australia with an approved Safety Case;
- Contingency –If required, source and contract a MODU outside Australia with an approved Australian Safety Case. This option is not required for Pyxis due to the high certainty of rig availability, further discussed below.

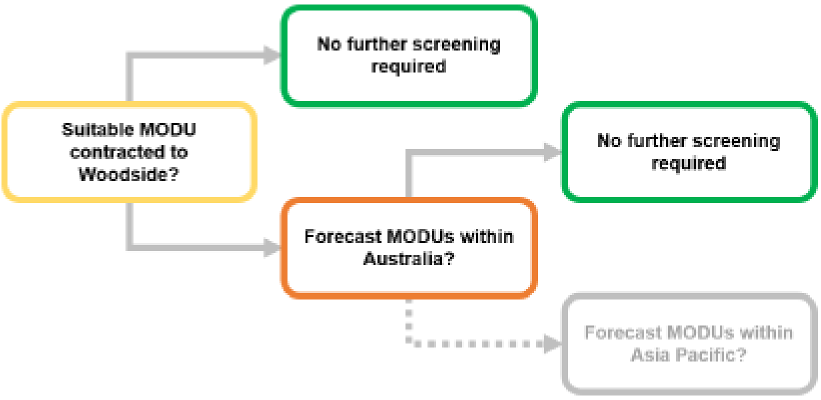


Figure 6-1: Woodside process for sourcing relief well MODU

Woodside has not assessed the timeframe for obtaining a relief well MODU through international supply for this project as the certainty of supply has been confirmed through local supply. Screening of a relief well MODU from international waters is undertaken only if required, i.e. there is low confidence in local (Australian) availability. The screening of relief well MODUs is undertaken and presented at a well design stage peer assessment. The capability, location and Australian Safety Case status is assessed for each Woodside contracted MODU. In the event the Woodside contracted MODUs are unsuitable, screening is extended to all MODUs operating in Australian Waters. The suitability and location of pre-identified relief well MODUs is tested again prior to the operation. Though the APPEA MoU will serve as the instrument to facilitate the transfer of drilling units and well site services between operators in the event of an emergency, Woodside will engage each of the identified titleholders in advance to maintain confidence in MODU suitability and availability.

Based on the detail provided, the Primary and Alternate approaches are expected to be achieved within the 21-day period.

The detail of these arrangements demonstrates that the risks have been reduced to ALARP and Acceptable levels through the control measures and performance standards outlined in Section 5.2.

6.2.4.1 Relief Well drilling timings

The duration of a blowout (from initiation to a successful kill) is assessed as 67 days for WA-34-L Pyxis Drilling and Subsea Installation Activities Program. The estimate is specific to relief wells for worst case credible blowout cases for PYA-01. However, relief wells for other wells within the field are expected to be similar duration.

Details on the time required to source and contract a MODU is shown in Table 6-6 below. A dynamically positioned (DP) MODU will be used in the event that one is available and within a shorter range/ response time than a moored MODU, however, DP MODUs are typically not readily available in Australia and thus the predictions for moored MODUs in the table are expected to be the most likely scenario during a real event.

On a monthly basis, Woodside tracks and assesses the suitability of available MODUs internally and externally, plus MODU activities of registered operators and MODUs with approved safety cases. MODUs expected to be stationed in Australia for the duration of project are identified as part of the Relief Well Peer review conducted during the planning phase and immediately prior to spud.

The ability to meet MODU mobilisation of 21 days is screened based on where the pre-identified MODUs will be stationed. For this project, suitable MODUs based in Australia have been identified by Woodside and thus there is a high level confidence that the stated 21 day timeframe can be met.

To validate the effectiveness of the relief MODU supply arrangements through the APPEA MoU, the 21-day mobilisation period was tested in April 2019 in an exercise facilitated by an external party. This exercise included suspension of the assisting operator's activities, contracting the MODU, vessel safety case revision and transit to location. The testing of mobilisation arrangements has been incorporated into Woodside's Hydrocarbon Spill Arrangements Testing Schedule.

Table 6-6: Relief well drilling timings

Estimate Relief Well duration for WA-34-L Pyxis Drilling and Subsea Installation Activities Program Well (days)	
Source and contract MODU comprising the following stages:	**21 days total:**
Activate MOU. Secure and suspend well. *Complete relief well design.* *Secure relief well materials.*	*Eight days*
Transit to location based on mobilisation from Northwest shelf region.	*Two days*
Backload and loadout bulks and equipment, complete internal assurance of relief well design.	*Two days*
Contingency for unforeseen event (e.g.: Longer transit from another area of Australia, problems in securing well, cyclone event)	*Nine days*
Pre-spud survey	**Already included**
DP/Anchoring	**Two days**
Drilling, casing and look ahead estimate	**29.4**
Drill 42" OH and run LPWHH and conductor	*1.3*
Drill 26" OH	*2.9*
Run 20" Casing and HPWH	*2.1*
Run and test BOP	*4.8*
Rill 17" OH	*3.9*
Run and cement 13 3/8" casing	*4.0*
Dir Drill 12-1/4" hole to Jo/MU (IH2)	*6.0*
Run 9.5/8" Liner (IH2)	*3.7*
BOP test	*0.7*
Intersection & well kill comprising the following stages:	**14 days total:**
Drill out shoe, conduct formation integrity test and drill towards intersection point	*1.5 days*
Execute well-specific ranging plan to intersect blowout wellbore in minimum timeframe, with highest possible accuracy.	*9.5 days*
Pump kill weight drilling fluid per the relief well plan. Confirm the well is static with no further flow.	*0.5 days*
Contingency for unforeseen technical issues (e.g.: more ranging runs required to make intersect, additional mud circulations required to execute kill	*2.5 days*
Total	**66.4 days (rounded to 67 days)**

The following conditions and assumptions are applicable:

- The 21-day mobilisation time assumes a local MODU is available in Australia with another operator titleholder and regulatory approvals do not delay the spud date.

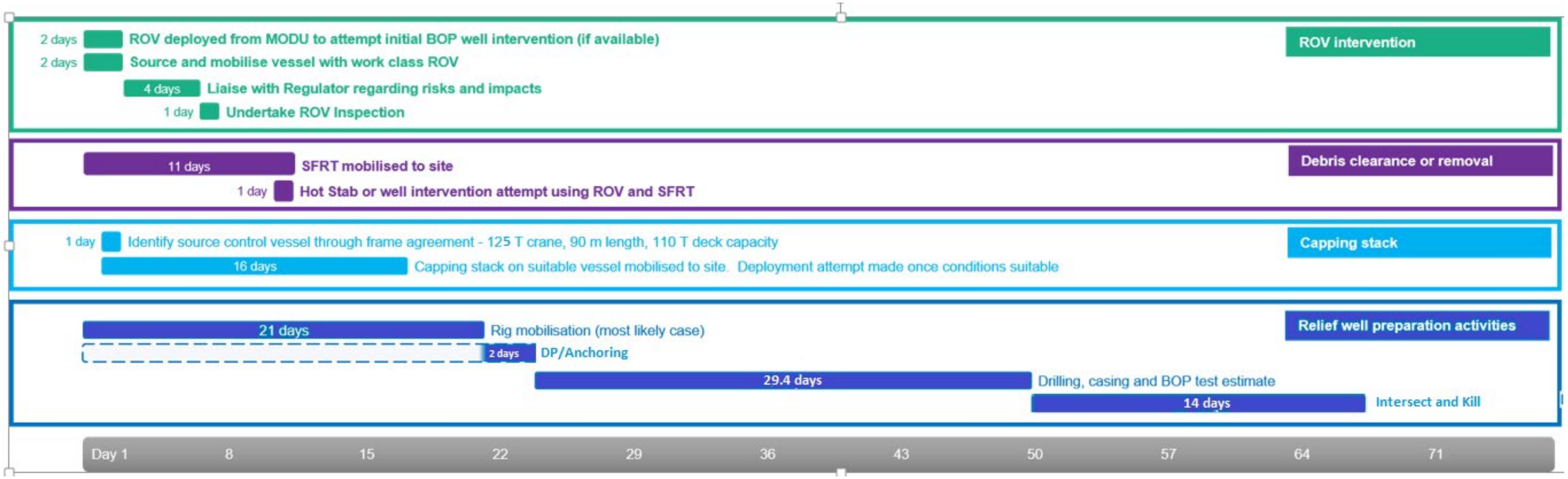


Figure 6-2: Source control and well intervention response strategy deployment timeframes

6.2.4.2 Safety Case Revision

Woodside will not be the Operator or holder of the Safety Case for the MODU and/or vessels involved in relief well activities. In the event that a revision to the Operator's Safety Case is required for relief well drilling, Woodside has identified measures to ensure timely response and optimise preparedness as far as practicable that can be undertaken to expedite a straightforward Safety Case revision for a MODU/vessel to commence drilling a relief well. Performance standards associated with these measures have been included in Section 5.2.

These include;

- Access to Safety and Risk discipline personnel with specialist knowledge.
- Monitoring internal and external rigs and vessel availability in region and extended area through contracted arrangements on a monthly basis.
- Prioritisation of rigs/vessels with current or historical contracting arrangements. Woodside maintains records of previous contracting arrangements and companies. All current contracts for vessels and rigs are required to support Woodside in the event of an emergency.
- Leverage mutual aid arrangements such as the APPEA MOU for vessel and rig support
- Woodside Planning and Logistics, and Safety Officers (on-Roster /Call 24/7) which can articulate need for, and deliver Woodside support, in key delivery tasks including sitting with potential outside operators.
- Ongoing strategic industry engagement and collaboration with NOPSEMA to work toward time reductions in regulatory approvals for emergency events.

Woodside has assessed the timing for three possible safety case revisions for a vessel/ MODU and plotted these alongside the other relief well preparation activities in Figure 6-3. The assumptions for each of the cases are detailed in Table 6-7.

The MODUs screened for contingency relief well drilling all operate under an Accepted base Safety Case. A relief well Safety Case Revision would leverage the previously accepted Safety Case Revision for the Pyxis drilling campaign, including the associated site-specific well hazards. As such, there is less new detail for the regulator to review and should present a short review timeframe with no impact expected to the commencement of relief well drilling activities.

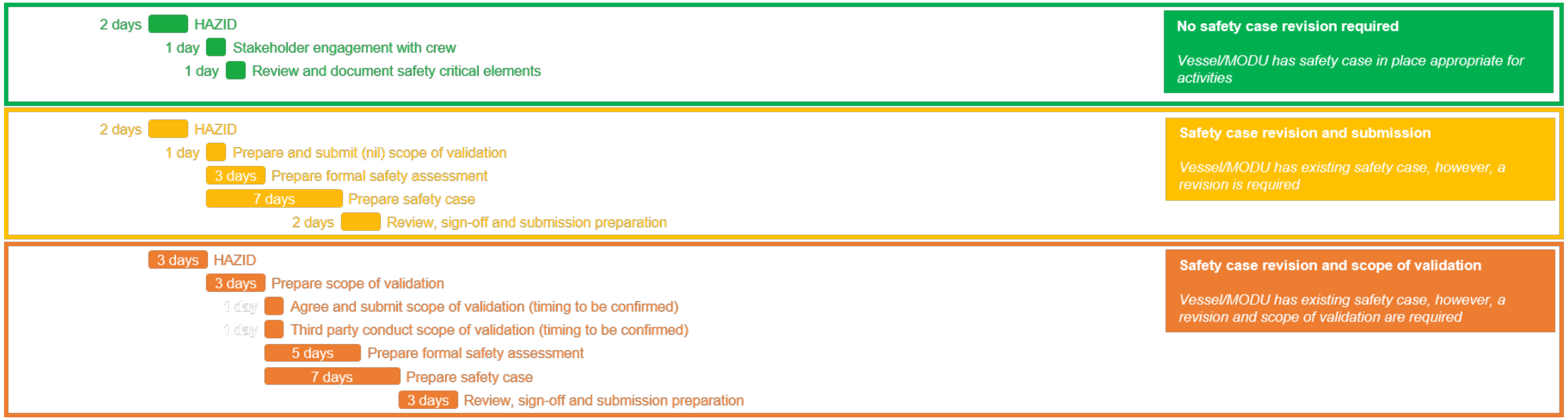


Figure 6-3: Timeline showing safety case revision timings

Table 6-7 Safety case revision conditions and assumptions

Case	No safety case revision required	Safety case revision and submission	Safety case revision and scope of validation
Description	Vessel/MODU has a safety case in place appropriate for activities	Vessel/MODU has an existing safety case, however, a revision is required	Vessel/MODU has an existing safety case, however, a revision is required plus scope of validation
Conditions/ assumptions	• Assumes that existing vessel/MODU safety case covers working under the same conditions or the loss of containment is not severe enough to result in any risk on the sea surface.	• Safety case timing assumes vessel/MODU selected and crew and available for workshops and safety case studies. • Assumes nil scope of validation. This assumes that the vessel allows for working in a hydrocarbon environment and control measures are already in place in the existing safety case. For MODU, it assumes that the relief well equipment is already part of the MODU facility and MODU safety case. • Assumes safety case preparation is undertaken 24/7.	• Safety case timing assumes vessel/ MODU selected and crew and available for workshops and safety case studies. • Validation will be required for new facilities only. The time needed for the validator to complete the review (from the last document received) and prepare validation statement is undetermined. This is not accounted for here as the safety case submission is not dependent on the validation statement, however the safety case acceptance is. • Assumes safety case preparation is undertaken 24/7.

6.2.5 Source Control – Control Measure Options Analysis

The assessment described in Section 6.2.7.1 and 6.2.7.2 outlines the primary and alternate approach respectively that Woodside would implement for relief well drilling**.**

Woodside has outlined the options considered against the activation, mobilisation (improved options), deployment (alternate and additional options) process described in Section 2.1.1 that provides an evaluation of:

- predicted cost associated with adopting the option
- predicted change/environmental benefit
- predicted effectiveness/feasibility of the option

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 disproportionate to the environmental benefit, and/or the option is not reasonably practical.

- Alternative options, including potentially more effective and/or novel control measures are evaluated as replacements for an adopted control.
- Additional control measures are evaluated in terms of their ability to reduce an impact or risk when added to the existing suite of control measures.
- 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

Options where there is not a clear justification for their inclusion or exclusion may be subject to a detailed assessment.

6.2.5.1 Activation/Mobilisation Options considered

Alternative
- SRC01 - Standby MODU shared for all Woodside activities
- SRC02 - Standby MODU shared across APPEA MOU Titleholders
- SRC03 – Pre-positioned Capping Stack

Additional
- SRC04 - Maintain minimum standard required for Safety Case development

Improved
- SRC05 - Monitor internal drilling programs for rig availability
- SRC06 - Monitor external drilling programs for rig availability
- SRC07 - Monitor status of Registered Operators / Approved Safety cases for rigs

6.2.5.2 Deployment Options considered

Additional
- SRC08 - Pre-drilling top-hole
- SRC09 - Pre-installed moorings
- SRC11 - Purchase and maintain mooring system
- SRC12 - Pre-design mooring spread
- SRC13 – Offset Capping stack deployment
- SRC14 - Contract in place with Wild Well Control Inc and Oceaneering to provide trained personnel

Improved
- SRC10 - Maintaining relief well drilling supplies (mud, casing, etc)

6.2.6 Activation/Mobilisation – Control Measure Options Analysis

Of the four steps outlined in Table 6-6, reducing the time to source, contract and mobilise the rig to site is the key step where timing may be reduced for well kill operations. The other three steps may be reduced once operations commence but limited options are available to reduce their duration until relief well drilling commences.

Table 6-8: Source Control – Activation/Mobilisation – Alternative Control Measure Options Analysis

Option considered	Environmental consideration	Feasibility	Cost	Assessment Conclusions	Implemented
Standby MODU shared for all Woodside activities	A standby MODU shared across all Woodside activities is likely to provide moderate environmental benefit as it may reduce the 21-day sourcing, contracting and mobilisation time by up to 10 days (to 11 days). This would reduce the volume and duration of the impacts. Given there is no potential for shoreline contact from floating hydrocarbon above threshold, the environmental benefit would only be to open ocean.	This option is not considered feasible for all Woodside activities as there are a large range of well depths, complexities, geologies and geophysical properties across all Woodside's operations. The large geographic area of Woodside activities also means that the MODU is unlikely to be in the correct location at the right time when required.	Even with costs shared across Woodside operations, the costs (approx. $219M per annum, $1,095B over the five years) of maintaining a shared MODU are considered disproportionate to the environmental benefit potentially achieved by reducing mobilisation times by up to 10 days.	The costs and complexity of having a MODU and maintaining this arrangement for the duration of the PAP are disproportionate to the environmental benefit gained above finding a MODU through the MOU agreement for all spill scenarios.	No
Standby MODU shared across APPEA MOU Titleholders	A standby MODU shared across all titleholders who are signatories to the APPEA MOU is likely to provide a minor environmental benefit as it may reduce the 21 day sourcing, contracting and mobilisation time by up to seven days (to 14 days). This would reduce the volume and duration of release and may reduce impacts on receptors and sensitivities.	This option is not considered feasible for a number of Titleholders due to the remote distances in Australia as well as a substantial range of well depths, types, complexities, geologies and geophysical properties across a range of Titleholders	As the environmental benefit is only considered minor and the reduction in timing would only be for the mobilisation period (reduction from 21 days to 14 days) the costs are considered disproportionate to the minor benefit gained.	The costs and complexity of having a MODU and maintaining a shared arrangement for the duration of the PAP are disproportionate to the environmental benefit gained above finding a MODU through the MOU agreement for all spill scenarios.	No
Pre-positioned Capping Stack (Australia) allowing intervention within 16 days	The capping stack would be available on site at the time of a well blowout but unlikely to be deployed and activated until approximately Day 16 due to requirement for wellhead evaluation, site survey and debris clearance / removal. The commencement of capping operations would be constrained by safety considerations and successful debris clearance	The capping stack is a shared resource, therefore standby for prolonged periods of time would not be feasible.	The cost associated with pre-positioning the Capping stack is an upfront cost as opposed to conventional capping, which would be paid in the event of a hydrocarbon release. Pre-positioned capping stack system on stand-by with suitable vessel based in Dampier would cost approximately $125M for the duration of the PAP (five years). This includes mobilisation and loading in Singapore, sailing to Dampier, standby, deployment and return.	The costs and complexity of having a capping stack for the duration of the PAP are disproportionate to the environmental benefit gained above finding a Capping Stack through the MOU agreement for all spill scenarios.	No

Table 6-9: Source Control – Activation/Mobilisation – Additional Control Measure Options Analysis

Option considered	Environmental consideration	Feasibility	Cost	Assessment conclusions	Implemented
Implement and maintain minimum standards for Safety Case development	Woodside's contingency planning consideration would be to source a rig from outside Australia with an existing Safety Case. This would require development and approval of a safety case revision for the rig and activities prior to commencing well kill operations.	This option is considered feasible and would require Woodside to develop minimum standards for safe operations for relevant Safety Case input along with maintaining key resources to support review of Safety Cases. Woodside would not be the operator for relief well drilling and would therefore not develop or submit the Safety Case revision. Woodside's role as Titleholder would be to provide minimum standard for safe operations that MODU operators would be required to meet and/or exceed.	Woodside has outlined control measures and performance standards regarding template Safety Case documentation and maintenance of resources and capability for expedited Safety Case review.	This option has been selected based on its feasibility, low cost and the potential environmental benefits it would provide.	Yes

Table 6-10: Source Control – Activation/Mobilisation – Improved Control Measure Options Analysis

Option considered	Environmental consideration	Feasibility	Cost	Assessment conclusions	Implemented
Monitor internal drilling programs for rig availability	Woodside may be conducting other campaigns that overlap with the Petroleum Activities Program, potentially providing availability of a relief well drilling rig within Woodside. The environmental benefit of monitoring other drilling programs internally is for Woodside to understand what other rigs may be rapidly available for relief well operations if required, potentially reducing the time to drill the relief well, resulting in less hydrocarbon to the environment.	Woodside monitors vessel and MODU availability through market intelligence services for location. Woodside will continually monitor other drilling and exploration activities within Australia and as available throughout the region to track rigs and explore rig availability during well intervention operations.	Associated cost of implementation is minimal to the environmental benefit gained. Woodside has outlined control measures and performance standards.	This option is a low-cost control measure with potential to reduce the volume of hydrocarbon released to the environment.	Yes
Monitor external activity for rig availability	The environmental benefit achieved by monitoring drilling programs and rig movements across industry provides the potential for increased availability of suitable rigs for relief well drilling. Additional discussions with other Petroleum Titleholders may be undertaken to potentially gain faster access to a rig and reduce the time taken to kill the well and therefore volume of hydrocarbons released.	Woodside will source a relief well drilling rig in accordance with the APPEA MOU on rig sharing in the unlikely event this is required. Commercial and operational provisions do not allow WEL to discuss current and potential drilling programs in detail with other Petroleum Titleholders.	Associated cost of implementation is moderate to the environmental benefit gained. Woodside will continually engage with other Titleholders and Operators regarding activities within Australia and as available throughout the region to track rigs and explore rig availability during well intervention operations.	This option is a low-cost control measure with potential to reduce the volume of hydrocarbon released to the environment.	Yes
Monitor status of Registered Operators / Approved Safety cases for rigs	The environmental benefit of monitoring rigs is for Woodside to understand what other rigs may be rapidly available for relief well operations if required, potentially reducing the time to drill the relief well, resulting in less hydrocarbon to the environment.	Woodside will monitor the status of rigs operating within Australia (and therefore safety case status) on a quarterly basis. This allows for a prioritised selection of rigs in the event of a response with priority given to those with an existing safety case.	Associated cost of implementation is minimal to the environmental benefit gained, Woodside will monitor the status of safety cases on a quarterly basis. Woodside has outlined control measures and performance standards to meet these controls.	This option is a low-cost control measure with potential to reduce the volume of hydrocarbon released to the environment.	Yes

6.2.7 Deployment Options Analysis

Table 6-11: Source Control – Deployment – Additional Control Measure Options Analysis

Option considered	Environmental consideration	Feasibility	Cost	Assessment Conclusions	Implemented
Pre-drilling top-holes	This option represents additional environmental impacts associated with discharge of additional drill cuttings and fluids along with benthic habitat disturbance. It is also not expected to result in a significant decrease in relief well timings.	This option is not considered feasible due to the uncertainties related to the location and trajectory of the intervention well, which may vary according to the actual conditions at the time the loss of containment event occurs. Additionally, there is only expected to be a minor reduction in timing for this option of one-two days based on the drilling schedule. Duration to drill and kill may be reduced by one-two days, but top-hole may have to be relocated, due to location being unsafe or unsuitable and further works will be required each year to maintain the top holes.	This strategy is not considered feasible, therefore no further ALARP assessment is conducted	This strategy is not considered feasible.	No

Offset capping equipment alternative to conventional capping stack deployment	The offset capping system is unlikely to be deployed within 50 days (verified by OSRL) following a blowout, with the offset capping stack needing to be transported from Trieste Italy and mobilised to site. Therefore, no environmental benefit predicted over the conventional capping stack	Offset installation equipment is becoming more available in the market. Systems such as the Offset Installation Equipment (OIE) from OSRL and the Delmar heave compensated landing system (HCLS) are examples. The equipment for these deployment methods is located in Europe (OIE) and the US Gulf of Mexico (HCLS). The OIS has air freight capability but will require a 600+MT crane vessel to deploy as well as steel fabrication work in Australia to build mooring anchors for the system. A crane vessel of that size could be used for an extended reach conventional deployment thereby eliminating the time and complexities required for deploying the OIE. The HCLS system is not practical for air transportation and is therefore not a possibility for this location.	Due to there being minimal environmental benefits gained by the prolonged lead times needed to execute this technique, plus a potential increase in safety issues, any cost would be disproportionate to the benefits gained.	This option would not provide an environmental benefit.	No
Contract in place with Wild Well Control and Oceaneering	Woodside has an agreement in place with Wild Well Control Inc and Oceaneering to provide trained personnel in the event of an incident. This will ensure that competent personnel are available in the shortest possible timeframe.	Having contracts in place to access trained, competent personnel in the event of an incident would reduce mobilization times. This option is considered reasonably practicable.	This control measure is adopted as the costs and complexity are not considered disproportionate to any environmental benefit that might be realised.	This control is selected to provide further certainty that competent personnel are available.	Yes
Dual vessel capping stack deployment	While the use of dual vessel to deploy the capping system could reduce the quantity of hydrocarbon entering the marine environment, this is an unproven technology. Given the water depth and vertical access to the well for Pyxis drilling activity, there is no requirement for offset capping and therefore no environmental benefit over standard capping stack deployment.	A dual vessel deployment is somewhat feasible provided a large enough deck barge can be located. Deck barges of 120 m are not, however, very common and will present a logistical challenge to identify and relocate to the region. Further, the longer length barges may need mooring assist to remain centred over the well. The capping stack would be handed off from a crane vessel to the anchor handler vessel (AHV) work wire outside of the exclusion zone. The AHV would then manoeuvre the barge into the plume to get the capping stack over the well. In this method, the barge would be in the plume, but the AHV and all personnel would be able to maintain a safe position outside of the gas zone. The capping stack would actually be lowered on the AHV work wire so a crane would not be required on the barge.	Due to there being minimal environmental benefits gained by the prolonged lead times needed to execute this technique, plus a potential increase in safety issues, any cost would be disproportionate to the benefits gained.	Given there is minimal environmental benefit and an increase in safety issues surrounding SIMOPS and deployment in shallow waters, this option would not provide an environmental or safety benefit.	No
Subsea Containment System alternative to capping stack deployment	While the use of a subsea containment system could reduce the quantity of hydrocarbon entering the marine environment, this is an unproven technology. Additionally, the system is unlikely to be feasibly deployed and activated for at least 90 days following a blowout due to equipment requirements and logistics. No environmental benefit is therefore predicted given the release duration is 67 days before drilling of a relief well under the adopted control measure.	The timing for mobilisation, deployment and activation of the subsea containment system is likely to be longer (>90 days), than the expected 67 day relief well drilling operations based on the location, size and scale of the equipment required, including seabed piles that can only be transported by vessel.	Woodside has investigated the logistics of reducing this timeframe by pre-positioning equipment but the costs of purchasing dedicated equipment by Woodside for this Petroleum Activities Program is not considered reasonably practical and are considered disproportionate to the environmental benefit gained.	This option would not provide an environmental benefit.	No

Table 6-12: Source Control – Deployment – Improved Control Measure Options Analysis

Option considered	Environmental consideration	Feasibility	Cost		Implemented
Maintaining relief well drilling supplies	There is not predicted to be any reduction in relief well timing or spill duration from Woodside maintaining stocks of drilling supplies (mud, casing, cement, etc.)	It would be feasible to source some relief well drilling supplies such as casing, but the actual composition of the cement and mud required will need to be specific to the well. This option is also not deemed necessary as the lead time for sourcing and mobilising these supplies is included in the 21 days for sourcing and mobilising a rig.	The capital cost of Woodside purchasing relevant drilling supplies is expected to be approximately $600K with additional costs for storage and ongoing costs for replenishment. These costs are considered disproportionate to the environmental benefit gained.	This option would not provide an environmental benefit.	No

6.2.8 Selected Control Measures

Following review of alternative, additional and improved control measures, the following controls were selected for implementation for the PAP.

- Alternative
  - None selected
- Additional
  - Implement and maintain minimum standards for Safety Case development
  - Contract in place with Wild Well Control and Oceaneering to supply trained, competent personnel
- Improved
  - Monitor internal drilling programs for rig availability
  - Monitor external activity for rig availability
  - Monitor status of Registered Operators / Approved Safety cases

6.3 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.

6.3.1 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. 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-fueling/re-stocking provisions, and other similar logistic and operational limitations that are beyond Woodside's direct control.

6.3.2 Waste Management - Control Measure Options Analysis

Table 6-13: Waste Management –Additional Control Measure Options considered

Option considered	Environmental consideration	Feasibility	Cost	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 waste contractor'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 contract and arrangements with OSRL. Existing arrangements meet identified need for the Petroleum Activities Program.	Given there is no environmental benefit, any costs are disproportionate to the benefit gained.	No

Table 6-14: Waste Management –Improved Control Measure Options considered

Option considered	Environmental consideration	Feasibility	Cost	Implemented
Faster response time	The access to Veolia waste storage options provides the resources to store and transport waste, permitting the wastes to be stockpiled and gradually processed within the regional waste handling facilities. Bulk transport to Veolia's licensed waste management facilities would be undertaken via controlled-waste-licensed vehicles and in accordance with *Environmental Protection (Controlled Waste) Regulations 2004*. 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.	Woodside already maintains an equipment stockpile in Dampier 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 WEL owned stockpile of waste equipment and transport is considered minor and cost is considered disproportionate to the benefit gained given predicted shoreline contact times.	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 PAP.

- Alternative
  - None selected
- Additional
  - None selected
- Improved
  - None selected

6.4 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.

6.4.1 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. The capability 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-fueling/re-stocking provisions, and other similar logistic and operational limitations that are beyond Woodside's direct control.

6.4.2 Wildlife Response - Control Measure Options Analysis

Table 6-15: Wildlife Response – Alternative Control Measure Options considered

Option considered	Environmental consideration	Feasibility	Cost	Implemented
Direct contracts with service providers instead of those sourced through the WAOWRP	Adoption of this control would provide minimal net environmental benefit as the resources supplied through AMOSC and OSRL would likely be shared by the direct contracts.	It is feasible to have direct contracts with service providers; however, this option duplicates the capability accessed through AMOSC and OSRL, potentially competing for the same resources.	Given there is no environmental benefit, any costs are disproportionate to the benefit gained.	No

Table 6-16: Wildlife Response – Additional Control Measure Options considered

Option considered	Environmental consideration	Feasibility	Cost	
Additional wildlife treatment systems	Current arrangements allow for all wildlife to be treated. Hydrocarbon is only limited to open water above the impact threshold. Therefore, there is no environmental benefit for having additional wildlife treatment systems as current capability meets the need.	Current arrangements allow response equipment and personnel to be delivered by day one, scaling up by day six, enough to treat up to 600 wildlife. An additional wildlife treatment system is feasible and would potentially reduce the time to deploy additional wildlife systems.	Given there is no environmental benefit, any costs are disproportionate to the benefit gained.	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.	Providing additional trained wildlife responders is feasible, however current capacity provides the capacity to treat approximately 600 wildlife units (primarily avian fauna) by day six, with additional capacity available from OSRL.	Given there is no environmental benefit, any costs are disproportionate to the benefit gained.	No

Table 6-17: Wildlife Response – Improved Control Measure Options considered

Option considered	Environmental consideration	Feasibility	Cost	
Faster mobilisation time for wildlife response through pre-positioned equipment and personnel.	Response time is limited by specialist personnel mobilisation time. Current timing is sufficient considering there is no potential for shoreline receptors to be contacted. 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 selected delivery options provide the capacity to mobilise an oiled wildlife response capable of treating up to 600 wildlife from at least day six and exceeds the estimated Level 4 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 cost of having dedicated equipment and personnel available to respond faster is considered disproportionate to the environmental benefit.	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 PAP.

- 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

Table 6-18: Scientific Monitoring - Control Measure Options considered – A. alternative control measures

Evaluate Alternative, Additional and Improved Control Measures					
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 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 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.

Table 6-19: Scientific Monitoring - Control Measure Options considered – B. 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*					
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 control 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 control 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 control from the PAP 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, 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 6-20: Scientific monitoring program operational plan actions.

Table 6-20: Scientific monitoring program operational plan actions

Responsibility	Action
Activation	
Perth ICC Planning (ICC Planning – Environment Unit)	Mobilises Chief Environmental Scientist or 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 assesses all outputs from OM01, OM02 and OM03 (Section 5 and ANNEX B) 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 SMP standby contractor as 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. Determines practicable baseline acquisition program based on predicted timescales to contact and anticipated SMP mobilisation times. Determines scope for preliminary post-contact surveys during the Response Phase. Determines 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 standby contractor SMP manager)	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 IMT.
Perth ICC Planning (ICC Planning – Environment Unit)	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.

Responsibility	Action
(SMP Lead/Manager, SMP Coordinator, SMP standby contactor SMP manager)	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 SMP 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 standby contactor SMP Manager, SMP Team Leads and Operations Point Coordinator.
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 Jacob's SMP Manager. Agree SMP mobilisation timeline and induction procedures with the Division and Sector Command Point(s).
Perth ICC Logistics	Coordinate with SMP standby contactor SMP 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 Sector Command point(s).

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></td><td>No additional, alternative and improved control measures would provide further benefit</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 a loss of well control.
• 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 scenarios, and uncertainty has not been used as a reason for postponing control measures.</td></tr>
<tr><td colspan="3">On the basis from the 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 STRATEGIES

The implementation of response strategies 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.

7.1.1 Identification of impacts and risks from implementing response strategies

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. There 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*
- *Presence of personnel on the shoreline*
- *Increase in entrained hydrocarbons*
- *Toxicity of dispersant*
- *Additional stress or injury caused to wildlife*
- *Secondary contamination from the management of waste*

7.1.2 Analysis of impacts and risks from implementing response strategies

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 & Groundwater	Marine Sediment Quality	Water Quality	Air Quality	Ecosystems/ Habitat	Species	Socio-Economic
Monitor and evaluate		✓	✓		✓	✓	
Source control		✓	✓		✓	✓	✓
Oiled Wildlife					✓	✓	
Scientific Monitoring	✓	✓	✓	✓	✓	✓	✓
Waste Management	✓			✓	✓	✓	✓

7.1.3 Evaluation of impacts and risks from implementing response strategies

Presence of personnel on the shoreline

Presence of personnel on the shoreline during shoreline operations could potentially result in disturbance to wildlife and habitats. During the implementation of response strategies, it is possible that personnel may have minimal, localised impacts on habitats, wildlife and coastlines. The impacts associated with human presence on shorelines during shoreline surveys may include:

- Damage to vegetation/habitat to gain access to areas of shoreline oiling
- Damage or disturbance to wildlife during shoreline surveys
- Removal of surface layers of intertidal sediments (potential habitat depletion)
- Excessive removal of substrate causing erosion and instability of localised areas of the shoreline.

Human Presence

Human presence for manual clean-up operations may lead to the compaction of sediments and damage to the existing environment especially in sensitive locations such as mangroves and turtle nesting beaches. However, any impacts are expected to be localised with full recovery expected.

Waste generation

Implementing the selected response strategies will result in the generation of the following waste streams that will require management and disposal:

- Debris (e.g. seaweed, sand, woods, plastics), collected during oiled wildlife response.

If not managed and disposed of correctly, wastes generated during the response have the potential for secondary contamination similar to that described above, impacts to wildlife through contact with or ingestion of waste materials and contamination risks if not disposed of correctly onshore.

Cutting back vegetation could allow additional oil to penetrate the substrate and may also lead to localised habitat loss. However, any loss is expected to be localised in nature and lead to an overall net environmental benefit associated with the response by reducing exposure of wildlife to oiling.

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.

7.1.4 Treatment of impacts and risks from implementing response strategies

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.

Presence of personnel on the shoreline

- Oversight by trained personnel who are aware of the risks (PS 17.6).
- Trained unit leader’s brief personnel of the risks prior to operations (PS 17.7).

Human presence

- Shoreline access route (foot, car, vessel and helicopter) with the least environmental impact identified will be selected by a specialist in SCAT operations (PS 17.4).
- Vehicular access will be restricted on dunes, turtle nesting beaches and in mangroves. (PS 17.3).

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 and in accordance with the processes and methodologies described in the WA OWRP and the relevant regional plan (PS 20.3).

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 with which to respond to the WCCS through the control measures identified.
- New and modified impacts and risks associated with implementing response strategies 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 to have been reduced to an acceptable level by meeting all of the following criteria:

- Strategies 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 three 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 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).

10 REFERENCES

Astron Environmental Service (2014). Exmouth Islands Turtle Monitoring Program January 2014 Field Survey. Report prepared on behalf of Apache Energy (now Quadrant Energy).

AAM (2012), Exmouth-Carnarvon Satellite Orphophoto from RapidEye, Vol 2, Deliverable to Woodside Energy Ltd, Perth, WA.

AAM (2014), RapidEye satellite images were captured along the coastline of Central/ Northern, Western Australia in between September 2011 to April 2014.

Allen, A.A. and Dale, D.H., 1996, April. Oil slick classification: A system for the characterization and documentation of oil slicks. In *International Oil Spill Conference* (Vol. 1997, No. 1, pp. 315-322). American Petroleum Institute.

ANZECC/ARMCANZ, (2000). Australian and New Zealand guidelines for fresh and marine water quality. Australian and New Zealand environment and conservation council/Agriculture and resource management council of Australia and New Zealand. Canberra, ACT, Australia.

AIMS (2010) Reefs: Ningaloo Reef Biodiversity Expeditions (2008-2010). http://www.aims.gov.au/creefs

AIMS (2014). AIMS 2013 Biodiversity Survey of Glomar Shoal and Rankin Bank. Report prepared by the Australian Institute of Marine Science for Woodside Energy Ltd. Australian Institute of Marine Science, Townsville. October 2014 Rev 1,153pp.

AIMS (2014). AIMS 2014 Extended Benthic Models and Habitat Maps of Rankin Bank. Report prepared by the Australian Institute of Marine Science for Woodside Energy Ltd. Australian Institute of Marine Science, Townsville. December 2014 Rev 0 (43pp.).

AIMS (2014). Ningaloo and Outer Shark Bay Baseline Survey 2014. AIMS Field Report for Woodside. 21 pp. Co-funded Baseline Surveys (November-December 2014) (Drims#9921709).

AIMS (2017a) Greater Western Flank-2 Environmental Monitoring Field Report: Pre-Drilling Baseline Survey. Report prepared by the Australian Institute of Marine Science for Woodside Energy Ltd. Australian Institute of Marine Science, Townsville. February 2017,43pp.

AIMS (2017b) Juvenile fish recruitment surveys, Ningaloo Reef, Western Australia (WAMSI Node 3 Project 3.1.2). https://data.gov.au/dataset/juvenile-fish-recruitment-surveys-ningaloo-reef-western-australia-wamsi-node-3-project-3-1-2

Australian Maritime Safety Authority. The National Plan Oil Spill Control Agents List. Available from: https://www.amsa.gov.au/environment/maritime-environmental-emergencies/national-plan/General-Information/control-agents/list/index.asp [Accessed 23 June 2014]

Australasian Fire and Emergency Service Authorities Council, 2011, Fundamentals of Doctrine: A best practice guide, East Melbourne, VIC, AFAC Limited.

AMOSC/DPAW (2014). Inter-Company Oil Spill Wildlife Response Plan – Pilbara region. pp. 272 http://www.dpaw.wa.gov.au/images/documents/conservation-management/marine/wildlife/PROWRP_20141103.pdf

APASA (2019) Wel Pyxis Drilling EP QSRA- Dispersant Modelling. Perth

Bancroft, K.P. (2009). Establishing long-term coral community monitoring sites in the Montebello/ Barrow Islands marine protected areas: data collected in December 2006. Marine Science Program Data Report Series MSPDR4. January 2009. Marine Science Program, Science Division, Department of Environment and Conservation, Perth, Western Australia. 68p.

Bamford M.J. (2004). Gorgon Development on Barrow Island. Technical Report: Avifauna

Bamford and Moro (2011). Barrow Island as an important bird area for migratory waders in the East Asian – Australasian Flyway. Stilt 60: 46–55

Brandvik, PJ, Johansen, Ø, Farooq, O, Angell, G. and Leirvik, F. (2014). Subsurface oil releases – Experimental study of droplet distributions and different dispersant injection techniques. A scaled experimental approach using the SINTEF Tower basin. SINTEF report no. A26122. Norway.

Brown M, 2012, Implementing an Operational Capability System within Fire & Rescue NSW, Australasian Fire and Emergency Service Authorities Council Conference Paper, September 2012.

BirdLife Australia (2017) Shorebirds 2020 programme – Data Extraction (1993-2017). http://www.birdlife.org.au/projects/shorebirds-2020 (http://dmslink/link/link.aspx?dmsn=1400456992)

BSEE. 2016. https://www.bsee.gov/site-page/worst-case-discharge-scenarios-for-oil-and-gas-offshore-facilities-and-oil-spill-response

BSEE. 2016. https://www.bsee.gov/what-we-do/oil-spill-preparedness/response-system-planning-calculators

Cassata, L. and L.B. Collins (2008). Coral reef communities, habitats and substrates in and near Sanctuary Zones of Ningaloo Marine Park. Journal of Coastal Research Vol. 24 (1): 139-51.

Chevron Australia (2010). Gorgon Gas Development and Jansz Feed Gas Pipeline: Coastal and Marine Baseline State and Environmental Impact Report: Domestic Gas Pipeline. Document Number: G1-NT-REPX0002750 http://www.chevronaustralia.com/Libraries/Chevron_Documents/Gorgon_Project_Coastal_and_Marine_Baseline_State_and_Environmental_Impact_Report_Domestic_Gas_Pipeline.pdf.sflb.ashx

Chevron Australia (2011). Gorgon Gas Development and Jansz Feed Gas Pipeline: Dredging and spoil disposal Management and Monitoring Plan, Document number: G1-NT-PLNX0000373. Pp. 255. https://www.chevronaustralia.com/docs/default-source/default-document-library/gorgon-emp-dredging-and-spoil-disposal-plan.pdf?sfvrsn=2

Chevron Australia (2014). Gorgon Gas Development and Jansz Feed Gas Pipeline: Post-Development Coastal and Marine State and Environment Impact Survey Report, Year 2:2012-2013. Document number G1-NT-REPX0005152. Pp. 362 https://www.chevronaustralia.com/docs/default-source/default-document-library/gorgon-emp-post-development-coastal-and-marine-state-and-environmental-impact-survey.pdf?sfvrsn=4

Colquhoun J and Heyward A. (eds) (2008). WAMSI Node 3 Project 1 Subproject 3.1.1 Deepwater Communities at Ningaloo Marine Park: Ningaloo Reef Marine Park Deepwater Benthic Biodiversity Survey Annual Report 2007. 209 pp. http://www.wamsi.org.au/sites/default/files/Node%203.1.1%20Ningaloo%20Reef%20Marine%20Park.pdf

CSIRO (2017) Environmental drivers shaping the Ningaloo shallow water fish communities. Presentation from Ningaloo Outlook Symposium 2017. https://research.csiro.au/ningaloo/research-outputs/

CSIRO (2017) Shallow Reefs. Presentation from Ningaloo Outlook Symposium 2017. https://research.csiro.au/ningaloo/research-outputs/

CSIRO (2017) Deep Reefs. Presentation from Ningaloo Outlook Symposium 2017. https://research.csiro.au/ningaloo/research-outputs/

Depczynski M, Heyward A, Wilson S, Holmes T, Case M, Colquhoun J, O'Leary RA, Radford B (2011). Methods of monitoring the health of benthic communities at Ningaloo – Coral & Fish recruitment. WAMSI Node 3 Project 3.1.2. Final Report to the Western Australian Marine Science Institution, Perth. 101 pp. http://www.wamsi.org.au/research-ningaloo/node-3-reports

EMSA, Manual on the applicability of oil spill dispersants, 2010, Vers 2, p 57.

Fingas, M. 2001. The Basics of Oil Spill Cleanup. Second Edition. Lewis Publishers, CRC Press LLC, Boca Raton, Florida. 233 p.

Fingas, M. 2011a. Physical Spill Countermeasures. *Oil Spill Science and Technology: Prevention, Response, and Cleanup*, edited by M. Fingas. Elsevier, Inc.

Fingas, M. 2011b. Weather Effects on Oil Spill Countermeasures. *Oil Spill Science and Technology: Prevention, Response, and Cleanup*, edited by M. Fingas. Elsevier, Inc.

Fitzpatrick B.M., Harvey E.S., Heyward A.J., Twiggs E.J. and Colquhoun J. (2012). Habitat Specialization in Tropical Continental Shelf Demersal Fish Assemblages. PLoS ONE 7(6): e39634. doi:10.1371/journal.pone.0039634 http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0039634

French-McCay DP, Horn M, Li Z, Jayko K, Spaulding ML, Crowley D & Mendelsohn D 2018, 'Modeling Distribution, Fate, and Concentrations of Deepwater Horizon Oil in Subsurface Waters of the Gulf of Mexico', in Oil Spill Environmental Forensics Case Studies, Elsevier, pp. 683-735.

Hutchins, J.B. (2004). Fishes of the Dampier Archipelago, Western Australia. *Records of the Western Australian Museum* Supplement No. 66: 343-398.

IPIECA, 2015, Dispersants: surface application, IOGP Report 532, p.43.

IPIECA, 2019, Source Control Emergency Response Planning Guide for Subsea Wells, IOGP Report 594, p.76.

ITOPF, 2014, Use of Dispersants to Treat Oil Spills, Technical Information Paper #4, p. 7.

ITOPF, 2014, Aerial Observation of marine oil spills, Technical Information Paper #1, p. 5

ITOPF, 2014, Use of skimmers in oil pollution response, Technical Information Paper #5, p. 9

Johnstone R.E, Burbidge A. H, Darnell J.C. (2013). Birds of the Pilbara Region, including seas and offshore islands, Western Australia: distribution, status and historical changes. Records of the Western Australian Museum, Supplement 78: 343-441. http://museum.wa.gov.au/sites/default/files/WAM_Supp78(B)_JOHNSTONEetal%20pp343-441_0.pdf

Joint Carnarvon Basin Operators (2012), 'Draft Joint Carnarvon Basin Operators North West Cape Sensitivity Mapping, Part A', Apache Energy Ltd, Woodside Energy Ltd, BHP Billiton and the Australian Marine Oil Spill Centre Pty Ltd (AMOSC).388 pp.Kobryn, H.T., Wouters, K.,

Keulen, M. Vand Langdon, M.W. (2011) Ningaloo Collaboration Cluster: Biodiversity and ecology of the Ningaloo Reef lagoon. Final Report No. 1c. http://www.ningaloo.org.au/www/en/NingalooResearchProgram/Publications/Cluster-finalreports.html

Kobryn, H.T., Wouters, K., Beckley, L.E. and T. Heege (2013). Ningaloo Reef: Shallow marine habitats mapped using a Hyperspectral sensor. PLoS ONE 8(7): e70105. doi:10.1371/journal.pone.0070105. http://dx.plos.org/10.1371/journal.pone.0070105

Markovina, K. (2015), 'Ningaloo Turtle Program Annual Report 2014-2015'. Department of Parks and Wildlife and the Ningaloo Turtle Program, Exmouth, Western Australia.

Markovina, K. (2016), 'Ningaloo Turtle Program Annual Report 2015-2016'. Department of Parks and Wildlife and the Ningaloo Turtle Program, Exmouth, Western Australia.

McLean, D. and Langlois, T. (2017) Fish and shark communities of the Pilbara: informing conservation and fisheries management. Proceedings from the Pilbara Marine Conservation Partnership Symposium 2016

Asquith, E. and Edwards, V., 1949. National Coal Board. *All England Law Reports*, *1*, p.747.

National Oceanic and Atmospheric Administration (NOAA) Characteristics of Response Strategies: A Guide for Spill Response Planning in Marine Environments, 2013, p.19 and p24.

National Offshore Petroleum Safety and Environmental Management Authority. 2012. Environment Plan Assessment Policy, N-04700-PL0930, Perth, WA.

National Offshore Petroleum Safety and Environmental Management Authority. 2012. Environment Plan Preparation Guidance Note, N-04700-GL0931, Perth, WA

National Offshore Petroleum Safety and Environmental Management Authority. 2012. Control Measures and Performance Standards, Guidance Note N04300-N0271, Perth, WA.

National Offshore Petroleum Safety and Environmental Management Authority. 2012. Oil Spill Contingency Planning, Guidance Note N-04700-GN0940, Perth, WA.

National Offshore Petroleum Safety and Environmental Management Authority. 2012. ALARP, Guidance Note N-04300-GN0166, Perth, WA.

National Offshore Petroleum Safety and Environmental Management Authority. 2016. ALARP, Guidance Note N-04750-GL1687 (DRAFT), Perth, WA.

Pendoley Environment (2005). Proposed Gorgon Development: Sea turtle Monitoring program results November 2004 to February 2005. Report for Chevron Australia.

Pendoley Environmental (2006). Pluto LNG Development Holden Beach Sea Turtle Habitat Use Survey(Conducted 3 January 2006). Report Prepared for Woodside Energy Limited.

Pendoley, K. (2009). Marine Turtle beach Survey. Onslow Mainland Area and Nearby Islands. Report to URS for the Chevron Wheatstone Project Team, 91 pp. https://www.chevronaustralia.com/Files/PDF/Wheatstone%20Draft%20EIS_ERMP%20Technical%20Appendices%20O8%20to%20O12%20and.pdf

Pitcher, C.R., Miller, M., Morello, E., Fry, G., Strzelecki, J., McLeod, I., Slawinski, D., Ellis, N., Thomson, D., Bearham, D., Keesing, J., Donovan, A., Mortimer, N. Babcock, R., Fromont, J, Gomez, O., Hosie, A., Hara, A., Moore, G., Morrison, S., Kirkendale, L., Whisson, C., Richards, Z., Bryce, M., Marsh, L., Naughton, K., O'Loughlin, M., O'Hara, T., Boddington, D., Huisman, J. (2016) Environmental Pressures: Regional Biodiversity — Pilbara Seabed Biodiversity Mapping & Characterisation. Final report, CSIRO Oceans & Atmosphere, Published Brisbane, March 2016, 62 pages

Quadrant Energy - Seabird Monitoring - Lowendal, Airlie, Serrurier islands - 1994 to present. Industry-Government Environmental Meta-database (IGEM). UUID: bdd428fe-cf24-4596-a822-cd578695ee16. Accessed June 2017

RPS-Bowman Bishaw Gorham (2005). Gorgon Development on Barrow Island, Technical Report, Marine Benthic Habitats. Prepared for Chevron Australia. https://www.chevronaustralia.com/docs/default-source/default-document-library/c8_marine_benthic_habitats.pdf?sfvrsn=0

Spence, A, McTaggart, A (2018) Defining response capability: effectiveness, limitations and determining ALARP. Interspill Conference, London 2018.

Stevens, J.D., Last, P.R., White, W.T., McAuley, R.B., Meekan, M.G. (2009) Diversity, abundance and habitat utilisation of sharks and rays. CSIRO Marine and Atmospheric Research. Final report to Western Australian Marine Science Institute

Surman CA and Nicholson LW (2015). Exmouth Sub basin Marine Avifauna Monitoring Program: Final Report. Unpublished report prepared for Apache Energy Ltd. by Halfmoon Biosciences. 188 pp.

Surman CA and Nicholson LW (2012) Monitoring of annual variation in seabird breeding colonies throughout the Lowendal Group of islands: 2012 Annual Report. Unpublished report prepared for Apache Energy Ltd. by Halfmoon Biosciences.

Watson, D.L., Harvey, E.S., Fitzpatrick, B.M. et al. Mar Biology (2010) Assessing reef fish assemblage structure: how do different stereo-video techniques compare? Vol 157 (6): pp 1237-1250. https://doi.org/10.1007/s00227-010-1404-x

Wadsworth, T, 1995, *Containment & Recovery of Oil Spills at Sea. Methods and limitations*, ITOPF, London, United Kingdom.

11 GLOSSARY & 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.
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.
Major Environment Event	The events with potential environment, reputation, social or cultural consequences of category C or higher (as per Woodside's operational risk matrix) which are evaluated against credible worst-case scenarios which may occur when all controls are absent or have failed.
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.

Term	Description / Definition
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.
Reliability	The probability that at any point in time a control measure will operate correctly for a further specified length of time.
Response strategy	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 – ≥100 ppb and entrained hydrocarbon concentrations – ≥500 ppb.
Environment that May Be Affected	The summary of quantitative modelling where the marine environment could be exposed to hydrocarbons levels exceeding hydrocarbon threshold concentrations.
Zone of Application	The zone in which Woodside may elect to apply dispersant. The zone is determined based on a range of considerations, such as hydrocarbon characteristics, weathering and metocean conditions. The zone is a key consideration in the Net Environmental Benefit Analysis for dispersant use.

11.2 Abbreviations

Abbreviation	Meaning
ABS	Above the seabed
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
ANZECC	Australian and New Zealand Environment and Conservation Council
APASA	Asia Pacific ASA
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AUV	Autonomous Underwater Vehicles
BAOAC	Bonn Agreement Oil Appearance Code
BOP	Blowout Preventer
CAR	Containment and Recovery
CERCLA	Environmental Response, Compensation, and Liability Act
CEDRE	Documentation, Research and Experimentation on Accidental Water Pollution
CF	Conditional Factor
CICC	Corporate Incident Coordination Centre
CMR	Commonwealth Marine Reserve
COP	Close of Play
DBCA	Western Australian Department of Biodiversity, Conservation and Attractions
DGV	Default Guideline Values
DM	Duty Manager
DoT	Western Australia Department of Transport
DP	Dynamically Positioned
DPaW	former Western Australian Department of Parks and Wildlife
D&C	Drilling and Completions
EMBA	Environment that May Be Affected
EROD	Ethoxyresorufin-O-Deethylase
FST	Functional Support Team
DWH	Deepwater Horizon
EMSA	European Maritime Safety Agency
EP	Environment Plan
Environment Regulations	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009
ESI	Environmental Sensitivity Index
ESD	Emergency Shut Down
ESP	Environmental Services Panel

Abbreviation	Meaning
FPSO	Floating Production Storage Offloading
FSRP	First Strike Response Plan
FWADC	Fixed Wing Aerial Dispersant Capability
GIS	Geographic Information System
GPS	Global Positioning System
GSI	Gonado-Somatic Index
HSP	Hydrocarbon Spill Preparedness
IAP	Incident Action Plan
ICC	Incident Coordination Centre
IGEM	Industry Government Environmental Meta-database
IMS	Invasive Marine Species
IMT	Incident Management Team
ISV	Installation Support Vessel
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
LMT	Long Term Monitoring
LSI	Liver Somatic Index
MARPOL	The International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78)
ME	Monitor and Evaluate
MODU	Mobile Offshore Drilling Unit
MoU	Memorandum of Understanding
NEBA	Net Environmental Benefit Analysis
NOAA	National Oceanic and Atmospheric Administration
NRDA	Natural Resource Damage Assessment
NRT	National Response Team
OILMAP	Oil Spill Model and Response System
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
OSRO	Oil Spill Response Organisation
OSTM	Oil Spill Trajectory Modelling
OWR	Oiled Wildlife Response

Abbreviation	Meaning
OWRP	Oiled Wildlife Response Plan
OWROP	Regional Oiled Wildlife Response Operational Plan
PAH	Polycyclic Aromatic Hydrocarbon
PAP	Petroleum Activities Program
PEARLS	People, Environment, Asset, Reputation, Livelihood and Services
PBA	Pre-emptive Baseline Areas
PPA	Priority Protection Area
PPB	Parts per billion
PPM	Parts per million
ROV	Remotely Operated Vehicle(s)
RPA	Response Protection Area
SCAT	Shoreline Contamination Assessment Techniques
SDA	Surface Dispersant Application
SDH	Sorbitol Dehydrogenase
SHC	Shoreline Clean-up
SIMAP	Integrated Oil Spill Impact Oil System
SSDI	Subsea Dispersant Injection
SFRT	Subsea First Response Toolkit
SME	Subject Matter Expert
SMP	Scientific monitoring program
SOP	Standard Operating Procedure
S&EM	Security and Emergency Management
SQGV	Sediment Quality Guideline Values
TRP	Tactical Response Plan
UAS	Unmanned Aerial Systems
UAV	Unmanned Aerial Vehicles
WAOWRP	West Australian Oiled Wildlife Response Plan
WEL	Woodside Energy Limited
WHA	World Heritage Area
Woodside	Woodside Energy Limited
WCC	Woodside Communication Centre
WWC	Wild Well Control
WCCS	Worst Case Credible Scenario
WMS	Woodside Management Systems
ZoA	Zone of Application

ANNEX A: NET ENVIRONMENTAL BENEFIT ANALYSIS DETAILED OUTCOMES

A NEBA has been conducted to assess the net environmental benefit of different response strategies to selected receptors in the event of a hydrocarbon spill from the PAP for Pyxis Condensate and Marine Diesel (representing WCCS). The complete list of potential receptor locations within the EMBA within the PAP is included in Section 6.7.2 and 6.7.3 of the EP. The locations used for the NEBA were limited to the identified sensitivities examined in the stochastic modelling because no RPA's were identified.

These include receptors which have potential for the following:

- Surface contact (>50 g/m^2)
- Shoreline accumulation (100g/m^2) at any time

The detailed NEBA assessment outcomes are shown below.

The full NEBA assessments are available at *Pre Spill NEBA – Pyxis Condensate* and *Pre Spill NEBA – Marine Diesel.*

Table A-1: NEBA assessment strategy recommendations for Pyxis Condensate

Receptor	Monitor and Evaluate	Containment and Recovery	Dispersant application: sub-sea	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	Well control and intervention
Commonwealth waters	Yes	No	No	No	No	No	No	No	Yes	No	No	Yes

Overall assessment

Sensitive receptor (Sites identified in EP)	Monitor and Evaluate	Containment and Recovery	Dispersant application: sub-sea	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	Well control and intervention
Is this response Practicable?	Yes	No	No	No	No	No	No	No	Yes	No	No	Yes
NEBA identifies Response potentially of Net Environmental Benefit?	Yes	No	No	No	No	No	No	No	Yes	No	No	Yes

Table A-2: NEBA assessment strategy recommendations for Marine Diesel

Receptor	Monitor and Evaluate	Containment and Recovery	Dispersant application: sub-sea	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	Well control and intervention
Commonwealth waters	Yes	No	No	No	No	No	No	No	Yes	No	No	Yes

Overall assessment

Sensitive receptor (Sites identified in EP)	Monitor and Evaluate	Containment and Recovery	Dispersant application: sub-sea	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	Well control and intervention
Is this response Practicable?	Yes	No	No	No	No	No	No	No	Yes	No	No	Yes
NEBA identifies Response potentially of Net Environmental Benefit?	Yes	No	No	No	No	No	No	No	Yes	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 > five 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 one–five 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 (< one 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.	Increase in duration of impact by several seasons (< one 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 one–five 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 > five years or unrecoverable	Increase in risk by two categories (e.g. Minor (E) to Major (A))

NOTE: 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 Operational Plan	Objectives	Activation triggers	Termination criteria
Operational Monitoring Operational Plan 2 (OM02) 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

Operational Monitoring Operational Plan	Objectives	Activation triggers	Termination criteria
Operational Monitoring Operational Plan 3 (OM03) 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 <u>Operational Plan</u>	Objectives	Activation triggers	Termination criteria
<u>Operational Monitoring Operational Plan 4 (OM04)</u> 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 service providers who hold a standby contract for SMP (SMP Standby Contractor) via the Woodside Environmental Services Panel (ESP). In the event that additional resources are required, other consultancy capacity within the Woodside ESP will be used (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 (SMP Liaison Officer)	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 lead in-field by a party chief).

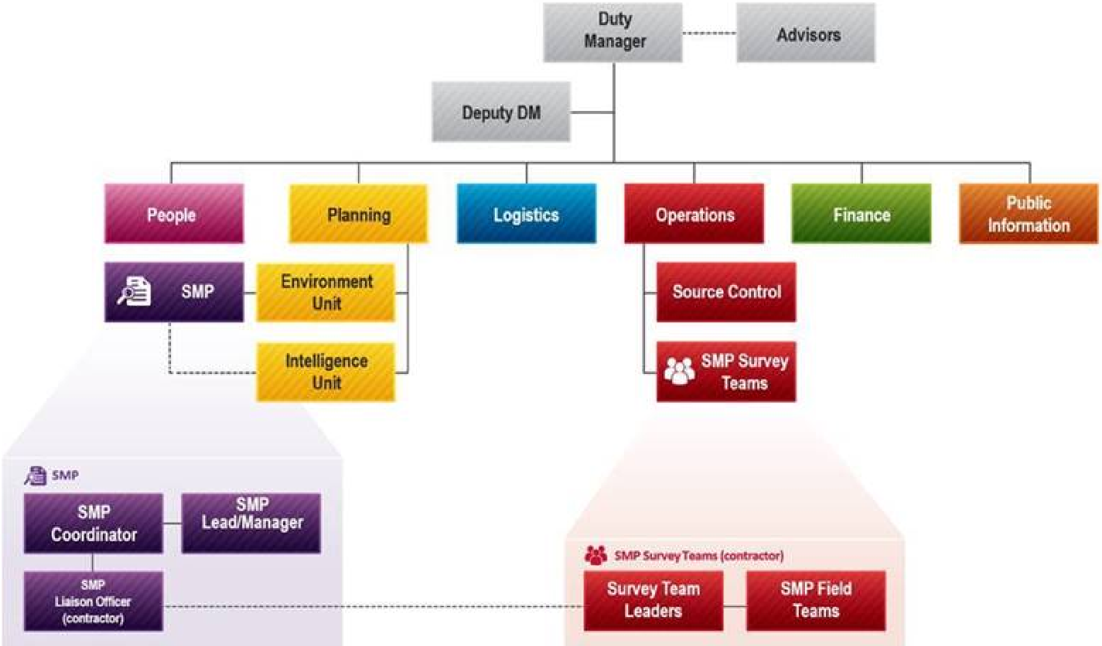


Figure C-1: Woodside Oil Spill Scientific Monitoring Program Delivery Team and Linkage to Incident Control Centre (ICC) organisational structure.

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[4]) 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/m^2 surface, five ppb for entrained/dissolved hydrocarbons and ≥one g/m^2 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[5]) 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/m^2 surface, five ppb for entrained/dissolved hydrocarbons and ≥one g/m^2 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	SM04 will be activated in the event of a Level two or three 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.

[4] NOPSEMA (2019) Bulletin #1 – Oil spill modelling – April 2019, https://www.nopsema.gov.au/assets/Bulletins/A652993.pdf

[5] 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
	• 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.	• Operational monitoring identified shoreline potential contact of hydrocarbons (at or above 0.5 g/m^2 surface, five ppb for entrained/dissolved hydrocarbons and ≥1 g/m^2 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/m^2 surface, 5 ppb for entrained/dissolved hydrocarbons and ≥1 g/m^2 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/m^2 surface, five ppb for entrained/dissolved hydrocarbons and ≥1 g/m^2 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/m^2 surface, ≥5 ppb for entrained/dissolved hydrocarbons and ≥1 g/m^2 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), gonadosomatic 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 (≥0.5 g/m^2 surface and ≥five 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 FSRP for the PAP. 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), AMPs, 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.

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, AMPs 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 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 guidelines. 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), AMPs, 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).

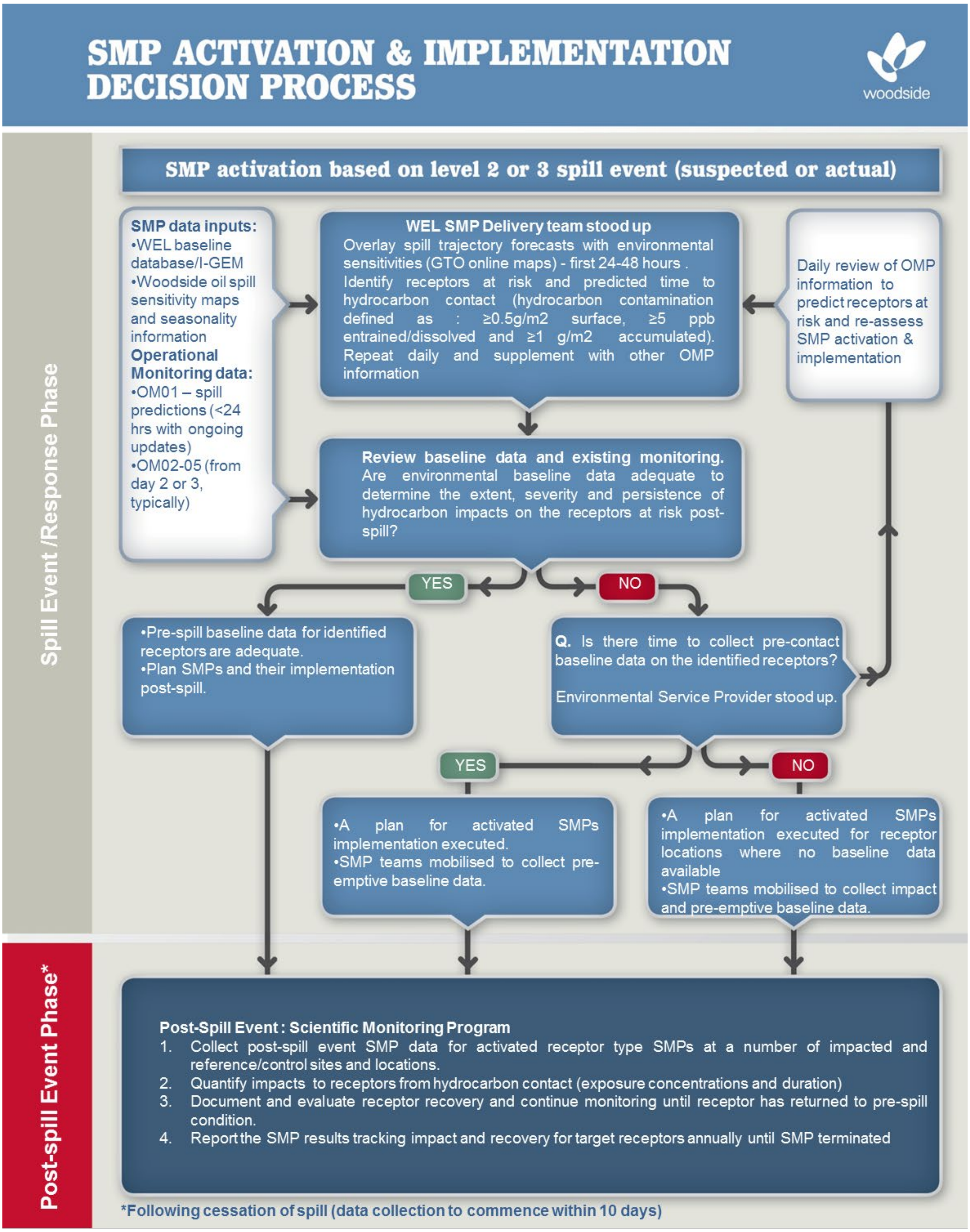


Figure C-2: Activation and Implementation Decision-tree for Oil Spill Environmental Monitoring

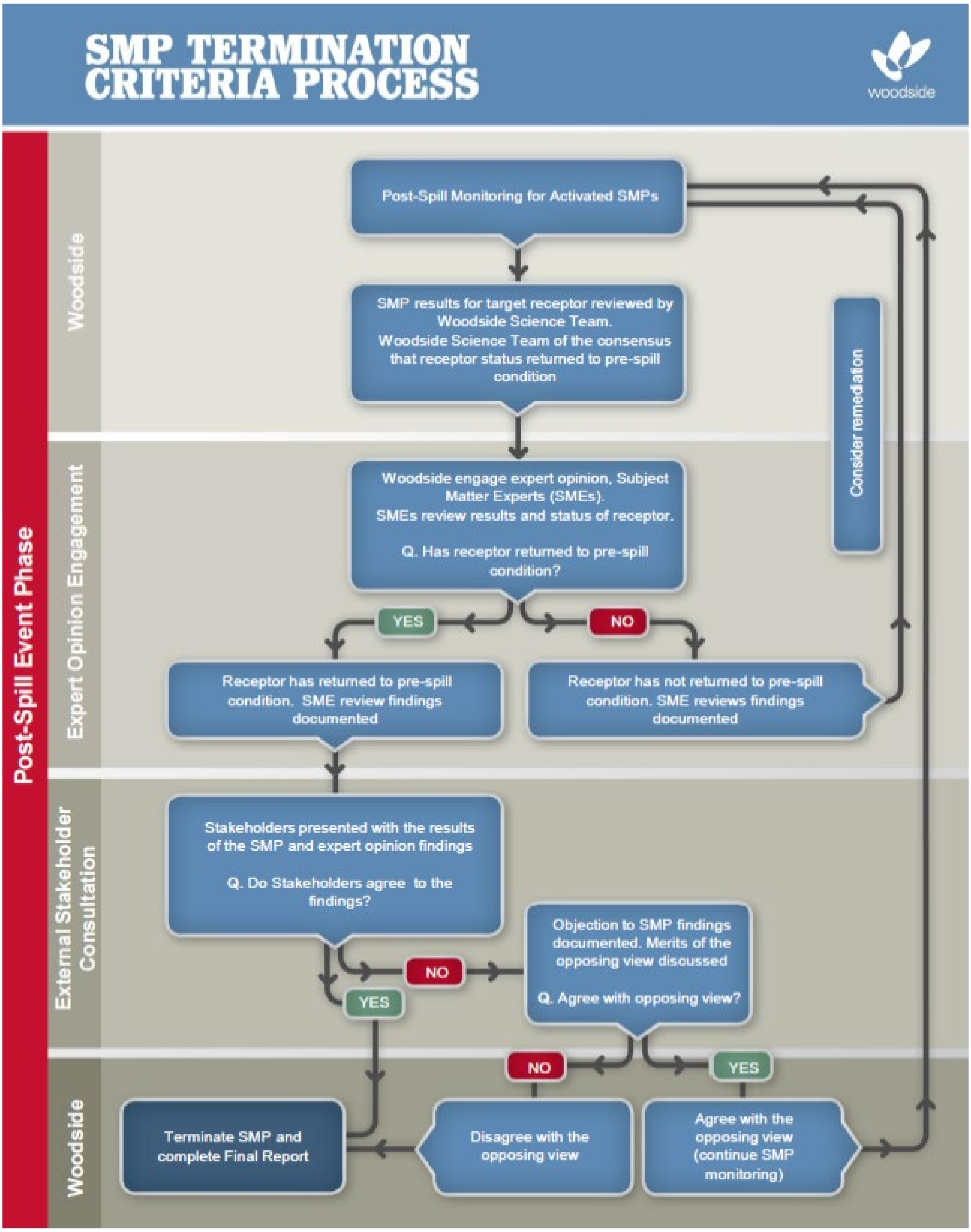


Figure C-3: Termination Criteria Decision-tree for Oil Spill Environmental Monitoring

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 the contracted SMP standby, 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 Meta-database, IGEM) was established. IGEM is a collaboration comprising oil and gas operators (including Woodside), government and research agencies and other organisations. The key objective of IGEM is for participating organisations to have the ability to identify quantitative marine baseline datasets available for species and habitats via a geo-spatially referenced metadata database. It provides members the ability to enter, view and filter metadata records on baseline studies as well as customise and generate report outputs. IGEM aims to provide a foundational baseline framework so industry and government can access the same knowledge base to understand baseline data in the event of an unplanned hydrocarbon release.

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, IGEM 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.

ANNEX D: SCIENTIFIC 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 Spill EMBAs Scenario 1 and 2

Receptors to be Monitored	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 State Maine Park)	Fantome Shoals	Adele Island	Lacepede Islands	Montebello Islands (including State Marine Park)	Lowendal Islands (including State Nature Reserve)	Barrow Island (including State Nature Reserves, State Marine Park and Marine Management Area)	Muiron Islands (WHA, State Marine Park)	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
Receptor Areas - Potential Impact and Reference Scientific Monitoring Sites (marked X)																																									
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	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	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	X	X	X
Mangroves and Saltmarsh	SM04																											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	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	
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	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	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 PAP

Major Baseline	Proposed Scientific monitoring operational plan and Methodology	Rankin Bank	Montebello AMP	Ningaloo and Muiron Islands[6]
Benthic Habitat (Coral Reef)	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. Glomar Shoals and Rankin Bank Environmental Survey Report, 2013, quantitatively surveyed benthic habitats and communities. AIMS report to Woodside. Scientific Publication - Biodiversity and spatial patterns of benthic habitat and associated demersal fish communities at two tropical submerged reef ecosystems, 2018. 2. Rankin Bank Environmental Survey Extension, 2014, Habitat assessment of an area southeast of Rankin Bank. 3. Glomar Shoals and Rankin Bank surveys, 2017. GWF-2 Monitoring Programme. Quantitatively surveyed benthic habitats and communities. 4. Temporal Studies survey of Rankin Bank and Glomar Shoals, 2018.	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.	1. AIMS/DBCA 2014 Baseline Ningaloo and Muiron Islands Survey – repeat and expansion on the LTM (Co-funded survey: Woodside and AIMS). 2.Australian Institute of Marine Science – CReefs: Ningaloo Reef Biodiversity Expeditions (2008-2010). 3.DBCA LTM Ningaloo Reef programme: 1991, 1994, 1998, 1999, 2001, 2005, 2006, 2010, 2011, 2012 and 2015. 4.(WAMSI LTM Study:) Ningaloo Research node: 2009 -10 over the length of Ningaloo reef system (with a focus on coral and fish recruitment). 5.Ningaloo Outlook (CSIRO) - Shallow and Deep Reefs Program (2019). 6.Ningaloo Collaboration Cluster: Habitats of the Ningaloo Reef and adjacent coastal areas determined through hyperspectral imagery. 7.AIMS Long Term Monitoring (LTM) Ningaloo Reef programme: 1995 and 2002. 8.Le Nohaic et al. 2017.Marine heatwave causes unprecedented Regional Mass Bleaching in NW Australia Coral Bay Location).
		Methods:		
		1. Towed video transects, photo quadrats using towed video system. 2. Towed video transects, photo quadrats using towed video system. 3. Towed video transects, photo quadrats using towed video system. 4. Towed video transects, photo quadrats using towed video system.	1.ROV Transects. 2. Benthic habitat mapping, multibeam acoustic swathing. 3. ROV video.	1. LTM sites, transects, diver-based video quadrat. 2. LTM transects, diver based (video) photo quadrats, specimen collection 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 quadrat. 8. Intertidal walks and snorkeling transects with photo quadrats. In situ water temperature loggers deployed for survey period.

[6] Ningaloo AMP contacted within 10 days so available baseline for Ningaloo presented

Major Baseline	Proposed Scientific monitoring operational plan and Methodology	Rankin Bank	Montebello AMP	Ningaloo and Muiron Islands[6]
		References and Data:		
		1. AIMS 2014b and Abdul Wahab et al., 2018. DATAHOLDER: AIMS. 2. AIMS 2014c. DATAHOLDER: AIMS. 3. AIMS. 2018 DATAHOLDER: AIMS 4. AIMS 2018. DATAHOLDER: AIMS	1. Advisian 2019 2. Keesing 2019 3. McLean et al. 2019	1. AIMS 2014a. DATAHOLDER: AIMS. 2. AIMS (2010) - http://www.aims.gov.au/creefs 3. DBCA unpublished data. DATAHOLDER: DBCA 4. Depczynski et al. 2011. DATAHOLDER: AIMS, DBCA and WAMSI. 5. CSIRO 2019 – Ningaloo Outlook Program 6. Murdoch University - Kobryn et al 2011 and Keulen and Langdon 2011. 7. AIMS unpublished data. DATAHOLDER: AIMS. 8. Le Nohaic et al., 2017
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. Glomar Shoals and Rankin Bank Environmental Survey Report, 2013, quantitatively surveyed benthic habitats and communities. AIMS report to Woodside. Scientific Publication - Biodiversity and spatial patterns of benthic habitat and associated demersal fish communities at two tropical submerged reef ecosystems, 2018. 2. Rankin Bank Environmental Survey Extension, 2014, Habitat assessment of an area southeast of Rankin Bank. 3. Glomar Shoals and Rankin Bank surveys, 2017. GWF-2 Monitoring Programme. Quantitatively surveyed benthic habitats and communities. 4. Temporal Studies survey of Rankin Bank and Glomar Shoals, 2018.	N/A – see table D – 1	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).
		Methods:		
		1. Towed video transects, photo quadrats using towed video system. 2. Towed video transects, photo quadrats using towed video system. 3. Towed video transects, photo quadrats using towed video system. 4. Towed video transects, photo quadrats using towed video system	N/A – see table D – 1	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.
		References and Data:		

Major Baseline	Proposed Scientific monitoring operational plan and Methodology	Rankin Bank	Montebello AMP	Ningaloo and Muiron Islands[6]
		1. AIMS 2014b and Abdul Wahab et al., 2018. DATAHOLDER: AIMS. 2. AIMS 2014c. DATAHOLDER: AIMS. 3. AIMS. 2018 DATAHOLDER: AIMS 4. AIMS 2018. DATAHOLDER: AIMS	N/A – see table D – 1	1. Cassata and Collins 2008. DATAHOLDER: Curtin University – Applied Geology. 2. CSIRO – Ningaloo Outlook Program 3. Murdoch University - Kobryn et al 2011 and Keulen and Langdon 2011. 4. AIMS (2010) - http://www.aims.gov.au/creefs
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. Glomar Shoals and Rankin Bank Environmental Survey Report, 2013, quantitatively surveyed benthic habitats and communities. AIMS report to Woodside. Scientific Publication - Biodiversity and spatial patterns of benthic habitat and associated demersal fish communities at two tropical submerged reef ecosystems, 2018. 2. Rankin Bank Environmental Survey Extension, 2014, Habitat assessment of an area southeast of Rankin Bank. 3. Glomar Shoals and Rankin Bank surveys, 2017. GWF-2 Monitoring Programme. Quantitatively surveyed benthic habitats and communities. 4. Temporal Studies survey of Rankin Bank and Glomar Shoals, 2018.	N/A – see table D – 1	WAMSI 2007 deep-water Ningaloo benthic communities' study, Colquhoun and Heyward (2008). CSIRO/BHP Ningaloo Outlook Program - Deep reef themes. 2019
		Methods:		
		1. Towed video transects, photo quadrats using towed video system. 2. Towed video transects, photo quadrats using towed video system. 3. Towed video transects, photo quadrats using towed video system. 4. Towed video transects, photo quadrats using towed video system	N/A – see table D – 1	Towed video and benthic sled (specimen sampling). Side-scan sonar and AUV transects.
		References and Data:		
		1. AIMS 2014b and Abdul Wahab et al., 2018. DATAHOLDER: AIMS. 2. AIMS 2014c. DATAHOLDER: AIMS. 3. AIMS. 2018 DATAHOLDER: AIMS 4. AIMS 2018. DATAHOLDER: AIMS	N/A – see table D – 1	Colquhoun and Heyward (eds) 2008. DATAHOLDER: WAMSI, AIMS. CSIRO – Ningaloo Outlook
	SM04	Studies:		

Major Baseline	Proposed Scientific monitoring operational plan and Methodology	Rankin Bank	Montebello AMP	Ningaloo and Muiron Islands[6]
Mangroves and Saltmarsh	Aerial photography and satellite imagery will be used in conjunction with field surveys to map the range and distribution of mangrove communities.	N/A – See Table D-1	N/A – see table D – 1	Atmospheric correct and land cover classification, NW Cape. Woodside hold Rapid Eye imagery of the Ningaloo Reef and coastal area. Hyperspectral survey (2006) of Ningaloo Reef and coastal area (not yet analysed for Mangroves). North West Cape sensitivity mapping 2012 included Mangrove Bay. Global mangrove distribution as mapped by the USGS and located on UNEP's Ocean Data viewer.
		Methods:		
		N/A – See Table D-1	N/A – see table D – 1	Modular Inversion Program. May 2017 Rapid Eye imagery – High resolution satellite imagery from October/November/December 2011. Remote sensing – acquisition of HyMap airborne hyperspectral imagery and ground truthing data collection. Reconnaissance surveys of the shorelines of the North West Cape and Muiron Islands. Remote sensing study of global mangrove coverage.
		References and Data:		
		N/A – See Table D-1	N/A – see table D – 1	EOMAP, 2019 DATAHOLDER: Woodside. AAM 2014. Dataholder: Woodside Kobryn et al. 2013. DATAHOLDER: Murdoch University, AIMS; Woodside. Joint Carnarvon Basin Operators, 2012. DATAHOLDER: Woodside Apache Energy Ltd. http://data.unep-wcmc.org/
Seabirds	SM05 Visual counts of breeding seabirds, nest counts, intertidal bird counts at high tide.	Studies:		
		N/A – See Table D-1	Present, in open water, no breeding habitat.	1. LTM Study of marine and shoreline birds: 1970-2011. 2. LTM of shorebirds within the Ningaloo coastline (Shorebirds 2020). 3. Exmouth Sub-basin Marine Avifauna Monitoring Program (Quadrant Energy/Santos). 4. Seabird and Shorebird baseline studies, Ningaloo Region – Report on January 2018 bird surveys. 5.Wedge-tailed shearwater foraging behaviour in the Exmouth Region – Final Report
		Methods:		

Major Baseline	Proposed Scientific monitoring operational plan and Methodology	Rankin Bank	**Montebello AMP**	Ningaloo and Muiron Islands[6]
		N/A – See Table D-1	N/A	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 2,500 km2 area of ocean adjacent to the Exmouth Sub-basin. 4.Shorebird counts, Shearwater Burrow Density. 5. Tagging (GPS & Satellite).
		References and Data:		
		N/A – See Table D-1	N/A	1. Johnstone et al. 2013. DATAHOLDER: WA MUSEUM. AMOSC/DBCA (DPaW) 2014. 2. BirdLife Australia 2017 Dataholder: Woodside 3. Santos – Report. 4. BirdLife Australia: Dataholder. Woodside 5. Cannel et al. 2019 Dataholder. UWA
Turtles	SM06 Beach surveys (recording species, nests, and false crawls).	Studies:		
		N/A – See Table D-1	Present, in open water, no nesting habitats.	1. Ningaloo LTM turtle program was established in 2002, with the most recent survey during the 2016-2017 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 Ningaloo Coast: Final Report (2019). 5. Spatial and temporal use of inter-nesting habitat by sea turtles along the Murion Islands and Ningaloo Coast – Final Report (2019).
		Methods:		

Major Baseline	Proposed Scientific monitoring operational plan and Methodology	Rankin Bank	Montebello AMP	Ningaloo and Muiron Islands[6]
		N/A – See Table D-1	N/A	1. Beach surveys, track counts, best location, mortality counts. 2. 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. On-beach monitoring and aerial surveys. 5. Tagging (satellite transmitter), analysis of internesting, migration and foraging grounds movements and behaviour.
		References/Data:		
		N/A – See Table D-1	N/A	1. Markovina, K, 2017. DATAHOLDERS: DBCA. Reports available at http://www.ningalooturtles.org.au/media_reports.html 2. Santos – Report. 3. Woodside (Author Keely Markovina). 4.Rob et al. 2019 DBCA Dataholder. 5.Tucker et al. 2019 DBCA Dataholder.
		Studies:		

Major Baseline	Proposed Scientific monitoring operational plan and Methodology	Rankin Bank	Montebello AMP	Ningaloo and Muiron Islands[6]
Fish	Baited Remote Underwater Video Stations (BRUVS), Visual Underwater Counts (VUC), Diver Operated Video (DOV).	1. Glomar Shoals and Rankin Bank Environmental Survey Report, 2013, quantitatively surveyed benthic habitats and communities. AIMS report to Woodside. Scientific Publication - Biodiversity and spatial patterns of benthic habitat and associated demersal fish communities at two tropical submerged reef ecosystems, 2018. 2. Rankin Bank Environmental Survey Extension, 2014, Habitat assessment of an area southeast of Rankin Bank. 3. Glomar Shoals and Rankin Bank surveys, 2017. GWF-2 Monitoring Programme. Quantitatively surveyed benthic habitats and communities. 4. Temporal Studies survey of Rankin Bank and Glomar Shoals, 2018.	1. CSIRO – Fish Diversity. 2. Fish species richness and abundance.	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. 4. Pilbara Marine Conservation Partnership Stereo BRUVS 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 3. 8. Ningaloo Outlook (CSIRO) - Shallow and Deep Reefs Program
		Methods:		
		1. BRUVs. 2. BRUVs. 3. BRUVs. 4. BRUVs.	1. Semi V Wing trawl net or an epibenthic sled. 2. ROV Video.	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. 5. Underwater visual census. 6. Diver operated video. 3. 7. Diver UVS.
		References/Data:		

Major Baseline	Proposed Scientific monitoring operational plan and Methodology	Rankin Bank	Montebello AMP	Ningaloo and Muiron Islands[6]
		1. AIMS 2014b and Abdul Wahab et al., 2018. DATAHOLDER: AIMS. 2. AIMS 2014c. DATAHOLDER: AIMS. 3. AIMS. 2018 DATAHOLDER: AIMS 4. AIMS 2018. DATAHOLDER: AIMS	1. Keesing 2019. 2. McLean et al. 2019.	1. AIMS 2014. DATAHOLDER: AIMS/Woodside. 2. Fitzpatrick et al. 2012. DATAHOLDERS: WAMSI, AIMS. 3. DBCA unpublished data. DATAHOLDER: DBCA/AIMS. 4. CSIRO Data DATAHOLDER: CSIRO Data Centre (data-requestes-hf@csiro.au). 5. Stevens, J.D: ast, P.R., White, W.T., McAuley, R.B., Meekan, M.G. 2009. 6. WAMSI unpublished data DATAHOLDER: AIMS (m.case@aims.gov.au). 7. WAMSI DATAHOLDER: Ben Fitzpatrick (whaleshark@oceanwise.com.au). 8. CSIRO – Ningaloo Outlook 2019.

References

Advisian (2019) Montebello Marine Park Benthic Habitat Survey ROV Analysis of the Scarborough Pipeline Route. Report Prepared for Woodside Energy Ltd. 183 pp.

Astron Environmental Service (2014). Exmouth Islands Turtle Monitoring Program January 2014 Field

AAM (2014), RapidEye satellite images were captured along the coastline of Central/ Northern, Western Australia in between September 2011 to April 2014.

Abdul Wahab, M, A., Radford, B., Cappo, C., Colquhoun, J., Stowar, M., Depczynski, M., Miller, K and Heyward, A. (2018). Biodiversity and spatial patterns of benthic habitat and associated demersal fish communities at two tropical submerged reef ecosystems. *Coral Reefs*. Vol. 37, Issue 2, pp. 327-343. https://doi.org/10.1007/s00338-017-1655-9

AIMS (2010) Reefs: Ningaloo Reef Biodiversity Expeditions (2008-2010). http://www.aims.gov.au/creefs

AIMS (2014a). AIMS 2013 Biodiversity Survey of Glomar Shoal and Rankin Bank. Report prepared by the Australian Institute of Marine Science for Woodside Energy Ltd. Australian Institute of Marine Science, Townsville. October 2014 Rev 1,153pp.

AIMS (2014b). AIMS 2014 Extended Benthic Models and Habitat Maps of Rankin Bank. Report prepared by the Australian Institute of Marine Science for Woodside Energy Ltd. Australian Institute of Marine Science, Townsville. December 2014 Rev 0 (43pp.).

AIMS (2014c). Ningaloo and Outer Shark Bay Baseline Survey 2014. AIMS Field Report for Woodside. 21 pp. Co-funded Baseline Surveys (November-December 2014).

AIMS (2017b) Juvenile fish recruitment surveys, Ningaloo Reef, Western Australia (WAMSI Node 3 Project 3.1.2). https://data.gov.au/dataset/juvenile-fish-recruitment-surveys-ningaloo-reef-western-australia-wamsi-node-3-project-3-1-2

AIMS (2018) Greater Western Flank-2 Environmental Monitoring Report: Report prepared by the Australian Institute of Marine Science for Woodside Energy Ltd. Australian Institute of Marine Science, Townsville. Rev B April 2019.

AMOSC/DPAW (2014). Inter-Company Oil Spill Wildlife Response Plan – Pilbara region. pp. 272 http://www.dpaw.wa.gov.au/images/documents/conservation-management/marine/wildlife/PROWRP_20141103.pdf

BirdLife Australia (2018) Seabird and Shorebird Baseline Studies, Ningaloo Region – Report on January 2018 bird surveys. Interim Report for Woodside Energy Ltd.

BirdLife Australia (2017) Shorebirds 2020 programme – Data Extraction (1993-2017). http://www.birdlife.org.au/projects/shorebirds-2020

Cannell B, Hamilton S and Driessen (2019). Wedge-tailed Shearwater foraging behaviour in the Exmouth Region. Final Report. Report prepared for Woodside Energy Limited. The University of Western Australia and BirdLife, pp.36.

Cassata, L. and L.B. Collins (2008). Coral reef communities, habitats and substrates in and near Sanctuary Zones of Ningaloo Marine Park. Journal of Coastal Research Vol. 24 (1): 139-51.

Colquhoun J and Heyward A. (eds) (2008). WAMSI Node 3 Project 1 Subproject 3.1.1 Deepwater Communities at Ningaloo Marine Park: Ningaloo Reef Marine Park Deepwater Benthic Biodiversity Survey Annual Report 2007. 209 pp. http://www.wamsi.org.au/sites/default/files/Node%203.1.1%20Ningaloo%20Reef%20Marine%20Park.pdf

CSIRO (2017) Environmental drivers shaping the Ningaloo shallow water fish communities. Presentation from Ningaloo Outlook Symposium 2017. https://research.csiro.au/ningaloo/research-outputs/

CSIRO (2017) Shallow Reefs. Presentation from Ningaloo Outlook Symposium 2017. https://research.csiro.au/ningaloo/research-outputs/

CSIRO (2017) Deep Reefs. Presentation from Ningaloo Outlook Symposium 2017. https://research.csiro.au/ningaloo/research-outputs/

Depczynski M, Heyward A, Wilson S, Holmes T, Case M, Colquhoun J, O'Leary RA, Radford B (2011). Methods of monitoring the health of benthic communities at Ningaloo – Coral & Fish recruitment. WAMSI Node 3 Project 3.1.2. Final Report to the Western Australian Marine Science Institution, Perth. 101 pp. http://www.wamsi.org.au/research-ningaloo/node-3-reports

EOMAP. (2017). Atmospheric correction and land cover classification, NW Cape. Report prepared for Woodside Energy Ltd.

Fitzpatrick B.M., Harvey E.S., Heyward A.J., Twiggs E.J. and Colquhoun J. (2012). Habitat Specialization in Tropical Continental Shelf Demersal Fish Assemblages. PLoS ONE 7(6): e39634. doi:10.1371/journal.pone.0039634 http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0039634

Hutchins, J.B. (2004). Fishes of the Dampier Archipelago, Western Australia. *Records of the Western Australian Museum* Supplement No. 66: 343-398.

Johnstone R.E, Burbidge A. H, Darnell J.C. (2013). Birds of the Pilbara Region, including seas and offshore islands, Western Australia: distribution, status and historical changes. Records of the Western Australian Museum, Supplement 78: 343-441. http://museum.wa.gov.au/sites/default/files/WAM_Supp78(B)_JOHNSTONEetal%20pp343-441_0.pdf

Joint Carnarvon Basin Operators (2012). Draft Joint Carnarvon Basin Operators North West Cape Sensitivity Mapping. Part A. (Apache Energy Ltd, Woodside Energy Ltd, BHP Billiton and the Australian Marine Oil Spill Centre Pty Ltd (AMOSC).

Keesing, J., K. (2019). Benthic habitats and biodiversity of the Dampier Archipelago and Montebello Australian Marine Parks. Report of the Director of Nationals Parks. CSIRO, Australia

Keulen, M. Vand Langdon, M.W. (2011) Ningaloo Collaboration Cluster: Biodiversity and ecology of the Ningaloo Reef lagoon. Final Report No. 1c. http://www.ningaloo.org.au/www/en/NingalooResearchProgram/Publications/Cluster-finalreports.html

Kobryn, H.T., Wouters, K., Beckley, L.E. and T. Heege (2013). Ningaloo Reef: Shallow marine habitats mapped using a Hyperspectral sensor. PLoS ONE 8(7): e70105. doi:10.1371/journal.pone.0070105. http://dx.plos.org/10.1371/journal.pone.0070105

Le Noahic, M., Cornwall, M. E., Comeau, S., McCulloch, M. T. and Schoepf, V. (2017). Marine heatwave causes unprecedented regional mass bleaching of thermally resistant corals in northwestern Australia. *Scientific Reports,* vol. 7, doi: 10.1038/s41598-017-14794-y

Markovina, K. (2017), 'Ningaloo Turtle Program Annual Report 2016-2017'. Department of Parks and Wildlife and the Ningaloo Turtle Program, Exmouth, Western Australia.

McLean, D., Taylor M., Vaughan B. (2019) Marine Communities of the Pluto Trunkline within the Montebello Marine Park. Report prepared for Woodside Energy Ltd. Australian Institute of Marine Science, Perth. 45 pp.

Rob D, Barnes P, Whiting S, Fossette S, Tucker T and Mongan T (2018) Turtle activity and nesting on the Muiron Islands and Ningaloo Coast: Final Report 2018, Ningaloo Turtle Program. Report prepared for Woodside Energy Limited. Department of Biodiversity, Conservation and

Stevens, J.D., Last, P.R., White, W.T., McAuley, R.B., Meekan, M.G. (2009) Diversity, abundance and habitat utilisation of sharks and rays. CSIRO Marine and Atmospheric Research. Final report to Western Australian Marine Science Institute

Tucker T, Fossette S, Whiting S, Rob, D and Barnes P (2018) Spatial and temporal use of inter-nesting habitat by sea turtles along the Muiron Islands and Ningaloo Coast. Final Report. Report prepared for Woodside Energy Limited. Department of Biodiversity, Conservation and Attractions, Kensington, pp.77.

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 & Glomar Shoals
Barrow and Lowendal Islands
Pilbara Islands - Southern Island Group
Montebello Is - Stephenson Channel Nth
Montebello Is Champagne Bay & Chippendale channel
Montebello Is - Claret Bay
Montebello Is - Hermite/Delta Is Channel
Montebello Is - Hock Bay
Montebello Is - North & 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 & 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

APPENDIX F: STAKEHOLDER CONSULTATION

Woodside Consultation Material

Consultation with all relevant stakeholders – 15 April 2018

Woodside sent the email below and consultation Information Sheet to all relevant stakeholders.

Dear Stakeholder

Woodside is planning to undertake drilling, construction, installation and pre-commissioning activities in Production Licence WA-34-L in Commonwealth waters, commencing in Q1 2020 pending approvals, vessel availability and weather constraints.

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 overview

Activity purpose:	Support ongoing production from the Pluto LNG Project.		
Activity:	• Drilling two new and two in-fill production wells and installation of subsea structures. • If required, Woodside may also need to intervene, workover or re-drill existing Pluto and Xena production wells within Production Licence WA-34-L.		
Activity location:	175 km North West of Dampier, Western Australia.		
Well locations*:	PYA01 well	19°49’40.371” S	115°10’34.956” E
	PL-PYA02 well	19°52’34.908” S	115°09’00.666” E
	XNA02 well	19°57’50.131” S	115°13’3.498” E
	XNA03 well	19°57’48.055” S	115°12’28.440” E
Approximate water depth:	178 m to 985 m		
Estimated start date:	From Q1 2020		
Approximate duration:	• Production wells – up to 70 days per well • Installation of subsea infrastructure and pre-commissioning – cumulative duration of approximately 240 days		
Vessel/rig:	• Moored semi-submersible mobile offshore drilling unit (MODU), a dynamically positioned drill ship or a dynamically positioned MODU • Subsea Installation vessel • Light well intervention vessel • Support vessels, including anchor handling vessels, heavy lift vessels and activity support vessels		
Exclusion zone:	• Petroleum safety zones of 500 m will be in place around the MODU and installation vessel for the duration of activities • Commercial fishers are permitted to use but should take care, when entering the wider Operational Areas, these being: • Dynamically positioned MODU/drillship – 500 m radius from each well centre		

	• Moored MODU – 4000 m radius from each well centre • Installation vessel – 1500 m radius around subsea locations

* The exact location of XNA02 and XNA03 production wells are to be determined and remain subject to change. Relevant stakeholders will be advised of these locations once planning is finalised.

Your feedback

Your feedback on the proposed activity and our response will be included in an Environment Plan for consideration by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA), as is required under the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

Please note under new public transparency arrangements being implemented by NOPSEMA, the Environment Plan for this activity will be published in full following acceptance by the Authority. Please advise Woodside if you do not wish any part of your feedback to be published and we will ensure it is included in the sensitive information part of the Environment Plan. The information received will form part of the EP assessment however it will not be released publicly and will remain confidential to NOPSEMA throughout.

Please provide your views by close of business **15 May 2019** to allow us sufficient time to inform our planning for the proposed activity. Comments can be made by email, letter or by phone.

Regards

[redacted]
Corporate Affairs Adviser | Corporate Affairs
Woodside Energy Ltd

Woodside consultation Information Sheet

Woodside

STAKEHOLDER CONSULTATION
INFORMATION SHEET

April 2019

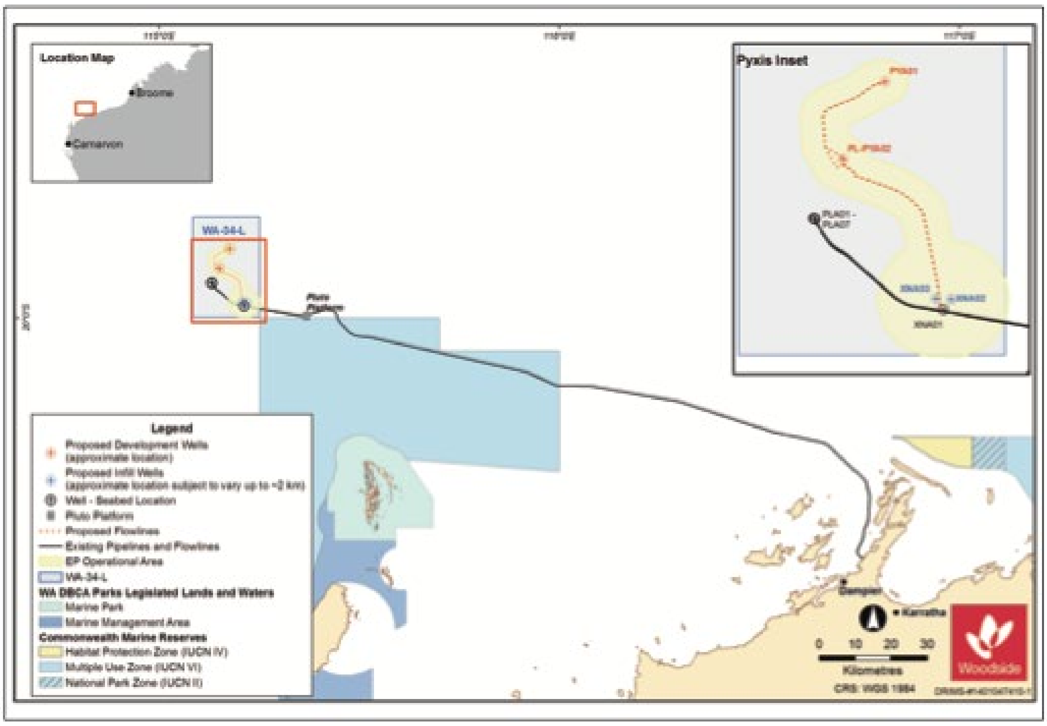
WA-34-L PYXIS DRILLING AND SUBSEA INSTALLATION

CARNARVON BASIN, NORTH-WEST AUSTRALIA

Woodside is planning to undertake drilling, construction, installation and pre-commissioning activities in Production Licence WA-34-L in Commonwealth waters to support ongoing production from the Pluto LNG Project, commencing in Q1 2020 pending approvals, vessel availability and weather constraints.

Two new and two in-fill production wells are proposed, as well as the installation of subsea structures, to complement production from existing wells at the Pluto and Xena fields. If required, Woodside may also need to intervene, workover or re-drill existing Pluto and Xena production wells within Production License WA-34-L.

Woodside is operator of Pluto LNG with a 90% interest, with Kansai Electric and Tokyo Gas each holding a 5% interest in the project.



1 WA-34-L Pyxis Drilling and Subsea Installation | Carnarvon Basin, North-West Australia | April 2019

WA-34-L Pyxis Drilling and Subsea Installation	
Earliest expected commencement date	+ Q1 2020 pending approvals, vessel availability and weather constraints
Approximate estimated duration	+ 70 days per well + Cumulative 240 days for installation and pre-commissioning
Water depth	+ 170 m to 990 m
Project vessels	+ Moored semi-submersible mobile offshore drilling unit (MODU), a dynamically positioned drill ship or a dynamically positioned MODU + Subsea Installation vessel + Light well intervention vessel + Support vessels, including anchor handling vessels, heavy lift vessels and activity support vessels
Distance to nearest port	+ 175 km north west of Dampier
Distance to nearest marine park	+ ~46 km north west of the Montebello Islands Marine Park (WA) + ~5 km north west of Montebello Marine Park - Multiple Use Zone (Cwlth)

Proposed activity

Woodside is proposing to develop and produce hydrocarbons from the Pyxis, Pluto and Xena fields to support ongoing production from the Pluto LNG Project.

The proposed activities comprise the drilling of two new and two in-fill wells, which will be tied-in to existing subsea infrastructure via subsea Xmas trees, flexible flowlines, production manifolds and service umbilicals. The proposed activities are planned to commence in Q1 2020, starting with the Pyxis wells and related subsea installation.

Xena-related drilling and subsea installation activities will follow at a later date and contingent intervention, workover or re-drill activities on existing production wells, if required. Relevant stakeholders will be advised prior to the commencement of activities if this work is required.

Drilling of the four production wells is expected to take approximately 70 days per well to complete. Installation of subsea infrastructure and pre-commissioning will commence on completion of the drilling of the relevant new wells and is expected to take a cumulative duration of approximately 240 days.

Activities will be 24 hours per day, seven days per week and timing and duration of these activities is subject to change due to project schedule requirements, drill rig and vessel availability, weather and unforeseen circumstances.

Project vessels

Woodside is currently considering rig options for the drilling of the four wells, which include a moored semi-submersible mobile offshore drilling unit (MODU), a dynamically positioned drill ship or a dynamically positioned MODU. Dynamic positioning is a computer-controlled system to automatically maintain a vessel or rig's position and heading by using its own propellers and thrusters.

Typically, two or three vessels will support drilling activities, with at least one vessel in the vicinity to complete standby duties, if required. Supply vessels from Dampier Port will visit the selected MODU/drill ship at regular intervals.

A primary installation vessel will be used for the installation of the subsea infrastructure, with support from additional dedicated vessels.

Communications with mariners

A petroleum safety zone of 500 m will be in place around the MODU and installation vessel for the duration of activities. The following Operational Areas will also apply:

+ Dynamically positioned MODU/drillship – 500 m radius from each well centre
+ Moored MODU – 4000 m radius from each well centre
+ Installation vessel – 1500 m radius around subsea locations

Marine notices will be issued prior to activity commencement to alert vessels which maybe operating in waters nearby.

Proposed locations

Approximate development well locations are provided in Table 1. The exact location of XNA02 and XNA03 production wells are to be determined and approximate locations are provided in Table 1. Relevant stakeholders will be advised of these locations once planning is finalised.

Table 1. Approximate well location details

Activity	Water Depth	Latitude	Longitude	Production Licence
PYA01 well	985 m	19°49'40.371" S	115°10'34.956" E	WA-34-L
PL-PYA02 well	862 m	19°52'34.908" S	115°09'00.666" E	WA-34-L
XNA02 well	178 m	19°57'50.131" S	115°13'3.498" E	WA-34-L
XNA03 well	189 m	19°57'48.055" S	115°12'28.440" E	WA-34-L

Implications for Stakeholders

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 in the activities 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 drilling, construction and installation activities.

A number of mitigation and management measures will be implemented and are summarised in Table 2. Further details will be provided in the Environment Plan.

Table 2. Summary of key risks and/or impacts and management measures.

Potential Risk and/or Impact	Mitigation and/or Management Measure
Planned	
Chemical use	+ Chemical use will be managed in accordance with Woodside and contractor chemical selection and approval procedures.
Interests of relevant stakeholders with respect to: + Defence activities + Petroleum activities + Commercial fishing activities + Shipping activities	+ Consultation with relevant 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 Environment Plan. + Advice to relevant stakeholders prior to the commencement of activities.
Marine fauna interactions	+ Measures will be taken to protect marine fauna and ecosystems from vessel activities and to prevent vessel collisions and groundings.
Marine discharges	+ All routine marine discharges will be managed according to legislative and regulatory requirements and Woodside's Environmental Performance Standards where applicable.
Seabed disturbance	+ Well location and site appraisal to identify and address well-specific hazards and drilling constraints. + MODU mooring analysis, anchor deployment and suction piling, if required, in accordance with internal standards. + No anchoring of support and installation vessels during drilling, construction and installation activities, as well as logging/ retrieval of wet-stored items.
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 500 m radius petroleum safety zone will be in place around the MODU or drill ship and installation vessel for the duration of activities + Commercial fishers and other marine users are permitted to use but should take care when entering the Operational Area around the MODU or drill ship. The Operational Area depending on the activity and vessel ranging from a 500 m radius for a dynamically positioned MODU or 4000 m radius for a moored MODU, and a 1500 m radius around subsea installation.
Waste generation	+ 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	
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.

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.

An Environment Plan for the proposed activity 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).

If you would like to comment on the proposed activities outlined in this information sheet, or would like additional information, please contact Woodside before 15 May 2019.

Andrew Winter
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.

www.woodside.com.au

Woodside

Consultation with specific stakeholders

Woodside sent the following emails, consultation Information Sheet, activity maps and other information relevant to specific stakeholder interests.

Email to WAFIC and DPIRD – 15 April 2019

Dear [redacted]

Woodside is planning to undertake drilling, construction, installation and pre-commissioning activities in Production Licence WA-34-L in Commonwealth waters, commencing in Q1 2020 pending approvals, vessel availability and weather constraints.

We have identified and assessed potential risks and impacts to active commercial fishers, fishing activity, the commercial fishing resource and the marine environment in the development of the proposed Environment Plan for this activity. These risks are summarised below.

Woodside has endeavoured to reduce these risks to as low as reasonably practical (ALARP) level. Please contact me if you believe we have overlooked any potential impacts to the commercial fishing industry or missed any points of importance.

An information sheet (also available on our website) and maps of State Fisheries relevant to the proposed activities are also attached.

Activity overview

Activity purpose:	Support ongoing production from the Pluto LNG Project.		
Activity:	• Drilling two new and two in-fill production wells and installation of subsea structures. • If required, Woodside may also need to intervene, workover or re-drill existing Pluto and Xena production wells within Production Licence WA-34-L.		
Activity location:	175 km North West of Dampier, Western Australia.		
State fisheries identified as relevant to the proposed activity*:	• Pearl Oyster Managed Fishery • Pilbara Demersal Scalefish Managed Fisheries - Pilbara Trap - Pilbara Line • Mackerel Managed Fishery – Pilbara (Area 2)		
Approximate well locations:**	PYA01 well	19°49’40.371” S	115°10’34.956” E
	PL-PYA02 well	19°52’34.908” S	115°09’00.666” E
	XNA02 well	19°57’50.131” S	115°13’3.498” E
	XNA03 well	19°57’48.055” S	115°12’28.440” E
Approximate Water depth:	178 m to 985 m		
Estimated Start date:	From Q1 2020		

Approximate Duration:	• Production wells – up to 70 days per well • Installation of subsea infrastructure and pre-commissioning – cumulative duration of approximately 240 days
Vessel/rig:	• Moored semi-submersible mobile offshore drilling unit (MODU), a dynamically positioned drill ship or a dynamically positioned MODU • Subsea Installation vessel • Light well intervention vessel • Support vessels, including anchor handling vessels, heavy lift vessels and activity support vessels
Exclusion Zone:	• Petroleum safety zones of 500 m will be in place around the MODU and installation vessel for the duration of activities • Commercial fishers are permitted to use, but should take care, when entering the wider Operational Areas, these being: - Dynamically positioned MODU/drillship – 500 m radius from each well centre - Moored MODU – 4000 m radius from each well centre - Installation vessel – 1500 m radius around subsea locations

* Fisheries have been identified as being relevant on the basis of fishing licence overlap with the proposed activity area, as well as consideration of fishing effort data, fishing methods and water depth. Individual licence holders or representative fishing organisations who have requested ongoing advice on Woodside's planned activities will also be advised.

** The exact location of XNA02 and XNA03 production wells are to be determined and remain subject to change. Relevant stakeholders will be advised of these locations once planning is finalised.

Potential risks to commercial fishing

Potential risk	Risk description	Mitigation and/or management measures
Planned Activities		
Vessel interaction	The presence of the MODU, subsea installation vessel, intervention vessel and other support vessels may preclude other marine users from access to the area.	• 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.
Seabed disturbance	Disturbance to the seabed from mooring of the MODU, drilling and subsea installation of infrastructure.	Woodside will seek to minimise seabed disturbance for the drilling and installation activities, including: • Well location and site appraisal to identify and address well-specific hazards and drilling constraints. • MODU mooring analysis and anchor deployment in accordance with internal standards. • No anchoring of support and installation vessels during drilling, construction and installation

		activities, as well as logging/retrieval of wet-stored items.
Underwater noise	Noise will be generated by the MODU, subsea installation vessel, intervention vessel and other support vessels. Due to the low acoustic source levels associated with MODU and vessel operations there is not likely to be any interaction or potential impact to fish hearing, feeding or spawning.	• Acoustic impacts to marine fauna from the operation of MODU and vessels are considered not significant with no lasting effect. Therefore, the risks associated with implementation of additional management measures is considered disproportionate to the potential reduction in impact achieved.
Marine discharges	Discharges from drilling include water-based drill mud and cuttings, brines and cement. Discharges from the operation of the MODU include sewage, grey water, cooling water, desalination brine, deck drainage, ballast and bilge water These discharges may result in a localised short-term reduction in water quality however they will be rapidly diluted and dispersed in the water column.	• Implementation of chemical assessment and approval process.
Unplanned Risks		
Hydrocarbon release	Loss of hydrocarbons to the marine environment via loss of well control or from a vessel collision resulting a tank rupture.	• In the unlikely event of an oil spill or unplanned discharge into the environment, relevant agencies and organisations will be notified as appropriate to the nature and scale of the event, as soon as practicable following the occurrence. • Oil spill response strategies will be assessed based on potential impact to identified key receptor locations and sensitivities, which includes fish spawning and nursery areas.
Invasive Marine Species	Introduction or translocation and establishment of invasive marine species to the area via vessels ballast water or biofouling.	• All vessels will be assessed and managed as appropriate to prevent the introduction of invasive marine species. • Compliance with Australian biosecurity requirements and guidance.

Your feedback
Your feedback on the proposed activity and our response will be included in an Environment Plan for consideration by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA), as is required under the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

Please note under new public transparency arrangements being implemented by NOPSEMA, the Environment Plan for this activity will be published in full following acceptance by the Authority. Please advise Woodside if you do not wish any part of your feedback to be published and we will ensure it is included in the sensitive information part of the Environment Plan. The information received will form part of the EP assessment however it will not be released publicly and will remain confidential to NOPSEMA throughout.

Please provide your views by close of business **15 May 2019** to allow us sufficient time to inform our planning for the proposed activity. Comments can be made by email, letter or by phone.

Regards

[redacted]
Corporate Affairs Adviser | Corporate Affairs
Woodside Energy Ltd

Letter to relevant State fishery licence holders – 15 April 2019

Woodside

Woodside Energy Ltd.
ACN 005 482 986
Mia Yellagonga
11 Mount Street
Perth WA 6000
Australia
T +61 8 9348 4000
F +61 8 9214 2777
www.woodside.com.au

Please direct all responses/queries to:
[redacted]

14 April 2019

Dear Licence Holder

CONSULTATION INFORMATION – PYXIS DRILLING AND SUBSEA INSTALLATION

Woodside is planning to undertake drilling, construction, installation and pre-commissioning activities in Production Licence WA-34-L in Commonwealth waters, commencing in Q1 2020 pending approvals, vessel availability and weather constraints.

We have identified and assessed potential risks and impacts to active commercial fishers, fishing activity, the commercial fishing resource and the marine environment in the development of the proposed Environment Plan for this activity. These risks are summarised in Appendix 1.

Woodside has endeavoured to reduce these risks to as low as reasonably practical (ALARP) level. Please contact the undersigned if you believe we have overlooked any potential impacts to the commercial fishing industry or missed any points of importance.

Details of the proposed activity

Purpose:	Support ongoing production from the Pluto LNG Project.		
Activity:	Drilling two new and two in-fill production wells and installation of subsea structures. If required, Woodside may also need to intervene, workover or re-drill existing Pluto and Xena production wells within Production Licence WA-34-L.		
Location:	175 km North West of Dampier, Western Australia		
Well locations:	PYA01 well	19°49'40.371" S	115°10'34.956" E
	PL-PYA02 well	19°52'34.908" S	115°09'00.666" E
	XNA02 well	19°57'50.131" S	115°13'3.498" E
	XNA03 well	19°57'48.055" S	115°12'28.440" E
	The exact location of XNA02 and XNA03 production wells are to be determined and remain subject to change. Relevant stakeholders will be advised of these locations once planning is finalised.		
Water depth:	178 m to 985 m		
Start date:	From Q1 2020		
Duration:	Production wells – up to 70 days per well		
	Installation of subsea infrastructure and pre-commissioning – cumulative duration of approximately 240 days		

Vessel/Rig:	Moored semi-submersible mobile offshore drilling unit (MODU), a dynamically positioned drill ship or a dynamically positioned MODU Subsea Installation vessel Light well intervention vessel Support vessels, including anchor handling vessels, heavy lift vessels and activity support vessels
Exclusion zone:	Petroleum safety zones of 500 m will be in place around the MODU and installation vessel for the duration of activities Commercial fishers are permitted to use, but should take care, when entering the wider Operational Areas, these being: • Dynamically positioned MODU/drillship – 500 m radius from each well centre • Moored MODU – 4000 m radius from each well centre • Installation vessel – 1500 m radius around subsea locations

Your feedback

Your feedback on the proposed activity and our response will be included in an Environment Plan for consideration by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA), as is required under the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009 (Cth).

Please note under new public transparency arrangements being implemented by NOPSEMA, the Environment Plan for this activity will be published in full following acceptance by the Authority. Please advise Woodside if you do not wish any part of your feedback to be published and we will ensure it is included in the sensitive information part of the Environment Plan. The information received will form part of the EP assessment however it will not be released publicly and will remain confidential to NOPSEMA throughout.

Please provide your views by close of business 15 May 2019 to allow us sufficient time to inform our planning for the proposed activity. Comments can be made by email, letter or by phone.

Kind Regards

[redacted]

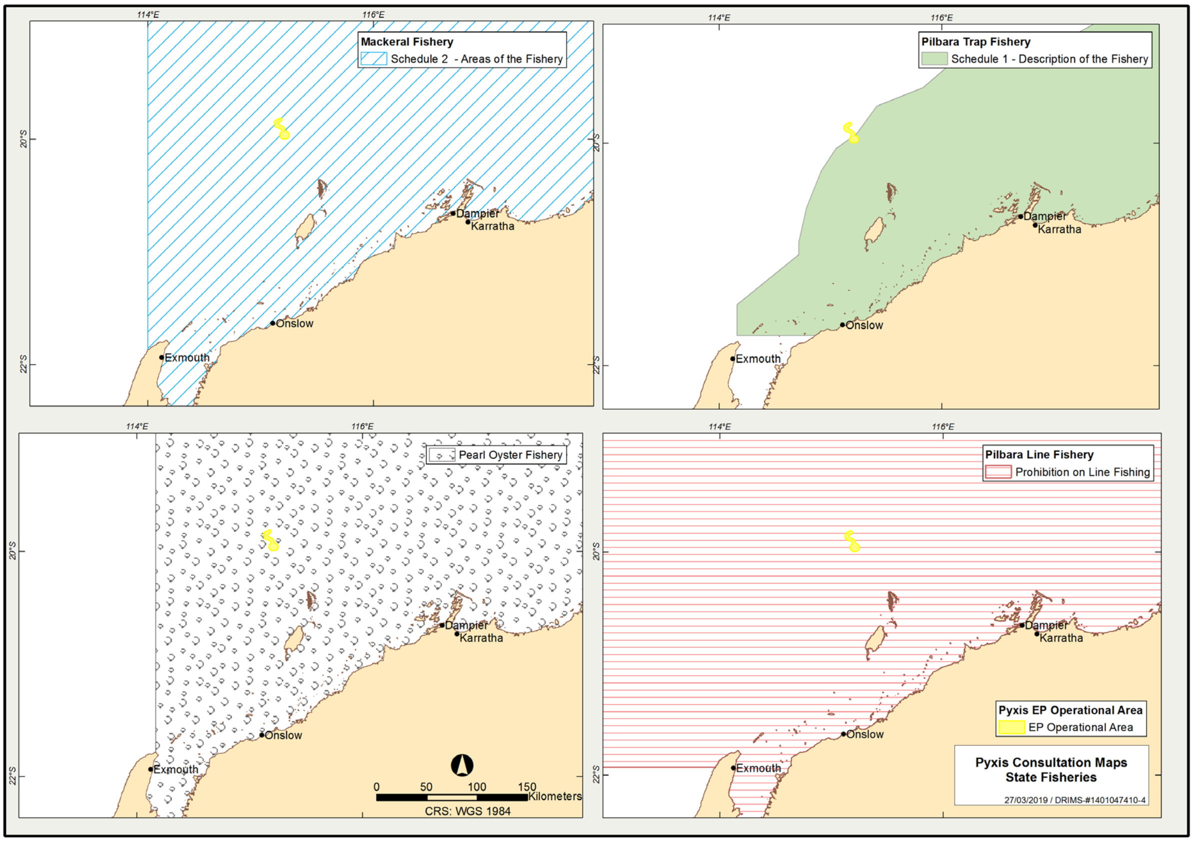
Corporate Affairs Adviser

Potential risks to commercial fishing

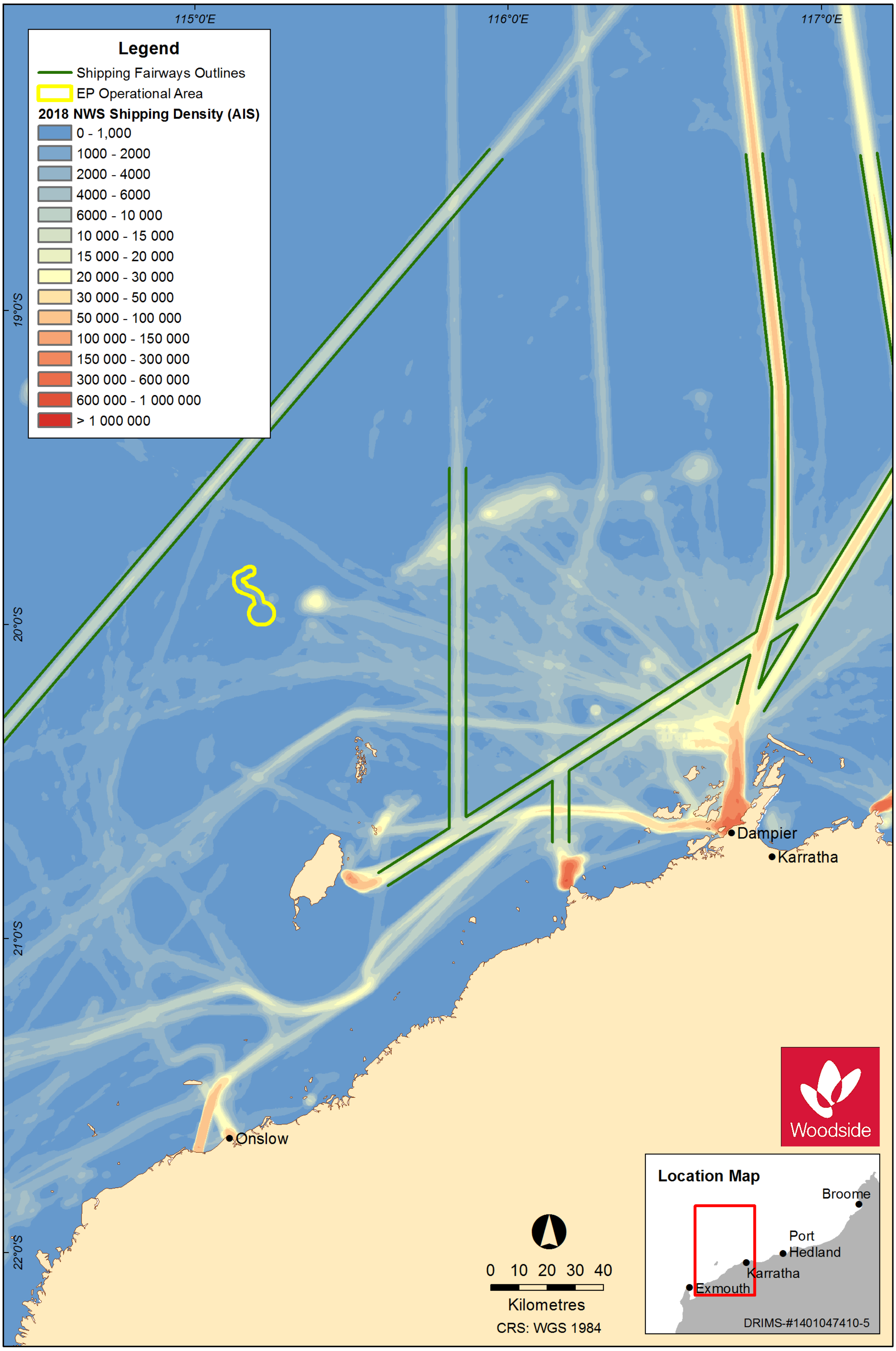
Potential risk	Risk description	Mitigation and/or management measures
Planned Activities		
Vessel interaction	The presence of the MODU, subsea installation vessel, intervention vessel and other support vessels may preclude other marine users from access to the area.	• Woodside will notify relevant fishery 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.
Seabed disturbance	Disturbance to the seabed from mooring of the MODU, drilling and subsea installation of infrastructure.	Woodside will seek to minimise seabed disturbance for the drilling and installation activities, including: • Well location and site appraisal to identify and address well-specific hazards and drilling constraints. • MODU mooring analysis and anchor deployment in accordance with internal standards. • No anchoring of support and installation vessels during drilling, construction and installation activities, as well as logging/retrieval of wet-stored items.
Underwater noise	Noise will be generated by the MODU, subsea installation vessel, intervention vessel and other support vessels. Due to the low acoustic source levels associated with MODU and vessel operations there is not likely to be any interaction or potential impact to fish hearing, feeding or spawning.	• Acoustic impacts to marine fauna from the operation of MODU and vessels are considered not significant with no lasting effect. Therefore, the risks associated with implementation of additional management measures is considered disproportionate to the potential reduction in impact achieved.
Marine discharges	Discharges from drilling include water-based drill mud and cuttings, brines and cement. Discharges from the operation of the MODU include sewage, grey water, cooling water, desalination brine, deck drainage, ballast and bilge water These discharges may result in a localised short-term reduction in water quality however they will be rapidly diluted and dispersed in the water column.	• Implementation of chemical assessment and approval process.

Unplanned Risks		
Hydrocarbon release	Loss of hydrocarbons to the marine environment via loss of well control or from a vessel collision resulting a tank rupture.	• In the unlikely event of an oil spill or unplanned discharge into the environment, relevant agencies and organisations will be notified as appropriate to the nature and scale of the event, as soon as practicable following the occurrence. • Oil spill response strategies will be assessed based on potential impact to identified key receptor locations and sensitivities, which includes fish spawning and nursery areas.
Invasive Marine Species	Introduction or translocation and establishment of invasive marine species to the area via vessels ballast water or biofouling.	• All vessels will be assessed and managed as appropriate to prevent the introduction of invasive marine species. • Compliance with Australian biosecurity requirements and guidance.

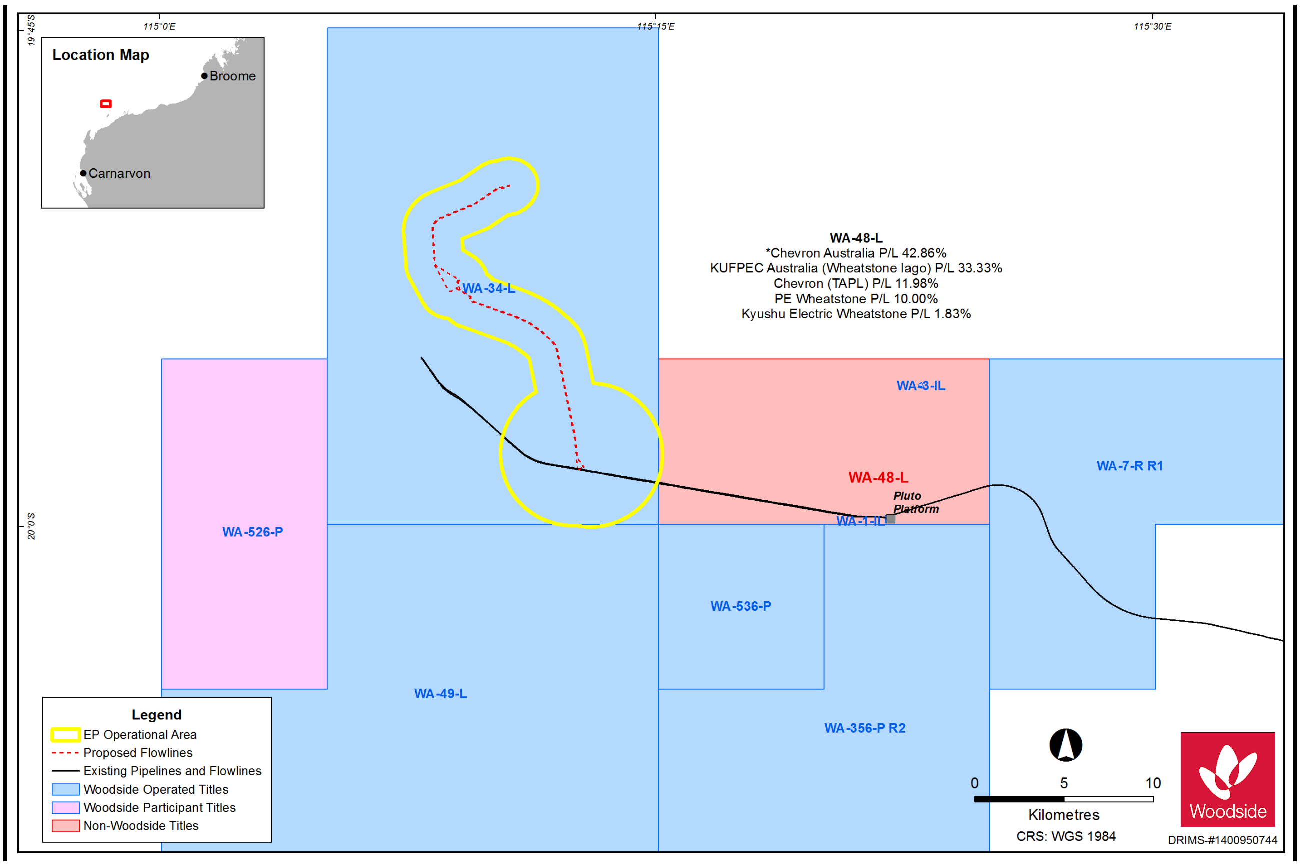
State Fishery map provided to DPIRD, WAFIC, PPA, Recfishwest and fishing licence holders – 15 April 2019



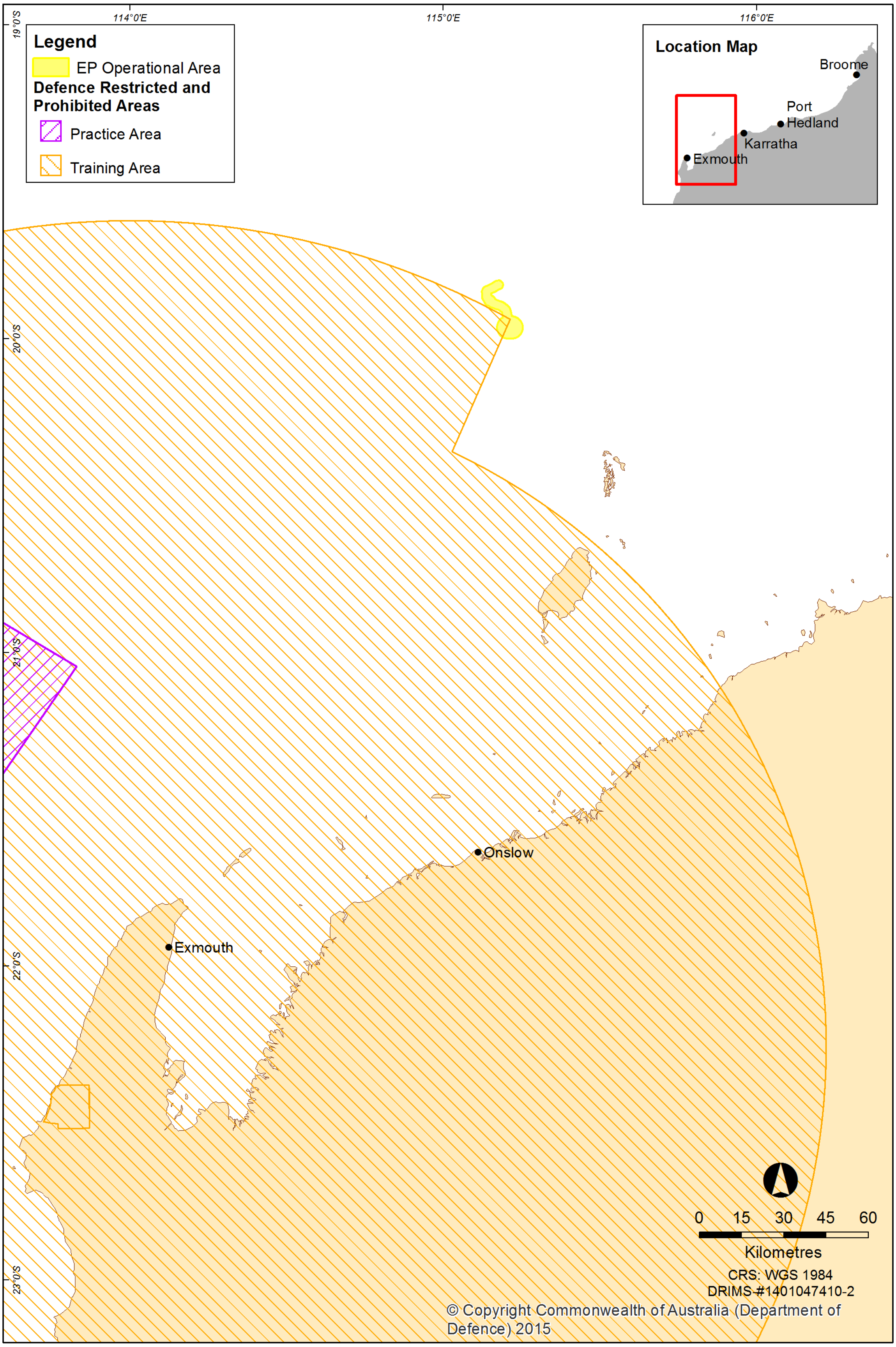
Shipping lane map provided to AMSA and AHO – 15 April 2019



Titleholders map provided to Chevron – 15 April 2019



Defence area map provided to DoD – 15 April 2019



Email to DNP – 13 June 2019

Dear Director of National Parks

Woodside is planning to undertake drilling, construction, installation and pre-commissioning activities in Production Licence WA-34-L in Commonwealth waters to support ongoing production from the Pluto LNG Project. Activities are planned from Q1 2020, pending approvals, vessel availability and weather constraints.

We note Australian Government Guidance on consultation activities with respect to the proposed activities and confirm that:

- The proposed activities are outside the boundaries of a proclaimed Commonwealth marine park, with the proposed activity being less than 2 km north west of Montebello Marine Park - Multiple Use Zone (Cwlth)).
- We have assessed potential risks to Commonwealth marine parks in the development of the proposed Environment Plan for this activity and believe that there are no credible risks as part of planned activities that have potential to impact marine park values.
- In the unlikely event of a loss of hydrocarbons, the worst case credible spill scenario assessed for this activity a loss of well integrity. For this consequence to occur, there must be a failure of multiple physical and procedural barriers within the well relevant to the activity. Given the controls in place to prevent and control loss of well control events and mitigate their consequences, it is considered that the risk associated with a loss of well integrity is managed to as low as reasonably practical. In the unlikely event of a loss of well integrity there is a risk of condensate entering the Montebello Marine Park - Multiple Use Zone.

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 parks.

For information, 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

[redacted]
Corporate Affairs Adviser | Corporate Affairs
Woodside Energy Ltd

Email to AHO – 26 July 2019

Dear AHO

Woodside is planning to undertake drilling, construction, installation and pre-commissioning activities in Production Licence WA-34-L in Commonwealth waters, commencing in Q1 2020 pending approvals, vessel availability and weather constraints.

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.

A shipping densities map if also attached for your reference.

Activity overview

Activity purpose:	Support ongoing production from the Pluto LNG Project.		
Activity:	· Drilling two new and two in-fill production wells and installation of subsea structures. · If required, Woodside may also need to intervene, workover or re-drill existing Pluto and Xena production wells within Production Licence WA-34-L.		
Activity location:	175 km North West of Dampier, Western Australia.		
Well locations*:	PYA01 well	19°49'40.371" S	115°10'34.956" E
	PL-PYA02 well	19°52'34.908" S	115°09'00.666" E
	XNA02 well	19°57'50.131" S	115°13'3.498" E
	XNA03 well	19°57'48.055" S	115°12'28.440" E
Approximate water depth:	178 m to 985 m		
Estimated start date:	From Q1 2020		
Approximate duration:	· Production wells – up to 70 days per well · Installation of subsea infrastructure and pre-commissioning – cumulative duration of approximately 240 days		
Vessel/rig:	· Moored semi-submersible mobile offshore drilling unit (MODU), a dynamically positioned drill ship or a dynamically positioned MODU · Subsea Installation vessel · Light well intervention vessel · Support vessels, including anchor handling vessels, heavy lift vessels and activity support vessels		
Exclusion zone:	· Petroleum safety zones of 500 m will be in place around the MODU and installation vessel for the duration of activities · Commercial fishers are permitted to use but should take care, when entering the wider Operational Areas, these being: • Dynamically positioned MODU/drillship – 500 m radius from each well centre • Moored MODU – 4000 m radius from each well centre · Installation vessel – 1500 m radius around subsea locations		

* The exact location of XNA02 and XNA03 production wells are to be determined and remain subject to change. Relevant stakeholders will be advised of these locations once planning is finalised.

Your feedback
Your feedback on the proposed activity and our response will be included in an Environment Plan for consideration by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA), as is required under the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

Please note under public transparency arrangements implemented by NOPSEMA, the Environment Plan for this activity will be published in full following acceptance by the Authority. Please advise Woodside if you do not wish any part of your feedback to be published and we will ensure it is included in the sensitive information part of the Environment Plan. The information received will form part of the EP assessment however it will not be released publicly and will remain confidential to NOPSEMA throughout.

Please provide your views by close business **16 August 2019** to allow us sufficient time to inform our planning for the proposed activity. Comments can be made by email, letter or by phone.

Regards
[redacted]
Corporate Affairs Adviser | Operations

Follow Up Email to DNP – 23 August 2019

Dear Director of National Parks

I'm following up on my email of 13 June regarding the information provided as part of the Pyxis Drilling and Subsea Installation Environment Plan.

Should you require further information or would like to discuss, please let me know.

Regards

[redacted]
Senior Corporate Affairs Adviser | Operations
Woodside Energy Ltd

Email to DAWR – 13 June 2019

Dear Department of Agriculture and Water Resources

Woodside is planning to undertake drilling, construction, installation and pre-commissioning activities in Production Licence WA-34-L in Commonwealth waters, commencing in Q1 2020 pending approvals, vessel availability and weather constraints.

Whilst four Commonwealth Fisheries overlap the proposed activity operational area (see attached map), it is our assessment that interaction with licence holders in Commonwealth Fisheries is unlikely, as historic fishing effort has taken place well beyond the operational area.

With respect to the DAWR's interest in biosecurity matters, we provide the attached consultation Information Sheet, which provides background on the proposed activity, including a summary of potential key risk and associated management measures for planned, as well as unplanned activities including invasive marine species. The Information Sheet is also available on our website.

A summary of these activities is outlined below.

Activity overview

Activity purpose:	Support ongoing production from the Pluto LNG Project.		
Activity:	• Drilling two new and two in-fill production wells and installation of subsea structures. • If required, Woodside may also need to intervene, workover or re-drill existing Pluto and Xena production wells within Production Licence WA-34-L.		
Activity location:	175 km North West of Dampier, Western Australia.		
Well locations*:	PYA01 well	19°49’40.371” S	115°10’34.956” E
	PL-PYA02 well	19°52’34.908” S	115°09’00.666” E
	XNA02 well	19°57’50.131” S	115°13’3.498” E
	XNA03 well	19°57’48.055” S	115°12’28.440” E
Approximate Water depth:	178 m to 985 m		
Estimated Start date:	From Q1 2020		
Approximate Duration:	• Production wells – up to 70 days per well • Installation of subsea infrastructure and pre-commissioning – cumulative duration of approximately 240 days		
Vessel/rig:	• Moored semi-submersible mobile offshore drilling unit (MODU), a dynamically positioned drill ship or a dynamically positioned MODU • Subsea Installation vessel • Light well intervention vessel • Support vessels, including anchor handling vessels, heavy lift vessels and activity support vessels		
Exclusion Zone:	• Petroleum safety zones of 500 m will be in place around the MODU and installation vessel for the duration of activities • Commercial fishers are permitted to use but should take care, when entering the wider Operational Areas, these being: - Dynamically positioned MODU/drillship – 500 m radius from each well centre - Moored MODU – 4000 m radius from each well centre - Installation vessel – 1500 m radius around subsea locations		

* The exact location of XNA02 and XNA03 production wells are to be determined and remain subject to change. Relevant stakeholders will be advised of these locations once planning is finalised.

Your feedback

Your feedback on the proposed activity and our response will be included in an Environment Plan for consideration by the National Offshore Petroleum Safety and Environmental Management

Authority (NOPSEMA), as is required under the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

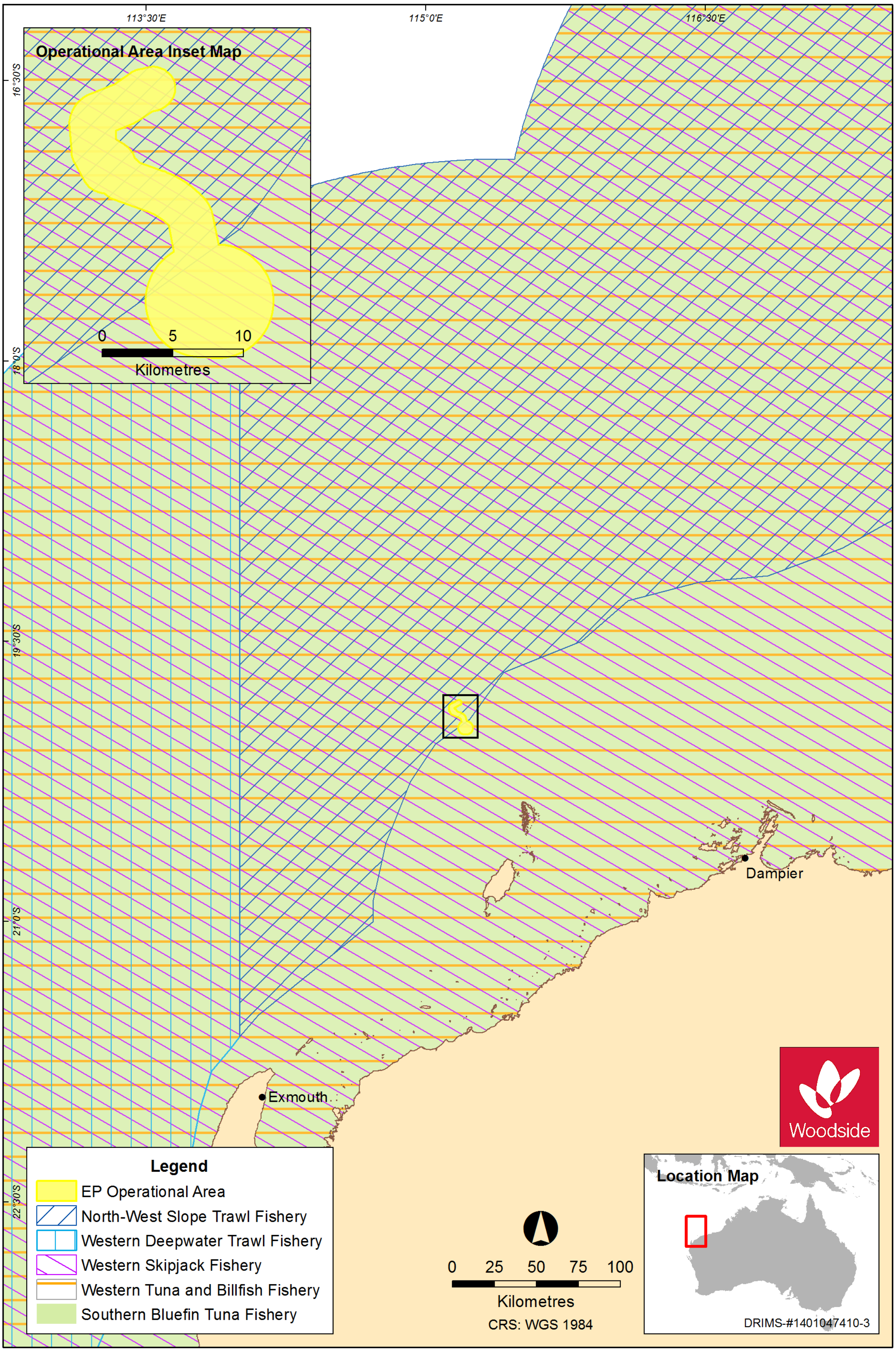
Please note under new public transparency arrangements being implemented by NOPSEMA, the Environment Plan for this activity will be published in full following acceptance by the Authority. Please advise Woodside if you do not wish any part of your feedback to be published and we will ensure it is included in the sensitive information part of the Environment Plan. The information received will form part of the EP assessment however it will not be released publicly and will remain confidential to NOPSEMA throughout.

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

[redacted]
Corporate Affairs Adviser | Corporate Affairs
Woodside Energy Ltd

Commonwealth Fishery map provided to DAWR – 13 June 2019



Email to AFMA, Commonwealth Fishery Association and relevant Commonwealth Licence Holders – 23 August 2019

Dear AFMA

Woodside is planning to undertake drilling, construction, installation and pre-commissioning activities in Production Licence WA-34-L in Commonwealth waters, commencing in Q1 2020 pending approvals, vessel availability and weather constraints.

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.

A map of Commonwealth Fisheries relevant to the proposed activities is also attached.

Activity overview

Activity purpose:	Support ongoing production from the Pluto LNG Project.		
Activity:	• Drilling two new and two in-fill production wells and installation of subsea structures. • If required, Woodside may also need to intervene, workover or re-drill existing Pluto and Xena production wells within Production Licence WA-34-L.		
Activity location:	175 km North West of Dampier, Western Australia.		
Well locations*:	PYA01 well	19°49’40.371” S	115°10’34.956” E
	PL-PYA02 well	19°52’34.908” S	115°09’00.666” E
	XNA02 well	19°57’50.131” S	115°13’3.498” E
	XNA03 well	19°57’48.055” S	115°12’28.440” E
Approximate Water depth:	178 m to 985 m		
Commonwealth fisheries identified as relevant to the proposed activity:**	• North West Slope and Trawl Fishery • Western Tuna and Billfish Fishery		
Estimated Start date:	From Q1 2020		
Approximate Duration:	• Production wells – up to 70 days per well • Installation of subsea infrastructure and pre-commissioning – cumulative duration of approximately 240 days		
Vessel/rig:	• Moored semi-submersible mobile offshore drilling unit (MODU), a dynamically positioned drill ship or a dynamically positioned MODU • Subsea Installation vessel • Light well intervention vessel • Support vessels, including anchor handling vessels, heavy lift vessels and activity support vessels		
Exclusion Zone:	• Petroleum safety zones of 500 m will be in place around the MODU and installation vessel for the duration of activities		

	• Commercial fishers are permitted to use but should take care, when entering the wider Operational Areas, these being: - Dynamically positioned MODU/drillship – 500 m radius from each well centre - Moored MODU – 4000 m radius from each well centre • Installation vessel – 1500 m radius around subsea locations

* The exact location of XNA02 and XNA03 production wells are to be determined and remain subject to change. Relevant stakeholders will be advised of these locations once planning is finalised.

** Fisheries have been identified as being relevant on the basis of fishing licence overlap with the proposed activity area, as well as conversations with AFMA.

Your feedback
Your feedback on the proposed activity and our response will be included in an Environment Plan for consideration by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA), as is required under the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth).

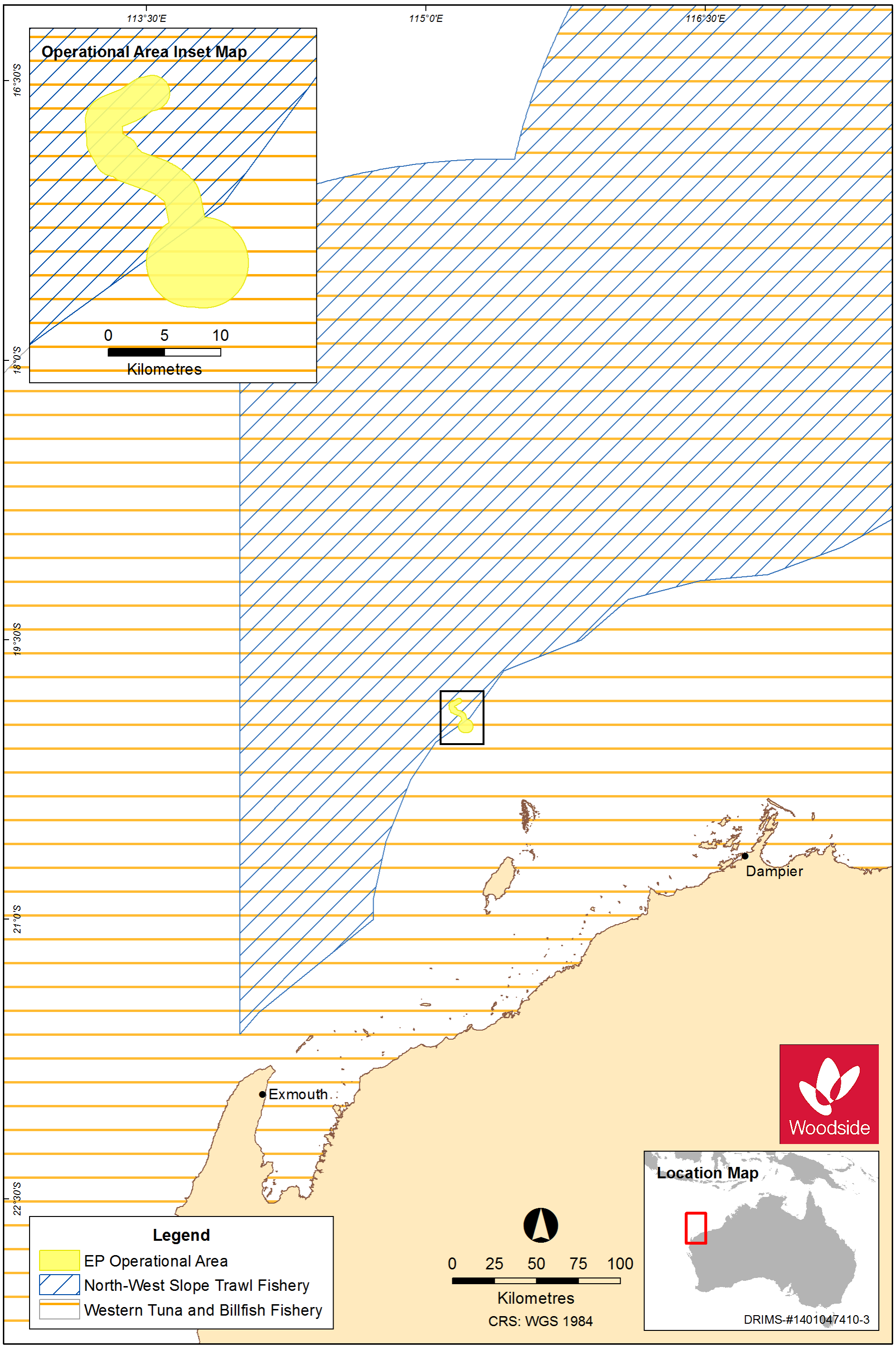
Please note under public transparency arrangements being implemented by NOPSEMA, the Environment Plan for this activity will be published in full following acceptance by the Authority. Please advise Woodside if you do not wish any part of your feedback to be published and we will ensure it is included in the sensitive information part of the Environment Plan. The information received will form part of the EP assessment however it will not be released publicly and will remain confidential to NOPSEMA throughout.

Please provide your views by close of business **17 September 2019** to allow us sufficient time to inform our planning for the proposed activity. Comments can be made by email, letter or by phone.

Regards

[redacted]
Senior Corporate Affairs Adviser | Operations
Woodside Energy Ltd

Commonwealth Fisheries Map provided to AFMA, Commonwealth Fisheries Association and relevant Commonwealth Licence Holders – 23 August 2019



Oil Pollution Consultation

Woodside sent the emails below to stakeholders with responsibilities for oil pollution response in Commonwealth and State waters.

Email to DoT – 17 June 2019

Good Afternoon [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 *WA-34-L Pyxis*

Drilling and Subsea Installation 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 attached, providing information on the proposed petroleum activities program, located about 175 km north-west of Dampier and form part of the field development to support ongoing production from the Pluto LNG Project. The Information Sheet is available on our website here.
- The *WA-34-L Pyxis Drilling and Subsea Installation Oil Pollution Emergency 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*(September 2018) and from recent engagement activities between DoT-Woodside, responses to the information requirements in a succinct summary and source of information.

Woodside propose to submit an EP 12 July 2019 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 5 July 2019 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.

[redacted]

Information Requested in the Offshore Petroleum Industry Guidance Note (September 2018)	Information Provided	References
Description of activity, including the intended schedule, location (including coordinates), distance to nearest landfall and map.	Woodside Burrup Pty Ltd (Woodside), on behalf of its Pluto LNG joint venture partners, and as Titleholder under the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth) (referred to as the Environment Regulations), proposes to undertake the following activities within Permit Area WA-34-L:	Included in the consultation information sheet attached and available Woodside's website.

	• drilling and development of two Pyxis production wells and subsea pipeline installation. • drilling and development of two Xena infill production wells. • contingent workover activities for Pyxis, Xena and Pluto wells. The Petroleum Activities Program is planned to commence in 2020 with the drilling of the Pyxisproduction wells and related subsea installation. Drilling operations for the four production wells are expected to take approximately 70 days per well to complete, including mobilization, demobilisation and contingency. Installation of subsea infrastructure and pre-commissioning will commence upon completion of drilling of the relevant new wells, and is expected to have a cumulative duration ofapproximately 240 days (including mobilisation, demobilisation and contingency). Additional information on the activity, timings, location (including coordinates) and planned and unplanned activities is included in the consultation information sheet.	
Worst case spill volumes.	· Well loss of containment of 147,755 m^3 over 67 days · Loss of Maine Diesel from vessel collision of 1000 m^3.	*WA-34-L Pyxis Drilling and Subsea Installation Oil Pollution First Strike Plan* (Appendix A) page 22.
Known or indicative oil type/properties.	· Well loss of containment – Pyxis Condensate API 41 · Loss of Maine Diesel from vessel collision - Diesel Fuel Oil (Southern USA 1) API of 37.2.	*WA-34-L Pyxis Drilling and Subsea Installation Oil Pollution First Strike Plan* (Appendix A) page 22.
Amenability of oil to dispersants and window of opportunity for dispersant efficacy.	Dispersant use has been assessed as not feasible for the WA-34-L Pyxis and Subsea Installation activity for the following reasons: Modelling results for a hydrocarbon release caused by a well loss of containment from pyxis condensate indicate that surface thresholds required for surface dispersant application are limited to within 1 km of the release location. Additionally, no shoreline accumulation above threshold 100 g/m^2 are expected. Therefore, surface application of dispersant is unlikely to be effective in preventing isolated incidents of accumulation. Furthermore, the ongoing nature of the release combined with the potential for the plume to breach the surface may cause conditions leading to high local concentrations of atmospheric volatiles producing a health and safety risk, thus limiting the ability of a surface dispersant response to safely target fresh pyxis condensate.	Refer Appendix D of the WA-34-L *Pyxis Drilling and Subsea Installation Environment Plan* (*Oil Spill Preparedness and Response Mitigation Assessment for WA-34-L Pyxis Drilling and Subsea Installation),* Section 2.2.2 (Spill Modelling Results).

	Dispersants is therefore considered ineffective, with no incremental benefit over natural weathering.	
Description of existing environment and protection priorities.	Contact from floating hydrocarbons above 10 g/m^2 concentration is not predicted for any shoreline receptor from the stochastic modelling. Additionally, accumulation >100 g/m^2 is not predicted on any shoreline receptor, with only minimal accumulation volumes below the 100 g/m^2 concentration (6 m^3). Consequently, no RPAs have been selected for response planning.	*WA-34-L Pyxis Drilling and Subsea Installation Oil Pollution First Strike Plan* (Section 4) outlines priority receptors and regional sensitive receptors in relation to the operational area. A comprehensive description of the existing environment is provided Section 4 of the *WA-34-L Pyxis Drilling and Subsea Installation Environment 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).	The credible spill scenarios have been identified and assessed for the WA-34-L Pyxis Drilling and Subsea Installation activity using Woodside's Oil Spill Preparedness and Response Mitigation Assessment (OPSRMA) template. The response planning process presented in the Woodside OSPRMA template is aligned with guidance provided by NOPSEMA in *Guideline N004750-GL1687*(2017) and the *Offshore Petroleum and Greenhouse Gas Storage Act and Regulations*, that compel titleholders to reduce risks and impacts to a level that is ALARP and Acceptable. The risk assessment considered the hydrocarbon type, volume, duration, predicted fate and weathering to inform the environment that may be affected (EMBA), time to impact on identified values and sensitivities, and predicted volumes ashore. Response strategy implementation uses this information to inform the feasibility and scaling of the response strategies. Three credible spill scenarios were assessed for oil pollution risks. Two scenarios relating to a loss of Marine Diesel via errant vessel collision and bunkering, and one scenario caused by a well loss of containment, resulting in a subsea and surface release of condensate. The maximum volume assessed for the diesel release was 1000 m^3 due to the diesel storage capacity of a support vessel having a maximum capacity of 1000 m^3. The maximum release for the condensate has been calculated at 147,755 m^3 of condensate over 67 days.	*Oil Spill Preparedness and Response Mitigation Assessment for WA-34-L Pyxis Drilling and Subsea Installation* (Section 2) Oil Spill Risk Assessment.
Outcomes of oil spill trajectory modelling, including predicted times to enter State	***Condensate:*** In general, approximately 11.4% of the Pyxis Condensate (surface) mass has the capacity to evaporate within the first 12 hours (BP <180 °C); a further 38.3% could evaporate within the	Refer Appendix D of the *WA-34-L Pyxis Drilling and Subsea Installation Environment Plan* (*Oil Spill Preparedness and Response Mitigation*

waters and contact shorelines.	first 24 hours (180 °C < BP < 265 °C); and a further 30.5% could evaporate over several days (265 °C < BP <380 °C, leaving a small proportion of hydrocarbon remaining on the surface after 48 hours. · Floating surface oil is expected to be present with surface concentrations of 50 g/m^2 up to 1 km from the well location, and 10g/m^2 up to 30 km from the well location for the WCCS subsea release. · Shoreline contact from floating hydrocarbons >10 g/m^2 is not expected. · The time to contact for oil at concentrations of entrained hydrocarbons greater than 500 ppb at shoreline receptors is 54 hours at Montebello MP. · Accumulation above 100 g/m^2 concentration is not expected. ***Diesel:*** In general, approximately 6% of the oil mass should 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 probability contour figures for floating oil indicate 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 up to 110 km, 60 km and 50 km from the spill site, respectively · Accumulation above 100 g/m^2 concentration is not expected · Shoreline contact from floating hydrocarbons >10 g/m^2 is not expected. · The time to contact for oil at concentrations of entrained hydrocarbons greater than 500 ppb at shoreline receptors is 280 hours at Ningaloo Coast North	*Assessment for WA-34-L Pyxis Drilling and Subsea Installation),* Section 2.2.2 (Spill Modelling Results).
Details on initial response actions and key activation timeframes.	Immediate notifications are provided in the First Strike Plan.	*WA-34-L Pyxis Drilling and Subsea Installation Oil Pollution First Strike Plan:* · Table 1-1 (Immediate Notifications)

		· Section 2 (Level 1 Response Summary) · Section 3 (Level 2/3 Response Summary).
Potential Incident Control Centre arrangements.	Included in First Strike Response Plan.	*WA-34-L Pyxis Drilling and Subsea Installation Oil Pollution First Strike Plan* Appendix E (Coordination Structure for a concurrent Hydrocarbon spill in Commonwealth and State Waters) and Appendix F (Woodside Incident Management Structure).
Potential staging areas / Forward Operating Base.	Due to no probability of shoreline contact above thresholds no staging areas are identified for this activity. Woodside has identified staging sites for immediate and sustained response operations in Dampier region.	N/A
Details on response strategies.	The response strategies and pre-identified tactics assessed as being suitable for the worst case credible scenarios include: · Operational Monitoring for both Diesel and Condensate: o Predictive Modelling of Hydrocarbons to Assess Resources at Risk (OM01), o Surveillance and reconnaissance to detect hydrocarbons and resources at risk (OM02) o Monitoring of hydrocarbon presence, properties, behaviour and weathering in water (OM03) o Pre-emptive Assessment of Sensitive Receptors (OM04), and; o Shoreline Assessment (OM05). · Oiled Wildlife Response · Possibly Capping stack · Scientific Monitoring · Well intervention · Relief well drilling · Capping Stack.	*WA-34-L Pyxis Drilling and Subsea Installation Oil Pollution First Strike Plan* Section 2 (Level 1 Response) and Section 3 (Level 2/3 Response).
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	*WA-34-L Pyxis Drilling and Subsea Installation Oil Pollution First Strike Plan* Appendix E (Coordination Structure for a concurrent Hydrocarbon spill in Commonwealth and State Waters) and Appendix F (Woodside Incident Management Structure).
Details on testing of arrangements of OPEP/OSCP.	1 x oil spill response themed level 1 drill to be conducted within two weeks of arriving on location. This drill should test elements of the	*WA-34-L Pyxis Drilling and Subsea Installation Environment Plan* Section 6.9.5 (Emergency

	recommended response identified in the WA-34-LPyxis Oil Pollution First Strike Plan in relation to the level of the incident. 1x crisis oil spill response focused exercise annually. **9.1.1.1 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 HSP 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	Spill Response Drills and Exercises).

	improvement. Improvement actions and their close-out are actively recorded and managed. This is over and above the emergency management exercises conducted.	

[redacted]
Hydrocarbon Spill Adviser | Security & Emergency Management
Woodside Energy Ltd

Email to AMSA – 18 June 2019

Good Afternoon [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 *WA-34-L Pyxis Drilling and Subsea Installation 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 attached, providing information on the proposed petroleum activities program, located about 175 km north-west of Dampier and form part of the field development to support ongoing production from the Pluto LNG Project. The Information Sheet is available on our website here.

- The *WA-34-L Pyxis Drilling and Subsea Installation Oil Pollution Emergency 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 12 July 2019 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 5 July 2019 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.

[redacted]

[redacted]
Hydrocarbon Spill Adviser | Security & Emergency Management
Woodside Energy Ltd

APPENDIX G: DEPARTMENT OF ABORIGINAL AFFAIRS HERITAGE INQUIRY SYSTEM RESULTS

Aboriginal Heritage Inquiry System

List of Other Heritage Places

Search Criteria

No Other Heritage Places in Coordinates - Area (ZoC.xlsx) - 114.5867217°E, 20.61849435°S (GDA94) : 114.4554409°E, 20.79743182°S (GDA94) : 114.4995009°E, 20.7929359°S (GDA94) : 114.6716945°E, 20.69987043°S (GDA94) : 114.860523°E, 20.64546984°S (GDA94) : 114.8056728°E, 20.75292224°S (GDA94) : 114.8420897°E, 20.77000673°S (GDA94) : 114.9383024°E, 20.61894394°S (GDA94) : 114.998098°E, 20.66615106°S (GDA94) : 115.0160817°E, 20.77720019°S (GDA94) : 115.002594°E, 20.9219687°S (GDA94) : 115.0246239°E, 20.93051094°S (GDA94) : 115.0480027°E, 20.85835148°S (GDA94) : 115.0700327°E, 20.81226834°S (GDA94) : 115.0875668°E, 20.76438683°S (GDA94) : 115.1305028°E, 20.6746933°S (GDA94) : 115.1590518°E, 20.7821457°S (GDA94) : 115.1693925°E, 20.79630784°S (GDA94) : 115.1864769°E, 20.79248631°S (GDA94) : 115.2087317°E, 20.76798356°S (GDA94) : 115.2190723°E, 20.73426419°S (GDA94) : 115.2137896°E, 20.54790846°S (GDA94) : 115.2104177°E, 20.50137572°S (GDA94) : 115.237618°E, 20.4651836°S (GDA94) : 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Coordinate Accuracy

Coordinates (Easting/Northing metres) are based on the GDA 94 Datum. Accuracy is shown as a code in brackets following the coordinates.

Basemap Copyright

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Aboriginal Heritage Inquiry System

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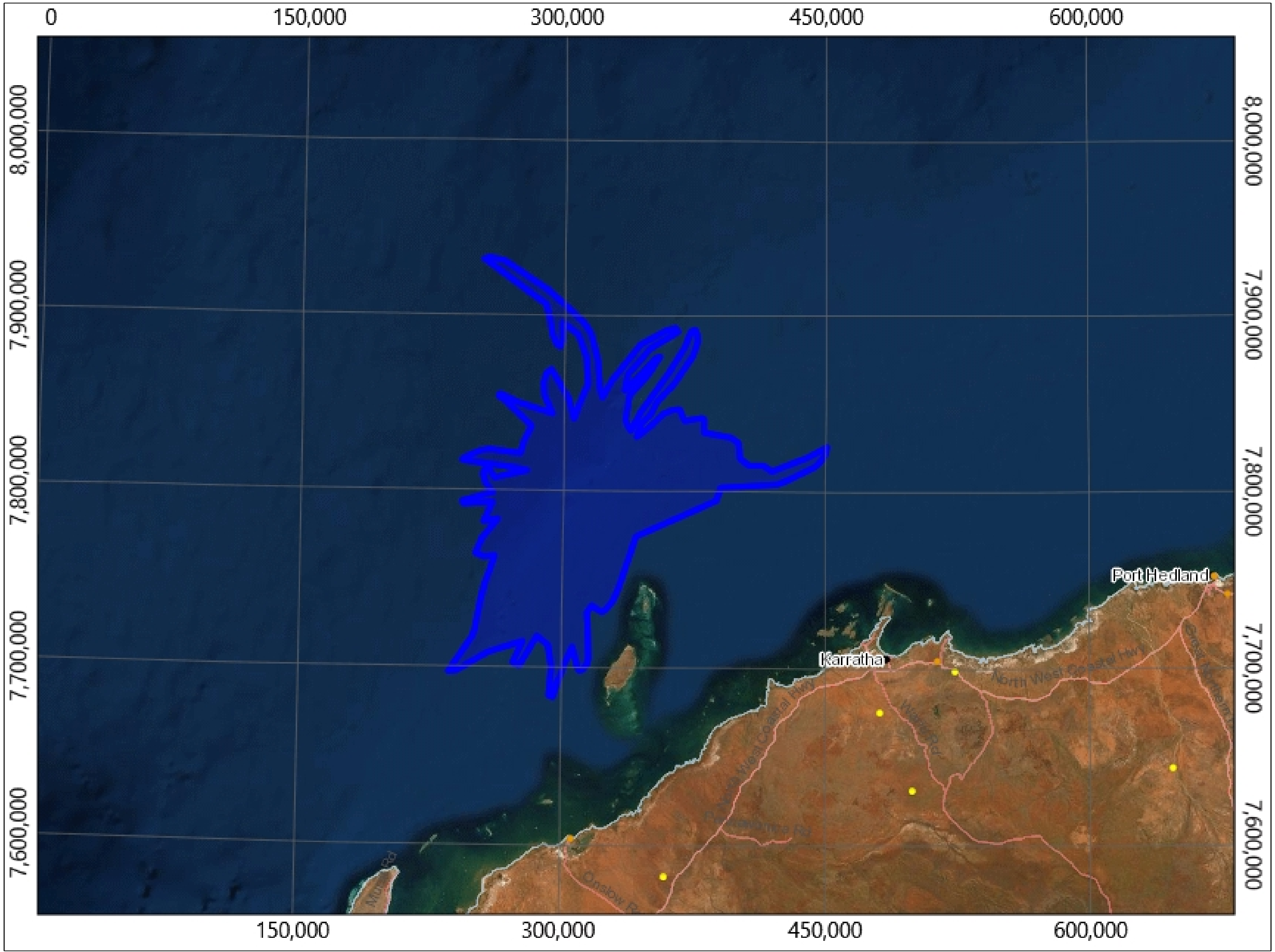


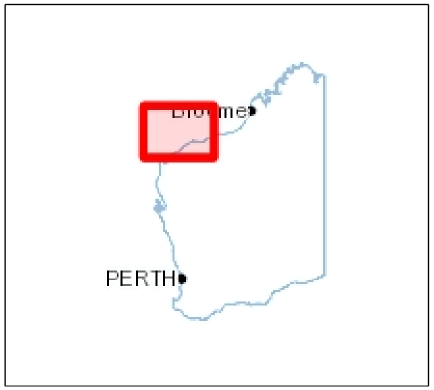
Legend

- Other Heritage Place
- Search Area
- Town
- Road
- River
- Local Government Authority

115.98 kilometres

Map Scale 1 : 3,510,000

MGA Zone 50 (GDA94)



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